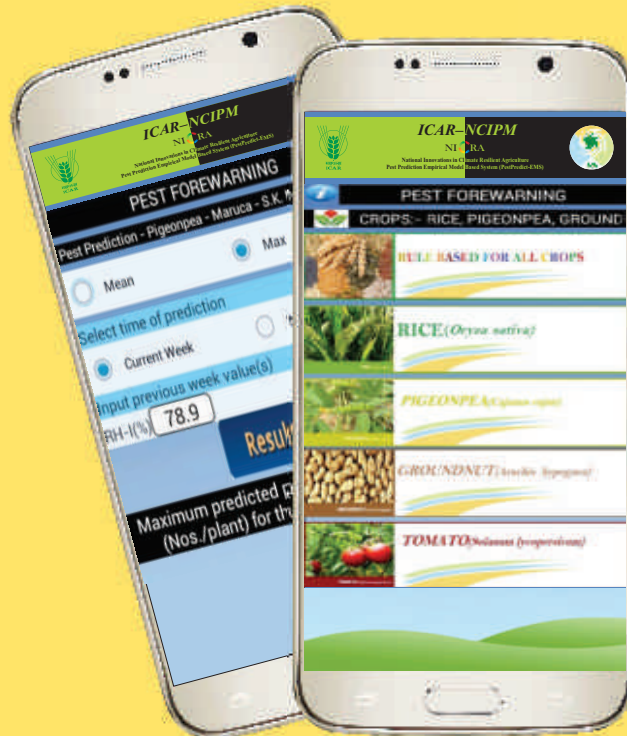


PESTPREDICT

An Android Application



USER MANUAL





ICAR-NCIPM

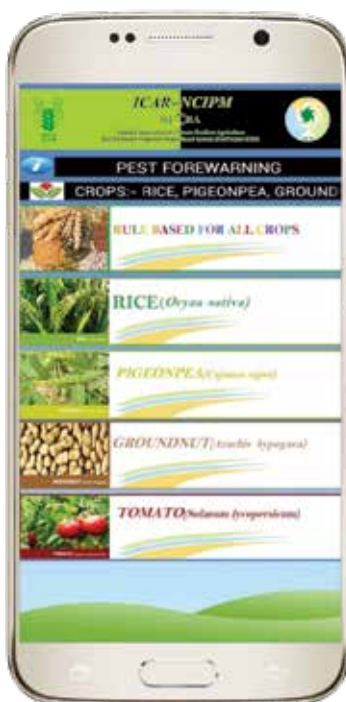
NI CRA

National Innovations in Climate Resilient Agriculture
Pest Prediction Empirical Model Based System (PestPredict-EMS)



USER MANUAL

PESTPREDICT : AN ANDROID APPLICATION



ICAR-National Research Centre for Integrated Pest Management

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www.ncipm.org.in

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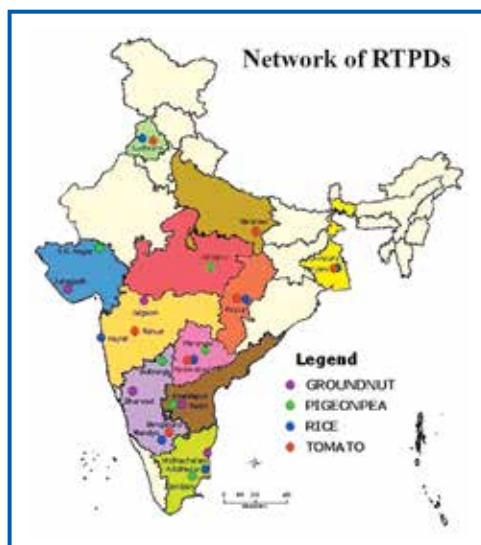
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PREAMBLE

In a world of technological advancements, android based smartphones are the rapidly growing segment of mobile market that give users a richer and faster access to services of choice. Mobile Apps are transforming agriculture by taking advantage of software designed for targeting desired needs of farmers. Ability to forecast insect pests to be prepared for their impending outbreaks and precise use of recommendations for their management on crops form a good agricultural practice in the arena of crop protection. Forewarning is an essential component of Integrated Pest Management (IPM). Predicting pest incidence dependent on weather is based on systematically recorded specific field data in an elaborate manner over considerable period of time along with the meteorological data. Simple rule based to sophisticated artificial intelligence approaches are being used for development of pest predictions. Prediction equations arrived using statistical techniques constitute empirical models.

National Innovations in Climate Resilient Agriculture (NICRA) for study of population dynamics of pests in relation to climate variability/change provided platform for the development of database for historical as well as real time pest and weather data for use in development of prediction of pest incidence. Twenty five centers from 11 States representing 10 agro climatic zones (3, 4, 6-13) and 12 agro ecological regions (R2-8 & R10-11, R15 & R18) of the country were involved for studies on real time pest dynamics (RTPD) in four target crops *viz.*, rice, pigeonpea, groundnut, and tomato. Database on the field occurrence of pests documented from 2011 and weather variables *viz.*, maximum temperature (°C), minimum temperature (°C), morning and evening relative humidity (%), rainfall (mm), sunshine hours (h/day) and wind velocity (km/h) on Standard Meteorological Week (SMW) basis for the specified locations collected from respective meteorological observatories using Information and Communication Technology (ICT) modules *viz.*, client and reporting applications of NICRA have been used in model development. All the models built in the current version of Mobile App are exclusive to *kharif* crop season.



The profile of insects pests, beneficials and diseases for different locations for which prediction models have been developed are depicted in figures. For insect pests of rice rule based models developed by combining weather criteria, pest severity and prediction rules based on light trap catches have also been made available.

PROFILE OF INSECT PESTS AND DISEASES FOR PREDICTION

Rule based models

Crop: Rice



Yellow stem borer

No. of locations : 7 [Ludhiana (PB), Chinsurah (WB), Raipur (CG), Karjat (MH), Hyderabad (TS), Mandya (KA), Aduthurai (TN)]



Brown plant hopper

No. of locations : 6 [Ludhiana (PB), Chinsurah (WB), Raipur (CG), Hyderabad (TS), Mandya (KA), Aduthurai (TN)]



Green leaf hopper

No. of locations : 6 [Chinsurah (WB), Raipur (CG), Karjat (MH), Hyderabad (TS), Mandya (KA), Aduthurai (TN)]



Leaf folder

No. of locations : 3 [Ludhiana (PB), Raipur (CG), Aduthurai (TN)]



White backed plant hopper

No. of location : 1 [Chinsurah (WB)]



Caseworm

No. of location : 1 [Raipur (CG)]

Crop: Groundnut**Tobacco caterpillar**

Number of locations : 3 [Kadiri (AP), Dharwad (KA), Junagadh (GJ)]

Crop: Tomato**Early blight**

Number of location : 1 [Bengaluru (KA)]

Empirical model based predictions
















In case of empirical model based predictions, not only the models predicting mean population have been programmed but also that of possible maximum severity are included. Since the models have been developed using lagged week's weather variables prediction for the current as well as the upcoming weeks are possible with input of relevant weather values built in the model. About 120 forecast models developed for prediction of mean and maximum population levels/severity across four target crops form a part of *PESTPREDICT*. Summary on weather based predictions developed through empirical models *in toto* for the target crops are given below.
















Crop	Insect	Beneficial insect	Disease
Rice	10	01	04
Pigeonpea	06	02	05
Groundnut	06	01	04
Tomato	07	01	11

Locations for which prediction models are available for a given pest and pests for which models are available for a given location are pictorially presented for ready reference.

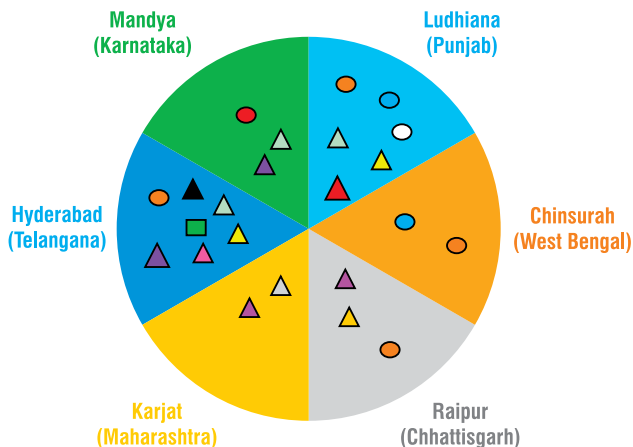
Profile of predictions for Rice




PESTWISE

INSECT		BENEFICIAL		DISEASE	
	Brown plant hopper (nos/hill) Ludhiana (PB)		Green mirid bug (nos/hill) Hyderabad (TS)		Blast (% severity) Mandya (KA)
	Brown plant hopper (% damaged tillers) Hyderabad (TS)				Brown spot (% severity) Ludhiana (PB), Chinsurah (WB)
	Case worm (% damaged leaves) Karjat (MH)				False smut (% damage) Ludhiana (PB)
	Gall midge (% silver shoots) Hyderabad (TS)				Sheath blight (% severity) Ludhiana (PB), Chinsurah (WB), Raipur (CG)
	Gundhi bug (nos/hill) Mandya (KA)				
	Hispa (% damaged leaves) Hyderabad (TS)				
	Leaf folder (% damaged leaves) Raipur (CG), Karjat (MH)				
	Stem borer (% dead heart or white ears) Ludhiana (PB), Hyderabad (TS), Mandya (KA)				
	Swarming caterpillar (% damaged leaves) Raipur (CG)				
	White backed plant hopper (nos/hill) Ludhiana (PB), Hyderabad (TS)				

Brown plant hopper (nos/hill)	
Stem borer (% dead heart or white ears)	
White backed plant hopper (nos/hill)	
Leaf folder (% damaged leaves)	
Swarming caterpillar (% damaged leaves)	
Caseworm (% damaged leaves)	
Brown plant hopper (% damaged tillers)	
Gall midge (% silver shoots)	
Hispa (% damaged leaves)	
Gundhibug (nos/hill)	
Green mirid bug (nos/hill)	
Brown spot (% severity)	
False smut (% damage)	
Sheath blight (% severity)	
Blast (% severity)	














LOCATIONWISE



Insect		Beneficial		Disease	
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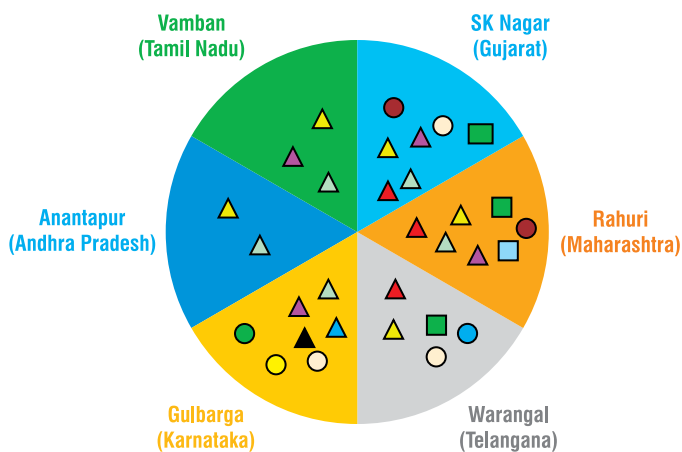
Profile of predictions for Pigeonpea

PESTWISE

INSECT		BENEFICIAL		DISEASE	
	Clavigralla (nos/plant) SK Nagar (GJ), Rahuri (MH), Warangal (TS)		Coccinellids (nos/plant) Rahuri (MH)		Alternaria blight (% severity) Gulbarga (KA)
	Jassids (nos/3 leaflets/plant) Gulbarga (KA)		Spiders (nos/plant) SK Nagar (GJ), Rahuri (MH), Warangal (TS)		Cercospora (% severity) Warangal (TS)
	H.armigera (no. of larvae/plant) SK Nagar (GJ), Rahuri (MH), Gulbarga (KA), Anantapur (AP), Vamban (TN)				Fusarium wilt (% incidence) SK Nagar (GJ), Warangal (TS), Gulbarga (KA)
	Lablab pod borer (no. of larvae/plant) Gulbarga (KA)				Phytophthora blight (% incidence) Gulbarga (KA)
	Leaf folder (no. of larvae/plant) SK Nagar (GJ), Rahuri (MH), Warangal (TS), Anantapur (AP), Vamban (TN)				Sterility mosaic (% incidence) SK Nagar (GJ), Rahuri (MH)
	Maruca (nos/plant) SK Nagar (GJ), Rahuri (MH), Gulbarga (KA), Vamban (TN)				

LOCATIONWISE












Clavigralla (nos/plant)	▲
H. armigera (no. of larvae/plant)	△
Leaf folder (no. of larvae/plant)	▲
Maruca (nos/plant)	▲
Jassids (nos/3 leaflets/plant)	▲
Loblab pod borer (no. of larvae/plant)	▲
Spiders (nos/plant)	■
Coccinellids (nos/plant)	□
Fusarium wilt (% incidence)	○
Sterility mosaic (% incidence)	●
Cercospora (% severity)	●
Alternaria blight (% severity)	●
Phytophthora blight (% incidence)	●














Insect	△	Beneficial	□	Disease	○
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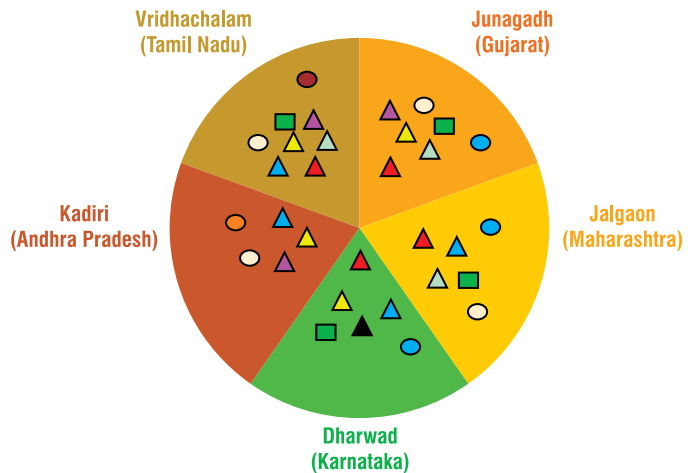
Profile of predictions for Groundnut




PESTWISE

INSECT		BENEFICIAL		DISEASE	
	Jassids (% infestation) Junagadh (GJ), Jalgaon (MH), Dharwad (KA), Vridhachalam (TN)		Coccinellids (nos/plant) Junagadh (GJ), Jalgaon (MH), Dharwad (KA), Vridhachalam (TN)		Alternaria leaf spot (% severity) Vridhachalam (TN)
	Leaf miner (% infestation) Jalgaon (MH), Dharwad (KA), Kadiri (AP), Vridhachalam (TN)				Early leaf spot (% severity) Junagadh (GJ), Jalgaon (MH), Dharwad (KA)
	Spodoptera (% infestation) Junagadh (GJ), Jalgaon (MH), Vridhachalam (TN)				Peanut bud necrosis disease-PBND (% incidence) Kadiri (AP)
	Spodoptera (moths/trap/week) Dharwad (KA)				Late leaf spot (% severity) Junagadh (GJ), Jalgaon (MH), Kadiri (AP), Vridhachalam (TN)
	Thrips (% infestation) Junagadh (GJ), Dharwad (KA), Kadiri (AP), Vridhachalam (TN)				
	Thrips (nos/3 leaves/plant) Junagadh (GJ), Kadiri (AP), Vridhachalam (TN)				

LOCATIONWISE




















Jassids (% infestation)	
Spodoptera (% infestation)	
Thrips (% infestation)	
Thrips (nos/3 leaves/plant)	
Leaf miner (% infestation)	
Spodoptera (trap catch)	
Coccinellids (nos/plant)	
Early leaf spot (% severity)	
Late leaf spot (% severity)	
PBND (% incidence)	
Alternaria leaf spot (% severity)	



Insect		Beneficial		Disease	
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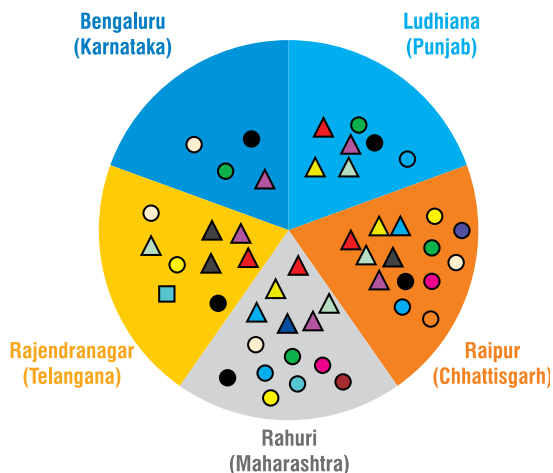
Profile of predictions for Tomato

PESTWISE

INSECT		BENEFICIAL		DISEASE	
	Aphids (nos/5 leaves/plant) Raipur (CG), Rahuri (MH)		Spiders (nos/plant) Rajendranagar (TS)		Bacterial canker (% severity) Raipur (CG), Rahuri (MH)
	H. armigera (% fruit damage) Ludhiana (PB), Raipur (CG), Rahuri (MH), Rajendranagar (TS)				Bacterial spot (% severity) Raipur (CH), Rahuri (MH), Rajendranagar (TS)
	H. armigera (no. of larvae/plant) Ludhiana (PB), Raipur (CG), Rahuri (MH), Rajendranagar (TS)				Bud blight (% incidence) Raipur (CG), Rahuri (MH), Rajendranagar (TS)
	Leaf miner (nos/5 leaves/plant) Ludhiana (PB), Raipur (CG), Rahuri (MH)				Cucurmo virus (% incidence) Rahuri (MH)
	Mites (nos/5 leaves/plant) Rajendranagar (TS)				Early blight (% severity) Ludhiana (PB), Raipur (CG) Rahuri (MH), Rajendranagar (TS), Bengaluru (KA)
	Thrips (nos/5 leaves/plant) Raipur (CH), Rahuri (MH), Rajendranagar (TS)				Late blight (% severity) Ludhiana (PB), Raipur (CG)
	Whiteflies (nos/5 leaves/plant) Ludhiana (PB), Raipur (CG), Rahuri (MH), Rajendranagar (TS), Bengaluru (KA)				Fusarium wilt (% incidence) Rahuri (MH)
					Leaf curl (% incidence) Ludhiana (PB), Raipur (CG), Rahuri (MH), Bengaluru (KA)
					Powdery mildew (% severity) Rahuri (MH), Bengaluru (KA)
					Ralstonia wilt (% incidence) Raipur (CG)
					Septoria leaf spot (% severity) Raipur (CG)

LOCATIONWISE

<i>H. armigera</i> (% fruit damage)	▲	Early blight (% severity)	●
<i>H. armigera</i> (no. of larvae/plant)	▲	Late blight (% severity)	●
Leaf miner (nos/5 leaves/plant)	▲	Leaf curl (% incidence)	●
Whiteflies (nos/5 leaves/plant)	▲	Bacterial canker (% severity)	●
Aphids (nos/5 leaves/plant)	▲	Bacterial spot (% severity)	●
Thrips (nos/5 leaves/plant)	▲	Bud blight (% incidence)	○
Mites (nos/5 leaves/plant)	▲	Ralstonia wilt (% incidence)	○
		Septoria leaf spot (% severity)	○
		Cucurmo virus (% incidence)	○
		Fusarium wilt (% incidence)	○
Spiders (nos./plant)	■	Powdery mildew (% severity)	○



Insect	▲	Beneficial	■	Disease	○
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WHAT IS PESTPREDICT-EMS MOBILE APP?

NCIPM-NICRA provides mobile app that helps to execute the functionality of pest forewarning system developed for locations associated with real time pest dynamic (RTPD) studies under the regime of climate variability and change. In the Pest Prediction Empirical Model Based System (*PESTPREDICT*) user can get predictions of insects, diseases and beneficials for locations by providing inputs of weather associated with model equations of *kharif*. Rule Based System (RBS) predicting largely rice insect pests, *Spodoptera litura* of groundnut and early blight of tomato (*PESTPREDICT*-RBS) have also been integrated in the application. This application assists researchers, extension personnel of agriculture and farmers to get location specific forecasts of desired insect pest(s) or disease(s) for their effective management on target crops. *PESTPREDICT*-EMS/RBS reduces calculation efforts and provides an instant and extempore framework for use of developed prediction models. The open source application also facilitates easy prediction of insect pest dynamics for current and future climate scenarios when the relevant values of temperature relating to the emission scenarios are available. Currently this application is aimed for field use to predict incidence of pests of four target crops of RTPD locations for purposes of issuing ‘pest alerts’ at times of high severity or above economic threshold levels. Accordingly person can plan pest control measures and in turn preparedness of farmers will improve to tackle pest problems.



WHICH DEVICES DOES THE MOBILE APP SUPPORT?

PESTPREDICT-EMS/RBS can be installed on mobile devices that have Android (mobile phones and tablets) operating systems. Application is built in Android version 4.1 (Jelly Bean) which support almost all android smartphones. *PESTPREDICT*-EMS/RBS has been built in Android SDK Eclipse Juno software which generates .apk (android package kit) file for installation as per the device requirement.

HOW TO INSTALL IT?

PESTPREDICT-EMS/RBS is an open access android application easily downloadable from the link:

<http://www.ncipm.org.in/ForewarningSystem/Androidapp.aspx>

or

Scan the QR Code to access the link for *PESTPREDICT*-EMS/RBS

Download the application from the above link followed by clicking the logo. Upon installation the icon of the app is displayed on the Home screen of the device.



HOW TO USE IT?

- A. Click on the *PESTPREDICT*-EMS icon on the device screen, which would show the main display page of application.



- B. Select the crop of interest for pest forewarning (rule based models for all crops, Rice, Pigeonpea, Groundnut & Tomato).



- C. Select ‘Crop’, ‘State’, ‘District’, ‘Taluka’, ‘Location’, ‘Pest’ ‘Year’ and ‘SMW’ of interest of rule based model. Weather records from the database of NICRA containing the module of weather reporting gets displayed. Click ‘Proceed’ button to get the result of prediction



- D. Select ‘Location’ or ‘Pest’ button. ‘Location’ selection displays name of RTPDs for which models are available. Upon specification of location user has to select the pest of interest for prediction and *vice versa*. Select ‘Proceed’ button.



- E. Select ‘Mean’ or ‘Max’ followed by time of prediction. Input the weather value as required. Click ‘Result’ button to get the prediction outcome along with the reporting unit of the specific pest, location and time of prediction.



- F. Press '**Back button**' on the action bar of the application to get back to previous screens for modifying any of the options at any point of time.
- G. Select '**Back**' button of the device to exit the application.

DON'T HAVE ANDROID SMARTPHONE?

To access the functionality of *PESTPREDICT*-EMS/RBS application, the web portal under NICRA home page of ICAR-NCIPM helps non-android users to predict and examine pest details according to their location for issuing 'pest alerts'. Website is currently password protected for researchers of RTPDs and others as it is under validation.

<http://www.ncipm.org.in/nicra/ForewarningSystem/Home.aspx>

The link directly accesses the website.

WAY FORWARD

The application is currently user authenticated for researchers of RTPDs under NICRA of the target crops to predict insect pests and diseases during *khariif* 2016 across the country with the purpose of issuing 'pest alerts' at times of prediction of higher pest severity levels. Mobile based *PESTPREDICT* is first of its kind making forewarning as a component of IPM in the area of crop protection advisory that could be replicated for other crops and regions. Application could also assist in rapidly estimating the scale of operation of the developed prediction models in the coming seasons. Also the non performing models would be refined for future use. Further upgradation of the application by addition of *rabi* season prediction models would facilitate wholesome use by researchers, extension agents and farmers. Awareness needs to be created on the availability of application to all the stakeholders related to crop protection for its wider utility. The possible convergence with department personnel, extension officials and other stakeholders of plant protection certainly would improve its applicability.

SUPPLEMENTARY INFORMATION

- I. *PESTPREDICT* is prepared with due consideration to the approaches of predictions utilizing calculations and assumptions.
- II. The precision and accuracy of pest incidence depends on quality of weather input data.
- III. *PESTPREDICT* is expected to provide values which are nearer to reality.
- IV. Models have been developed using any of the weather factors *viz.*, maximum/minimum temperature (limits <60) [Temp. Max. (°C)/Temp. Min. (°C)], morning/evening relative humidity (limits<99) [RH-I (%)/RH-II (%)], sunshine (h/day) (limits<18), rainy day (nos) (limits <7), rainfall (mm) and wind (km/h) that get populated on the screen as per selections made on crop/pest/location/parameter/period of prediction. Extreme care has to be taken to input correct values of weather for accurate predictions.
- V. *PESTPREDICT*-RBS also works as a standalone application. It is a requirement of user to update the *PESTPREDICT*-RBS app as and when the real time weather data are uploaded by RTPDs.
- VI. Since *PESTPREDICT*-EMS models have been developed for prediction of mean and maximum population/severity user has to specify the parameter (mean or maximum) of interest. Depending on the type of models developed the user is required to select either the period of prediction desired (current or next week) or straightaway input the values of weather factors for prediction of only ‘current week’. Depending upon the model equations built in, the weather value(s) required as inputs would be populated on the screen. For some pests inputs of weather for both *viz.*, previous and two weeks before need to be provided.
- VII. The authenticity of prediction could vary depending on other biotic variables (cultivars/ agronomic and plant protection practices) and at times of extreme events of weather/natural disasters. The predicted values are also a function of various other factors and enough caution is required to have final decision and dissemination on ‘pest alerts’.
- VIII. The information on methodology and technicalities involved in development of about 120 forecast models for prediction of mean and maximum population levels/severity across the four target crops is available with NCIPM and can be obtained by submitting the details of user.

