Diseases and Pests of Potato and their Management

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Sanjeev Sharma

ICAR-Central Potato Research Institute, Shimla

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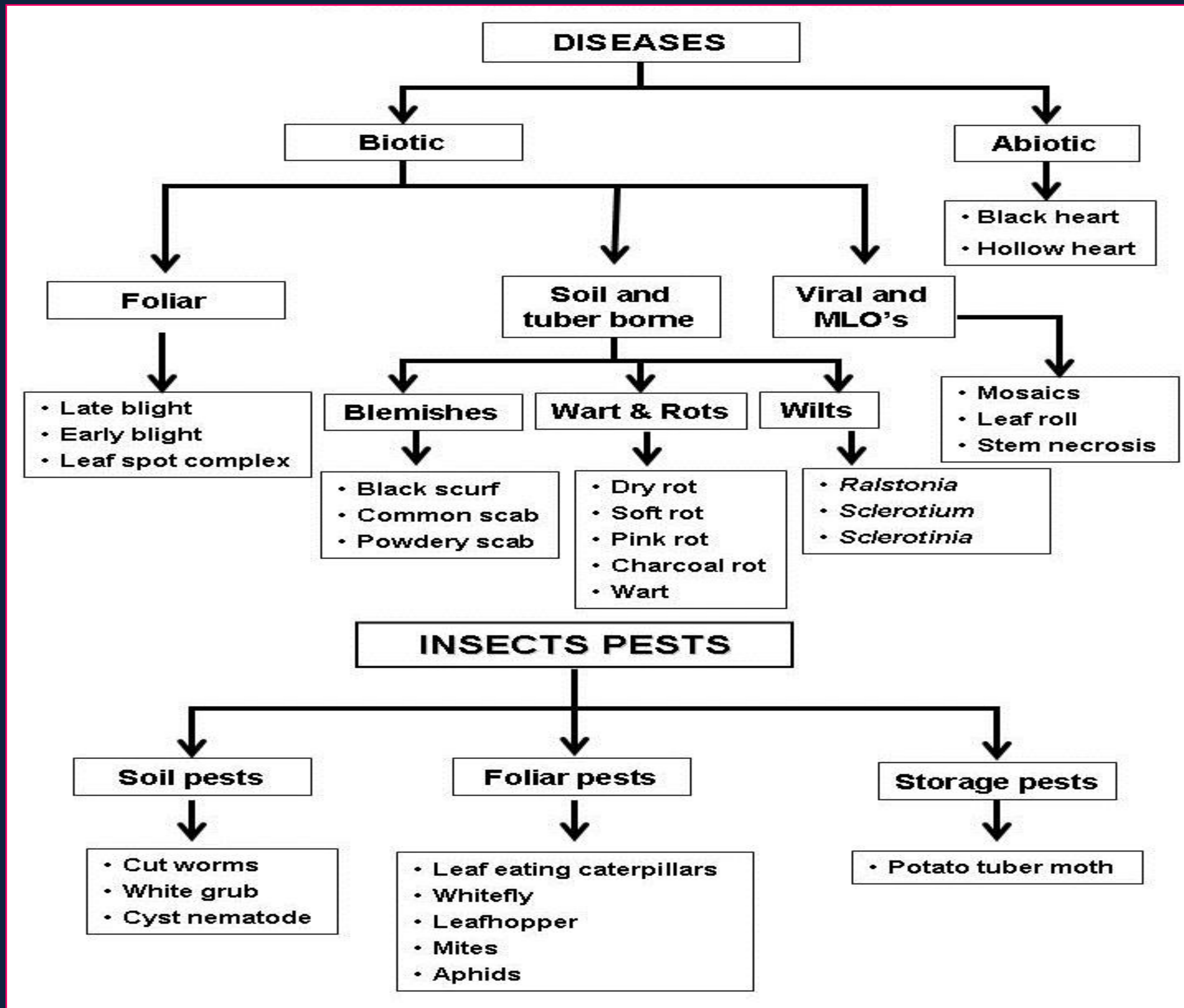
Diseases and Insect-pests of Potato



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Late blight severity zones: world scenario

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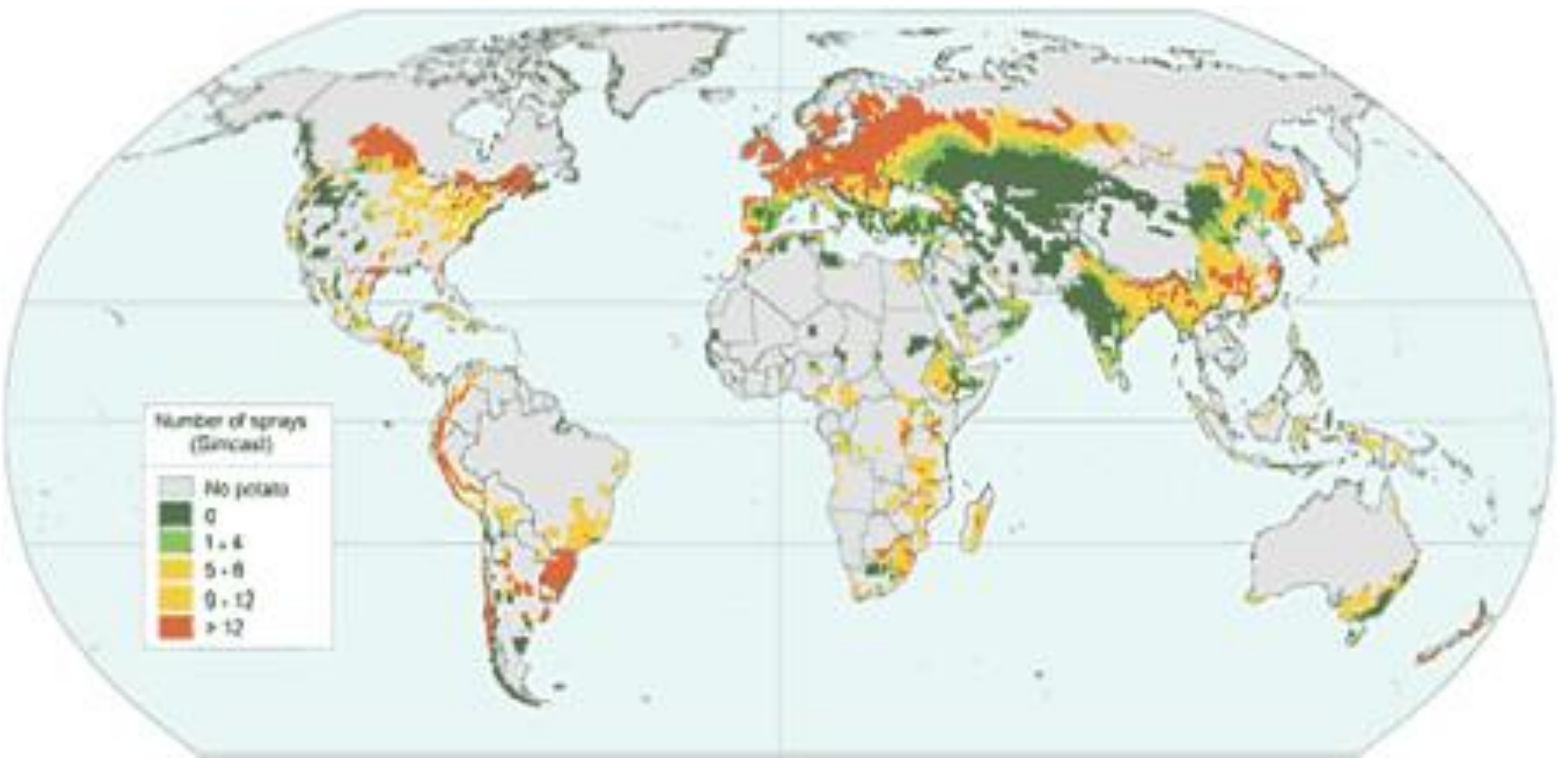

Zones of high late blight severity

- Tropical highlands
- Western Europe
- Northern USA
- East coast of Canada
- South eastern Brazil
- Central southern China

Low late blight severity zones

- Western plains in India
- North-central China
- North-western USA

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Late Blight Severity Zones: World Scenario

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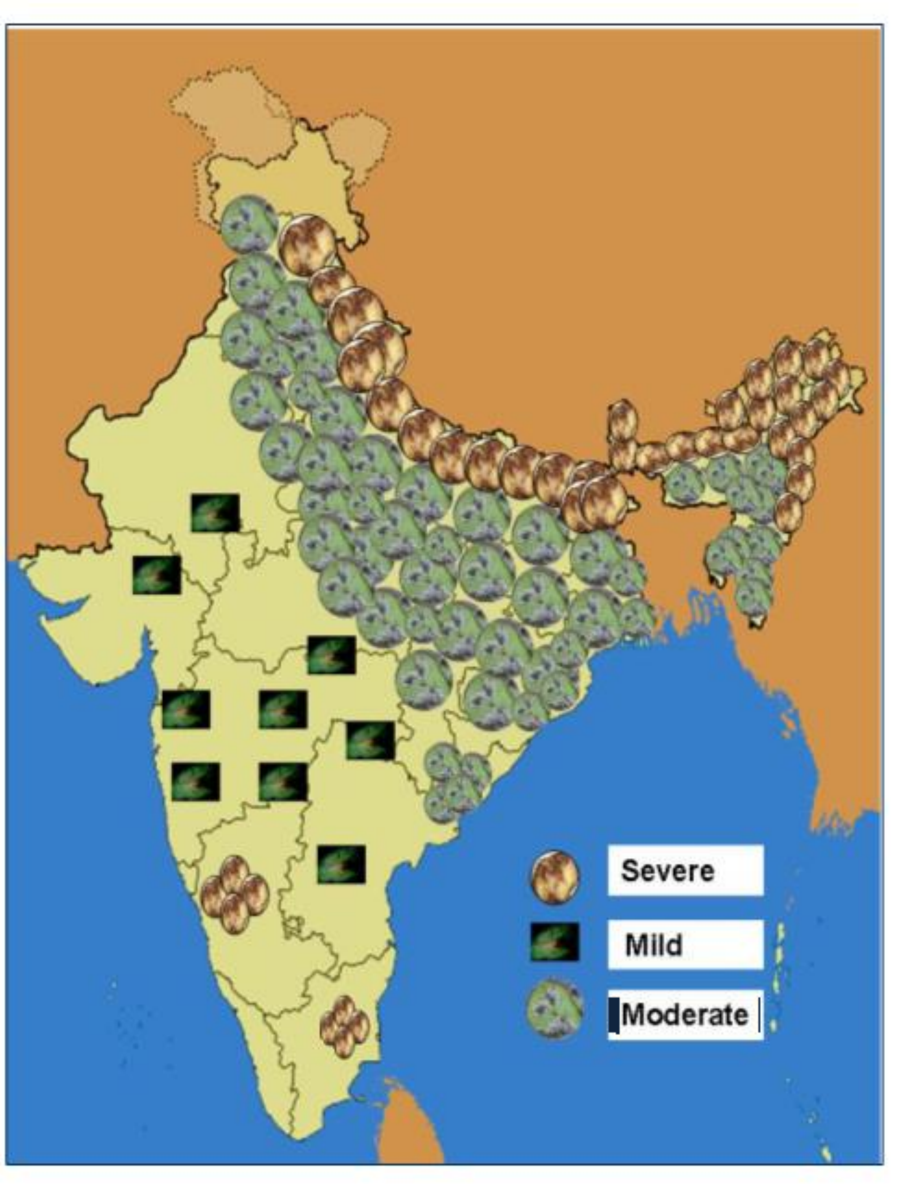
Country	Yield loss (%)
Sub-Saharan Africa	44
Latin America	36
Caribbean	36
South-East Asia	35
South-West Asia	19
Middle east & North Africa	9

Global losses: 12 billion USD

Late Blight of Potato

Distribution of crop losses in India



Eastern Hills 19-90%

NW Hills 11-90%

Southern Hills 31-80%

N W Plains 20-90%

Eastern Plains 10-85%

Plateau 50-100%

Av crop loss 15%

7.2 million tonne

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Symptoms

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Disease spread and Development

- Appearance and build-up of late blight depend solely on weather conditions.
- There are specific requirements of temperature and humidity for initiation and further build up of disease.

1. Temperature

Pathogen growth	-	16-20°C
Spore production	-	18-22°C
Spore germination	-	10-20°C
Infection and disease development	-	7.2-26.7°C(18$\pm$1°C)

2. Humidity

Spores are formed in moisture saturated atmosphere.

Spore germination and infection requires 100 per cent humidity.

Spores get killed under low humidity (less than 75% humidity)

3. Light

Spores are produced during the night and are sensitive to light.

Cloudiness favours disease development.

Integrated Disease Management

- Use of disease free seed.
- Selection of well drained soils.
- Destruction of plant debris.
- High ridging.
- Scouting of the field.
- Stop irrigation when conditions become congenial.
- Haulm cutting at 75% disease severity.
- Harvesting should be done 15-20 days after haulms cutting.
- Treat seed tubers with boric acid (30g per litre of water) before storage.

Host resistance

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For plains

K. Badshah, K. Jyoti, K. Sutlej, K. Jawahar, K. Anand, K. Chipsona I & III, K. Pukhraj.

For hills

K. Girdhari, K. Himalini, K. Giriraj, K. Shailja (HP Hills) and K. Megha (Khasi hills), K. Swarna (Nilgiri hills), K. Kanchan (Darjeeling and Sikkim hills).

- K. Girdhari, K. Giriraj, K Shailja & K. Himalini are doing well in other hills also.

Chemical Management

- Prophylactic spray with contact fungicides like mancozeb (0.2%) or chlorothalonil (0.2%) or propineb (0.2%) before the closure of canopy
- On appearance of the disease, spray the crop with fungicides like dimethomorph -based or cymoxanil -based or fenamidone -based @0.3%.
- Depending upon disease severity and weather conditions, number of spray may be increased or decreased.
- Ensure thorough coverage of plants top to bottom with fungicides. Special attention should be given to lower leaves which need to be covered with fungicides.
- Do not wait or allow late blight to appear and establish in the field. Always use a sticker @0.1% for proper sticking and uniform spread of fungicides on leaf surface.

Why Disease Forecasting

Assist in decision making both strategic and tactical

Strategic decisions – **policy decisions**

- • Assist decisions such as whether to go in for hot weather cultivation, soil treatment, planting a resistant cultivar, etc.)
- Assessment of climate change effects and adaptation

Tactical decisions – **operational decisions**

When to spray and whether to repeat the spray

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Conditions for Practical Gains from Forecasting

i) The disease causes economically significant damage
ii) The onset, speed of spread, and destructiveness of the disease is variable due to weather
iii) Control measures are known and can be economically applied
iv) Information on weather-disease relationship is fully known

Relevance of Forecasting in Potato Late Blight Management

- LB is highly weather dependent:

  Temperature: 7.2-26.6°C (Opt. 18 ± 1°C)

  RH: ≥80%

  Light: Photosensitive (DI inversely proportionate to light intensity)

LB is polycyclic in nature- abundant inoculum production

LB is amenable to chemicals but they need to be sprayed prophylactically




Disease forecasting studies at CPRI

"Dutch Rules' (Van Everdingen, 1926) laid foundation for developing forecasting models.

- ❖ Night temperatures must be ≥ 10° C.
- ❖ Four hours dew at night i.e. night temp below dew point for 4 hrs
- ❖ Mean cloudiness on next day ≥ 0.8.
- ❖ Rainfall during next 24 hrs at least 0.1 mm.

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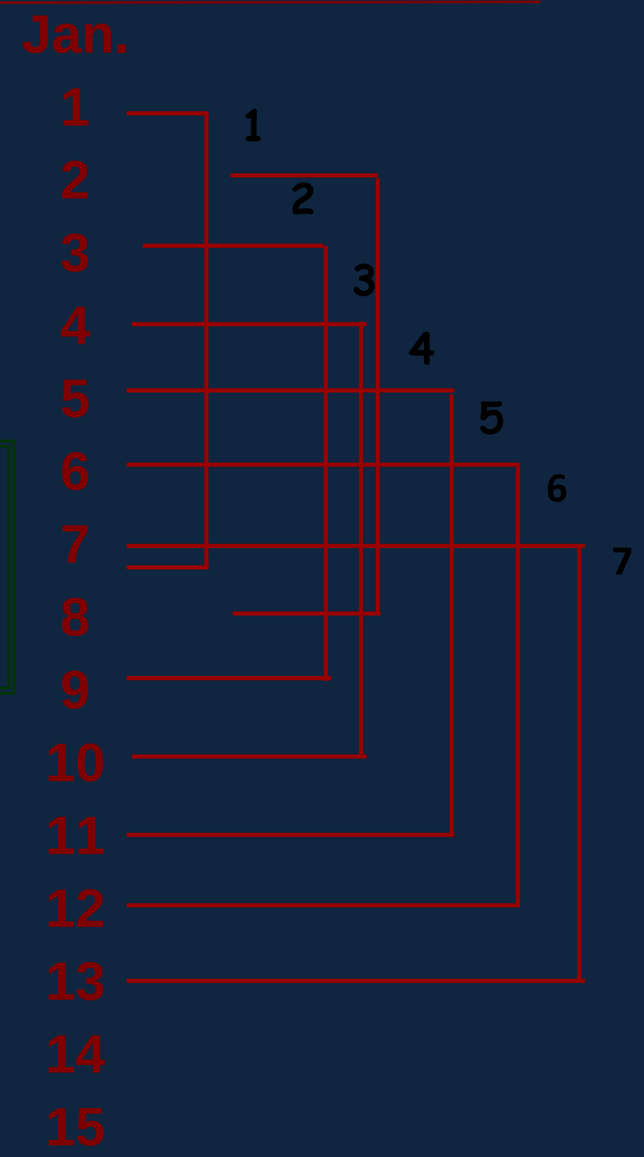
Moving-Day Concept

7-DAY MOVING CONCEPT

Cook (1947) gave the concept of 7-day moving temp. & rainfall for determining critical rainfall & temp.

If 7 day moving mean temp. remains below 75°F and total rainfall remains above critical limit for 7 consecutive days, the blight would appear within 2 weeks time



CRITICAL RAINFALL LIMIT

$$\frac{\text{Total rainfall in blight years} + \text{Total rainfall in non blight years}}{2}$$

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LATE BLIGHT FORECASTING IN INDIAN HILLS

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Bhattacharyya *et al.* (1982)

They compared various methods of disease prediction *viz.* Beaumont Rules, Cook and Hyre method and Hyre and Bonde method using 15 years weather data from Shimla, Shillong and Ooty hills

CONCLUSIONS

None of the method successfully predicted the disease in any of the areas

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Modifications proposed by Bhattacharyya *et al.* (1982)

1st Forecast

If 7-day movning precipitation of at least 30 mm for Shimla, 28.9 mm for Ootacamund and 38.5 mm for Shillong hills with mean temp. of 23.9 °C or less continues for 7-consecutive days, late blight would appear within three weeks time

2nd Forecast

If hourly temp. remains in between 10-20°C associated with RH 80% or more for continuous 18 hrs for at least two consecutive days, late blight would appear within a week time

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LB Forecasting for Plains

Fitness of models based on temp. and RH in UP

Year	Expected date of appearance: Bhattacharyya *et al* (1982) 2nd forecast	Expected date of appearance: Beaumont Rules	Actual date of appearance
1986-87	13-17 Dec.	8-22 Dec.	15 Dec.
1987-88	--	13-27 Dec.	No LB
1988-89	10-17 Jan.	8-22 Jan.	12 Jan.
1989-90	28 Dec.-4 Jan.	28 Dec.-11 Jan.	30 Dec.
1991-92	2-9 Dec.	17-31 Dec.	24 Dec.
1992-93	-	-	16 Dec.
1993-94	-	-	14 Jan.
1994-95	-	-	15 Dec.
1996-97	-	-	No LB
Success :	55%	55%	

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Model for Rainy Years

- Measurable rains (0.1-0.5 mm) for a minimum of two consecutive days
- 5-day moving ≥ 85% RH period ≥ 50 hrs
- 5-day moving congenial temp. (7.2-26.6°C) ≥105 hrs

If above conditions prevail for 5-consecutive days, blight would appear within 10 days

Model for Non-Rainy Years

- 7-day moving ≥ 85% RH period ≥60 hrs
- 7-day moving congenial temp (7.2- 26.6°C) ≥120 hrs

If above conditions prevail for 7-consecutive days, blight would appear within 10 days

JHULSACAST –A computerized system for LB forecasting

Data transfer through interface

JHULSACAST

DATA ENTRY

LB FORECAST

JHULSACAST MENU

RUN

Warning

Late Blight may appear within 8-10 days

Message transferred to AIR & Doordarshan

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Validation of Jhulsacast Model

Year	Expected date of late blight appearance	Actual date of late blight appearance
1997-1998	8-18 Nov.	9 Nov.
1998-1999	13-23 Nov.	24 Nov.
1999-2000	9-18 Nov.	14 Nov.
2000-2001	20-29 Nov.	28 Nov.
2001-2002	4-14 Jan.	6 Jan.
2002-2003	17-26 Dec.	18 Dec.
2010-2011	25-28 Dec	27 Dec
2014-2015	28 Dec – 7 Jan	6 Jan

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JHULSACAST – A computerized system for LB forecasting for Punjab

Data transfer through interface

JHULSACAST

DATA ENTRY

LB FORECAST

JHULSACAST MENU

RUN

Warning

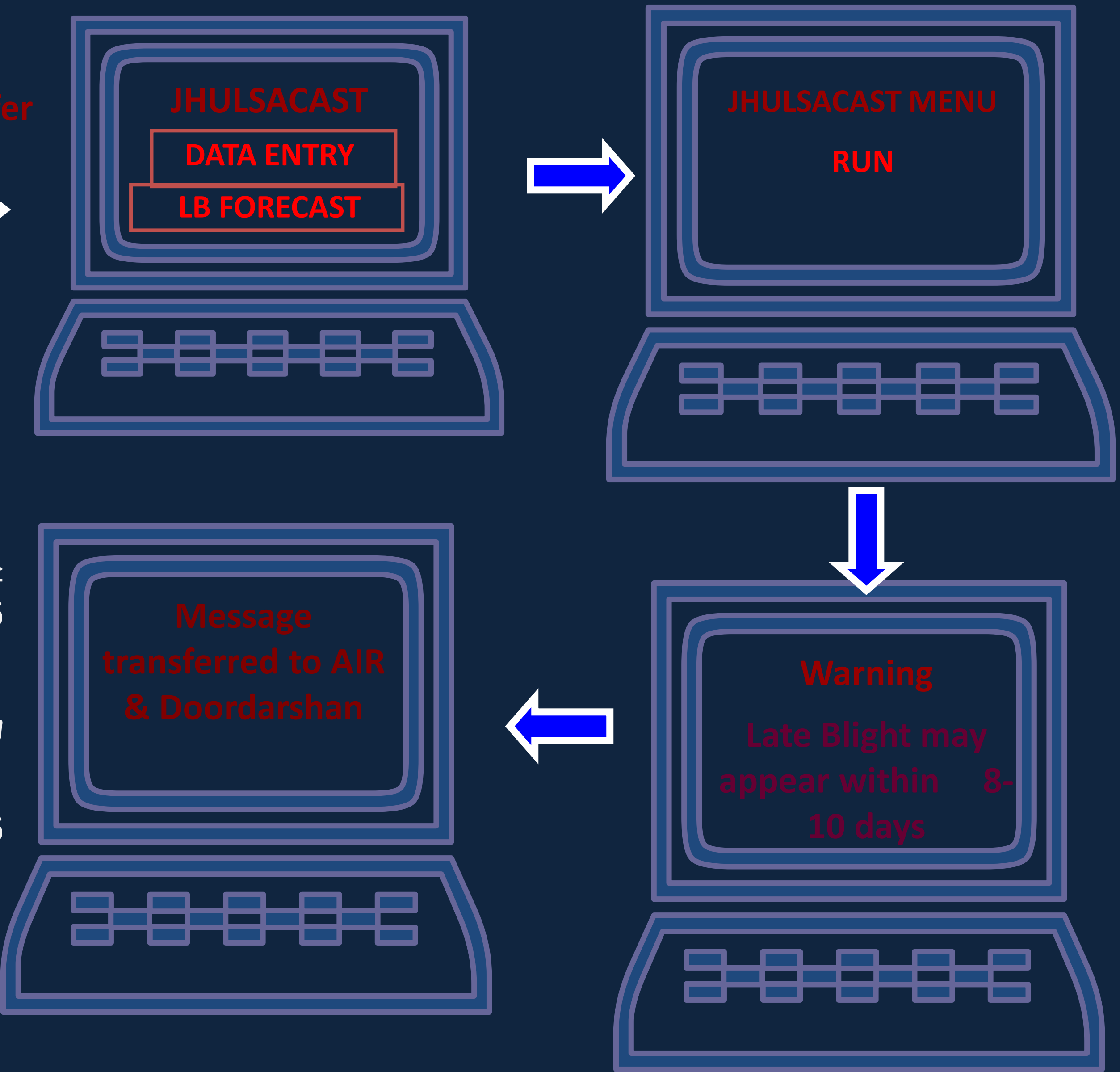
Late Blight may appear within 8-10 days

Message transferred to AIR & Doordarshan

- 7-day moving ≥ 85% RH period ≥ 90 hrs
- 5-day moving congenial temp. (7.2-26.6°C) ≥115 hrs

JHULSACAST – A computerized system for LB forecasting for tarai region of Uttarakhand

Data transfer through interface



- 7-day moving ≥ 85% RH period ≥ 85 hrs
- 7-day moving congenial temp. (7.2-26.6°C) ≥135 hrs

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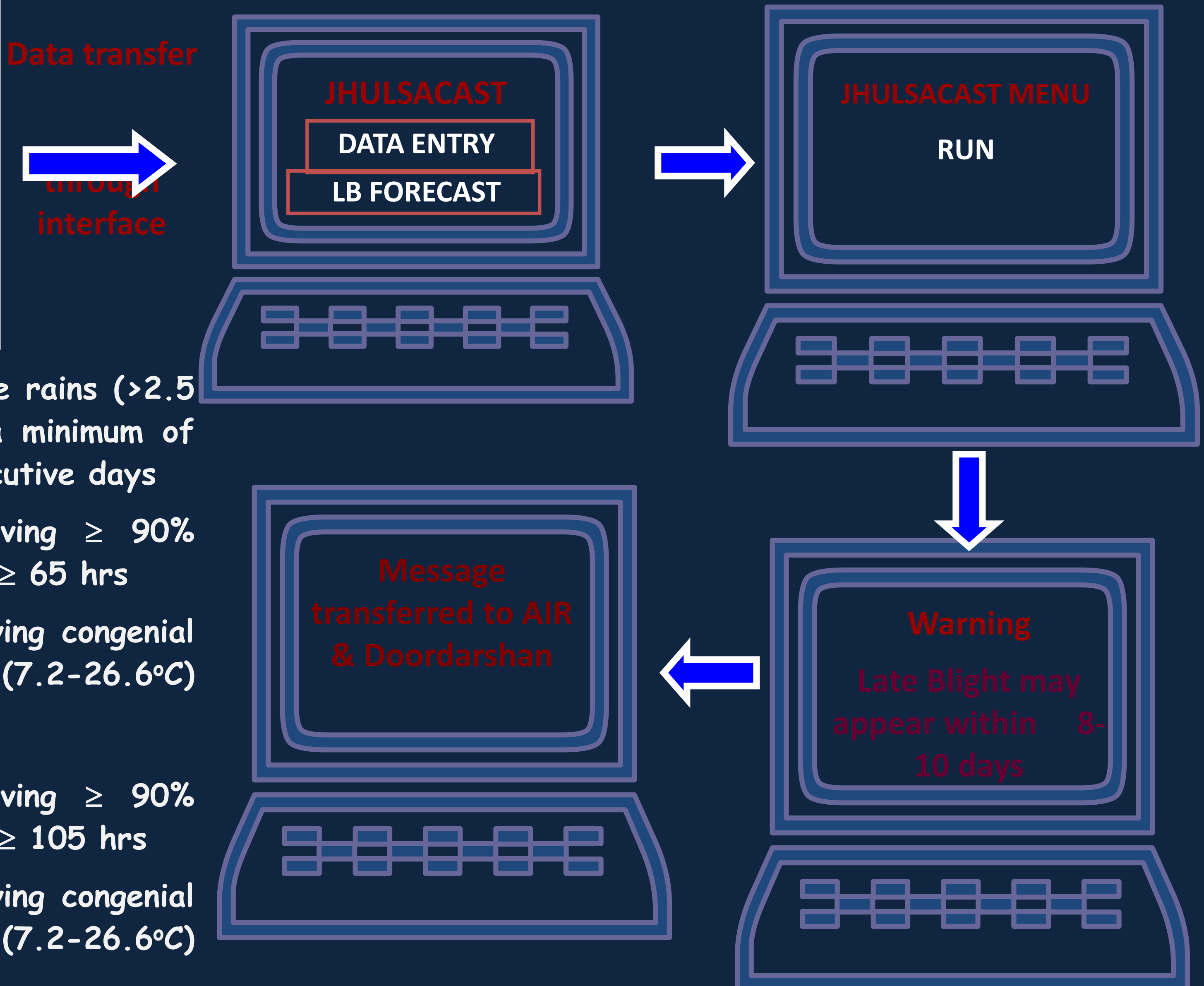
JHULSACAST – A computerized system for LB forecasting for plains of West Bengal



- Measurable rains (>2.5 mm) for a minimum of two consecutive days
- 5-day moving ≥ 90% RH period ≥ 65 hrs
- 5-day moving congenial temp. (7.2-26.6°C) ≥105 hrs
- 7-day moving ≥ 90% RH period ≥ 105 hrs
- 7-day moving congenial temp. (7.2-26.6°C) ≥150 hrs

Decision rules for need-based fungicide application

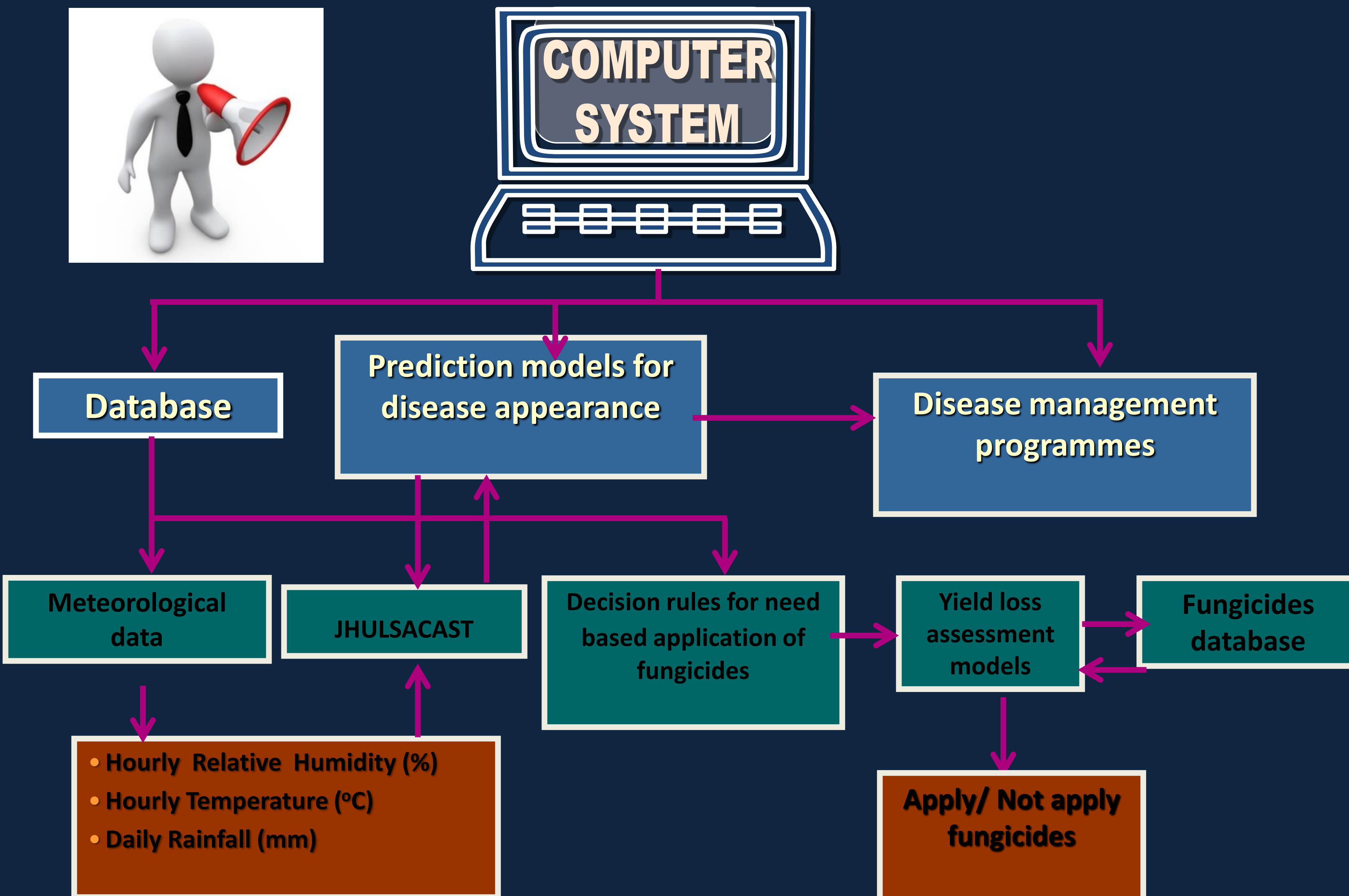
Decision rules for need based application of fungicides

- Weighted congenial hours of severity are calculated as per following relationship between congenial temperature (7.2 – 26.6 ^{o}C) & RH (≥ 85%)

Temperature ^{o}C	Relationship score (weight)
7.2 – 9.0	1.00
9.1 – 12.0	1.25
12.1 – 18.0	1.50
18.1 – 23.0	1.75
23.1 – 26.6	1.00

- Fungicide spray is recommended on the day when the accumulated weighted congenial hours of severity is 150 and 175 for contact and systemic fungicides respectively. The subsequent sprays are repeated after the accumulation of above severity values.
- A computer programme module has been developed for calculating and accumulating weighted congenial hours of severity based on temperature and % RH data.
- Accuracy of the DSS is 82%

Decision Support System (DSS) for LB Management



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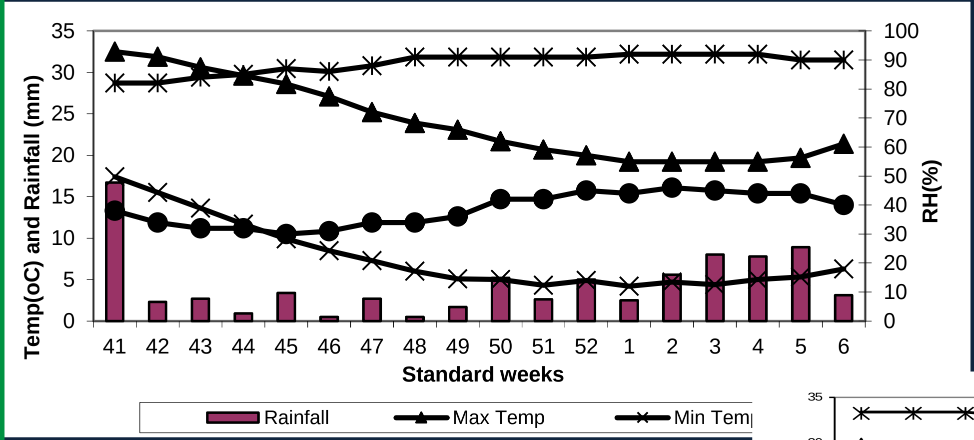
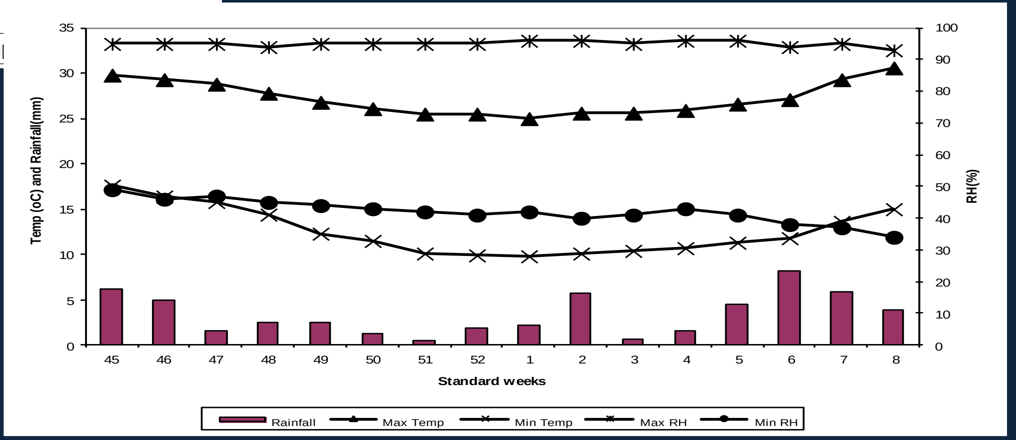
Limitations of LB Forecasting Models

- The forecasting models available are location specific
- e.g. Initiation of PLB when 7-day moving ≥85% RH (≥50 hours) and congenial temperature (7.2-26.6°C) periods (≥105 hours) these values vary from location to location
- Thermohygrograph data is not available for most of the locations.



Jalandhar

- Meteorological conditions vary widely at different locations – and this determines the time of appearance and disease severity.
- Calibration to each location is a slow process.



Kalyani

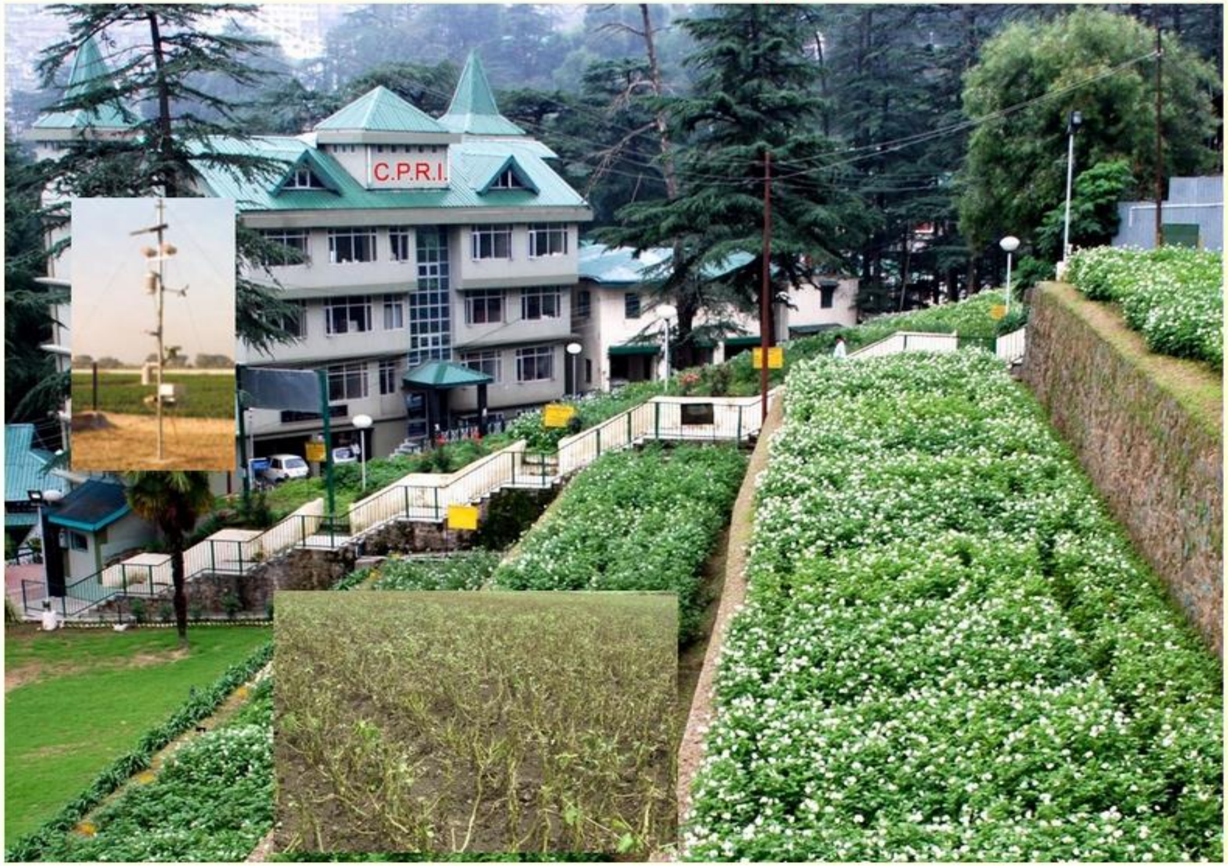
Objectives of the new model

- Model should be applicable across locations without the need for local calibration.

- It should use simple easily available meteorological data

- It should forecast disease appearance and also be amenable to use as decision support.

IndoBlightCast:
A potato late blight forecasting system



Indo-Blightcast forcasting model developed by **CPRI and AICRP (Potato), Shimla** is operationalized in collaboration with **AGROMET DIVISION, INDIAN METEOROLOGICAL DEPARTMENT, New Delhi.**

Agromet advisories on potato late blight appearance and its management is being issued by 40 centres spread across the country.

Continue

Developed by: ***BP Singh, PM Govindakrishnan, Islam Ahmad, Shashi Rawat and Sanjeev Sharma***

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Central Potato Research Institute
&
All India Coordinated Research on Potato

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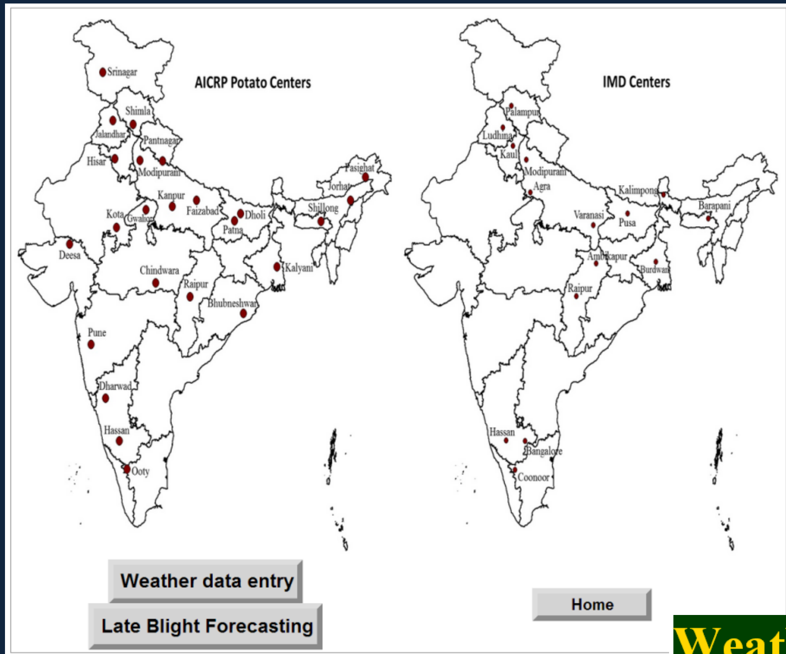
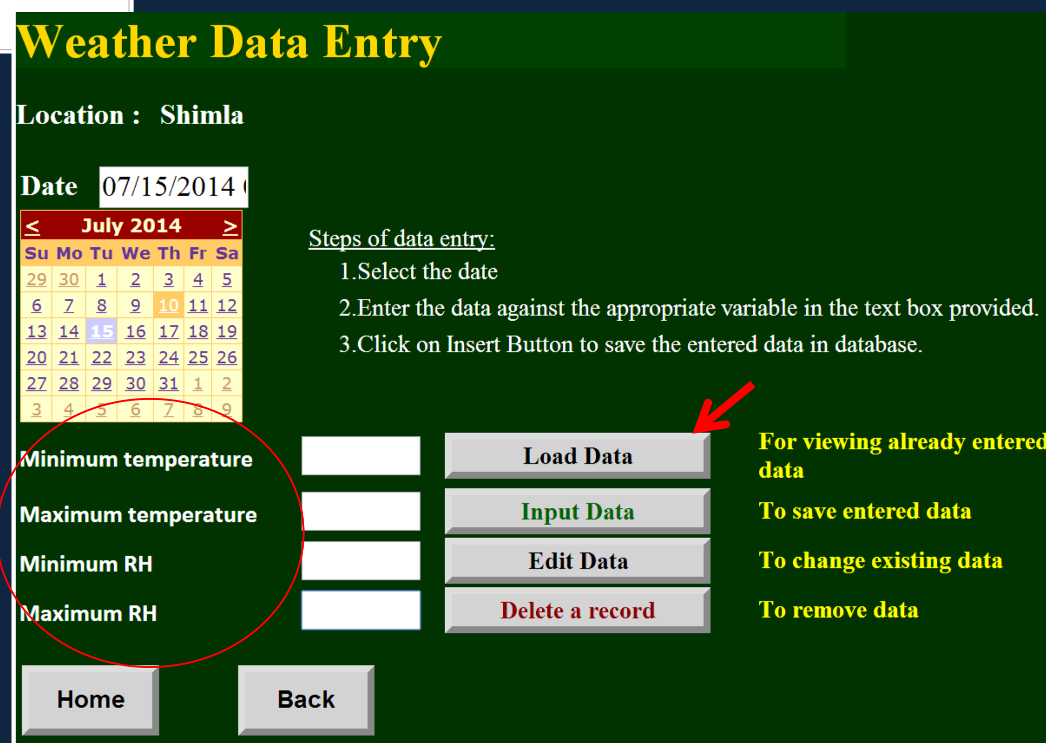


Window for data entry (restricted)



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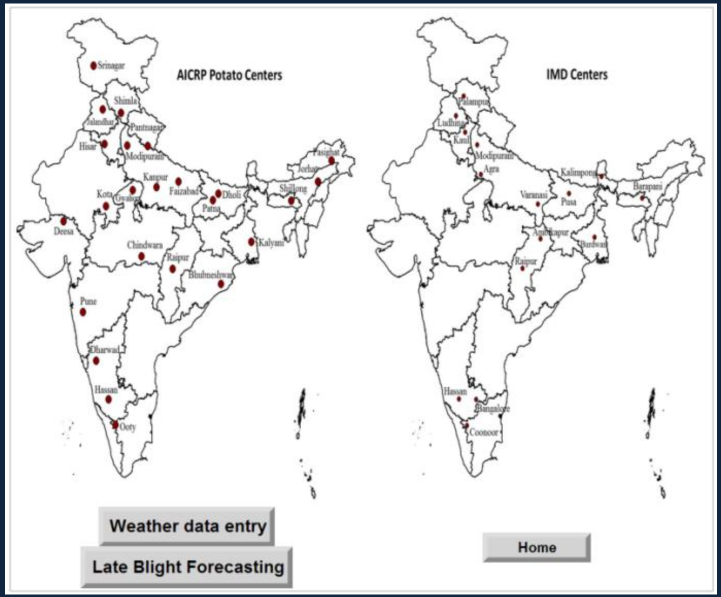
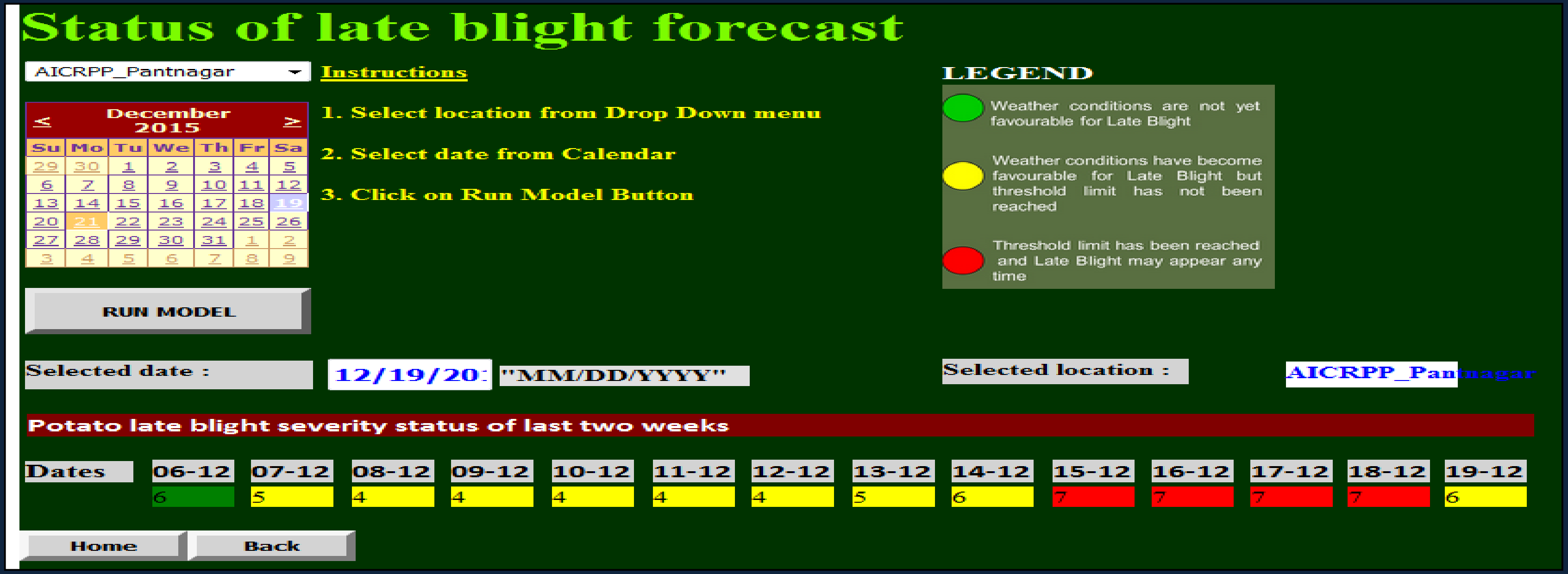


Window for getting forecast (unrestricted)



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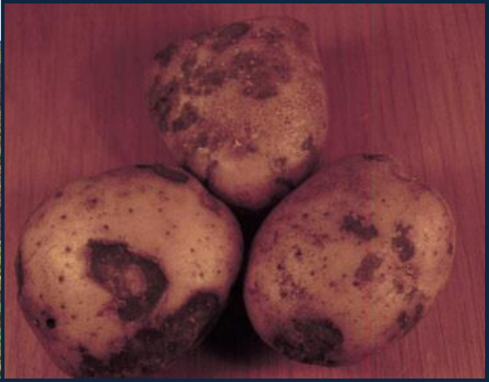
Validation of Indo-Blightcast Model

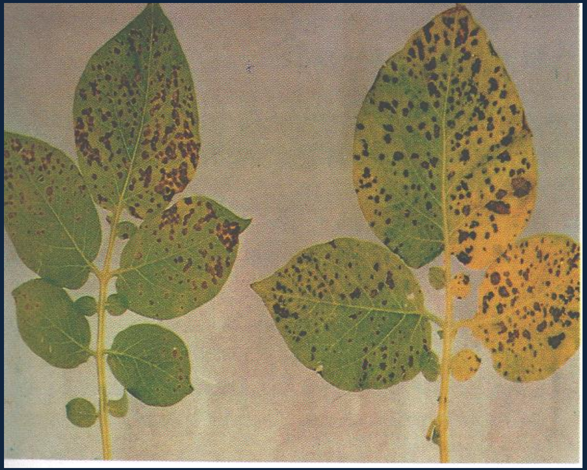
Location	Prediction date of late blight	Actual date of late blight appearance
Shimla (HP)	25.06.2015	07.07.2015
Ludhiana (Punjab)	06.12.2015	12.12.2015
Modipuram (UP)	15.11.2015	27.11.2015
Kalyani (WB)	26.01.2016	30.01.2016
Pantnagar (Uttarakhand)	05.12.2015	08.12.2015
Jorhat (Assam)	18.01.2016	22.01.2016

Early Blight and Leaf Spots

- Ubiquitous disease
- Prevalent in Asia, Africa, Australia, Europe, North, Central and South America
- May cause annual loss between 10 to 25 per cent



Phoma Leaf Spots



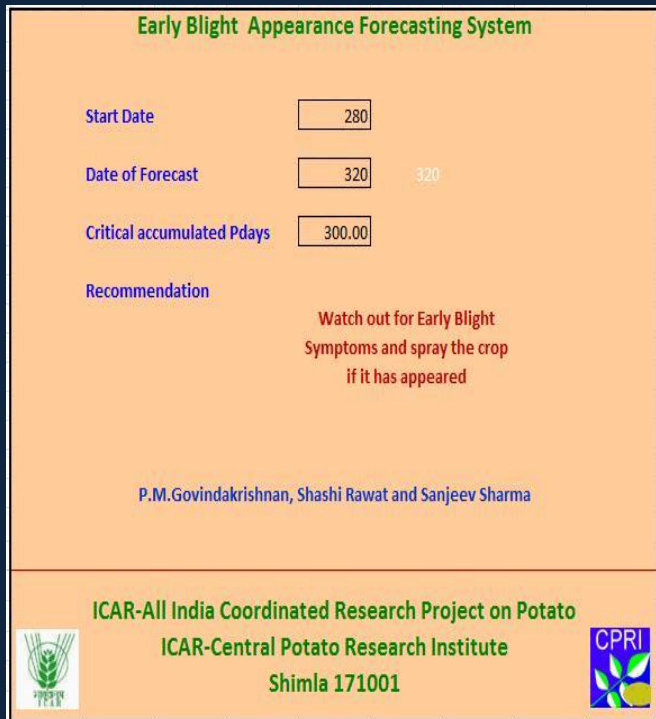
Disease spread and Development

- Favoured by moderate temperature (17-25°C) and high humidity (75%).
- Intermittent dry and wet weather is more conducive for early blight.
- Pathogens can survive in soil and plant debris particularly in temperate climate.

Disease Management

- Use disease free seed tubers.
- Balanced doses of fertilizers, especially nitrogen.
- Spray of 1.0% urea at 45 days crop growth and subsequent spray after 8-10 days may easily escape the severe onslaught of early blight and leaf spots.
- Fungicidal sprays are effective in controlling early blight and other leaf spots. Mancozeb (0.2%)/Copper oxychloride (0.3%)/ Bordeaux mixture (1.0%), chlorothalonil (0.2%) or hexaconazole (0.04%) are effective. Fungicides recommended for control of late blight, can take care of early blight and leaf spots.
- Cultivation of Solanaceous crops, being collateral hosts, nearby potato fields must be avoided.
- Removal and burning of haulms of the affected potato crop help in reducing the inoculum in the field.

Management of Early Blight



Year	Location	Date of Prediction	Date of appearance
2012-13	Bhubaneshwar	21.11.2012	Did not appear
	Deesa	03.12.2012	05.12.2012
	Pune	04.08.2013	13.08.2013
2013-14	Bhubaneshwar	01.01.2014	02.01.2014
	Deesa	15.12.2013	22.12.2013
	Pune	06.18.2014	08.08.2014
2014-15	Bhubaneshwar	28.12.2014	28.12.2014
	Deesa	22.12.2014	25.12.2015
	Pune	30.07.2015	14.08.2015

Soil and Tuber Borne Diseases

Soil and tuber borne diseases may cause-

- ✍ Disfiguring of tubers thereby impairing their quality - Black scurf, powdery scab, common scab.
- ✍ Tuber rots in transit and stores - Dry rots, charcoal rot, pink rot.
- ✍ Wilts and stem rots in field - Bacterial wilt, Verticillium wilt, Sclerotium wilt, Fusarium wilt.
- ✍ Both causing yield reduction and disfiguring of tubers - Potato wart

Black scurf (*Rhizoctonia solani*)

Distribution: Ubiquitous

Losses: Varies from region to region

Affects: tubers, sprouts, stems and stolons

Epidemiology: Pathogen survives in soil, crop residues and tubers.

- Low soil temp. and high moisture favour canker development
- Optimum soil temperature for disease development is 18°C
- High soil temp. (28-32°C) and high soil moisture favour development of sclerotia.

Charcoal rot (*Macrophomina phaseolina*)

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Distribution: Eastern & central plains

Pathogen causes: stem blight, charcoal tuber rot and dry tuber rot.

- 2 to 8 mm black spots surrounding lenticels and eyes.
- Underneath tissue (2-5mm) becomes uniformly black
- Under high humidity, tuber may be invaded by saprophytes resulting in soft rot.

- Both tubers and soil may serve as primary source of inoculum however, soil is the main source.
- Soil temperature is the most crucial factor for disease development.
- Temperature below 28°C almost completely checks the disease.

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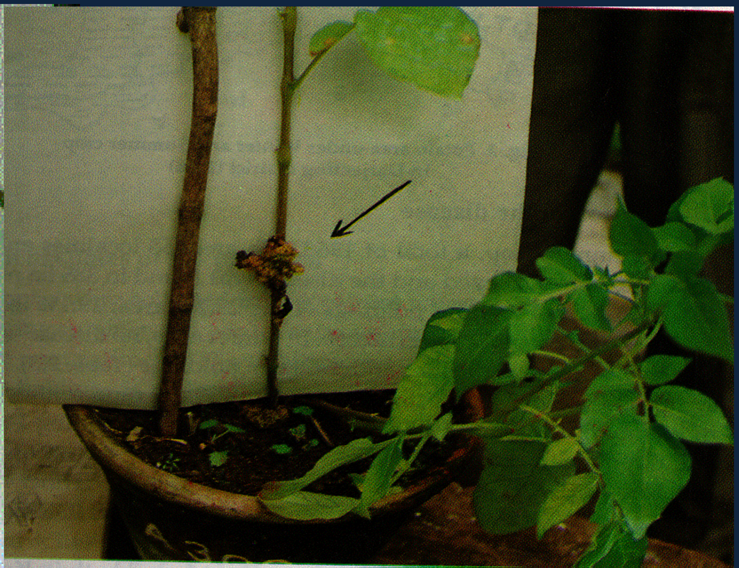
Powdery Scab (*Spongospora subterranea*)

- All underground parts are affected without showing any adverse effect on plant growth.
- The damage to the tubers is more serious.
- No effect on yield but tubers are disfigured and are unsuitable for seed purpose.
- Pimple like spots appear on the surface of young tubers.
- Deep pustules of powdery scab resemble deep pitted common scab lesions. However, powdery scab pustules are filled with mass of fungal spore ball whereas common scab lesions are empty.
- Small galls some times occur on the roots of affected plants.

- The fungus over winters through spores in soil and on infected seed tubers.
- The fungus may infect the tubers at or below 10°C.
- Low soil temperature (10-15°C) coupled with high soil moisture are ideal for disease development.
- This disease is a high altitude disease and is seldom noticed below 2500 meter above msl.

WART (*Synchytrium endobioticum*)

- Characterized by 'cauliflower -like' warty growths on tubers.
- Not recognised until tubers are dug out.
- Warty growths on the stalks may be observed near the ground level.
- Roots are not affected.
- A typical wart is roughly spherical but is usually not a solid structure.
- The warts are initially whitish or light cream in colour but with age turn brown to black.



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Epidemiology

- Both soil and tuber borne.
- Resting spores survive for 25-30 years even if the land is kept fallow.
- Sporangia germinate over a wide range of temperature (12-28^{o}C) if the moisture is favourable.
- Soil moisture essential for germination, liberation & movement of the zoospores.
- Soil reaction from neutral to slightly acidic.
- Spread through:
    - ✓ transportation of material containing resting sporangia
    - ✓ infected tubers
    - ✓ contaminated soil sticking to the surface of tubers, feet of human beings or animals
    - ✓ farm implements
    - ✓ manure containing diseased material
    - ✓ contaminated soil washed down from the infested field to another (in the hills) by rain water.

Integrated management of soil and tuber borne diseases

- Use disease free seed, preferably from disease free area/field.
- Treat seed potato with 3% boric acid for 20-30 minutes or through spray application before storage.
- Do not grow potato every year in the same field. Rotate it with crops like cereals, millets and non-solanaceous crops.
- Follow hot weather cultivation or soil solarization in plains and plateau and cold weather cultivation in hills.
- In plains and plateau, harvest potato crop before soil temperature rises above 28°C *i.e.*, by the end of February.
- Avoid injuries to the tubers during harvest, handling and transportation.
- Allow the potato tubers to cure for 8-10 days immediately after harvest preferably at 10-15°C.
- Store potatoes in well ventilated cool stores.
- If field remains fallow, plough regularly to minimize weeds, which harbour the pathogens. Alternatively, apply green manures.

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Bacterial wilt (*Ralstonia solanacearum*)

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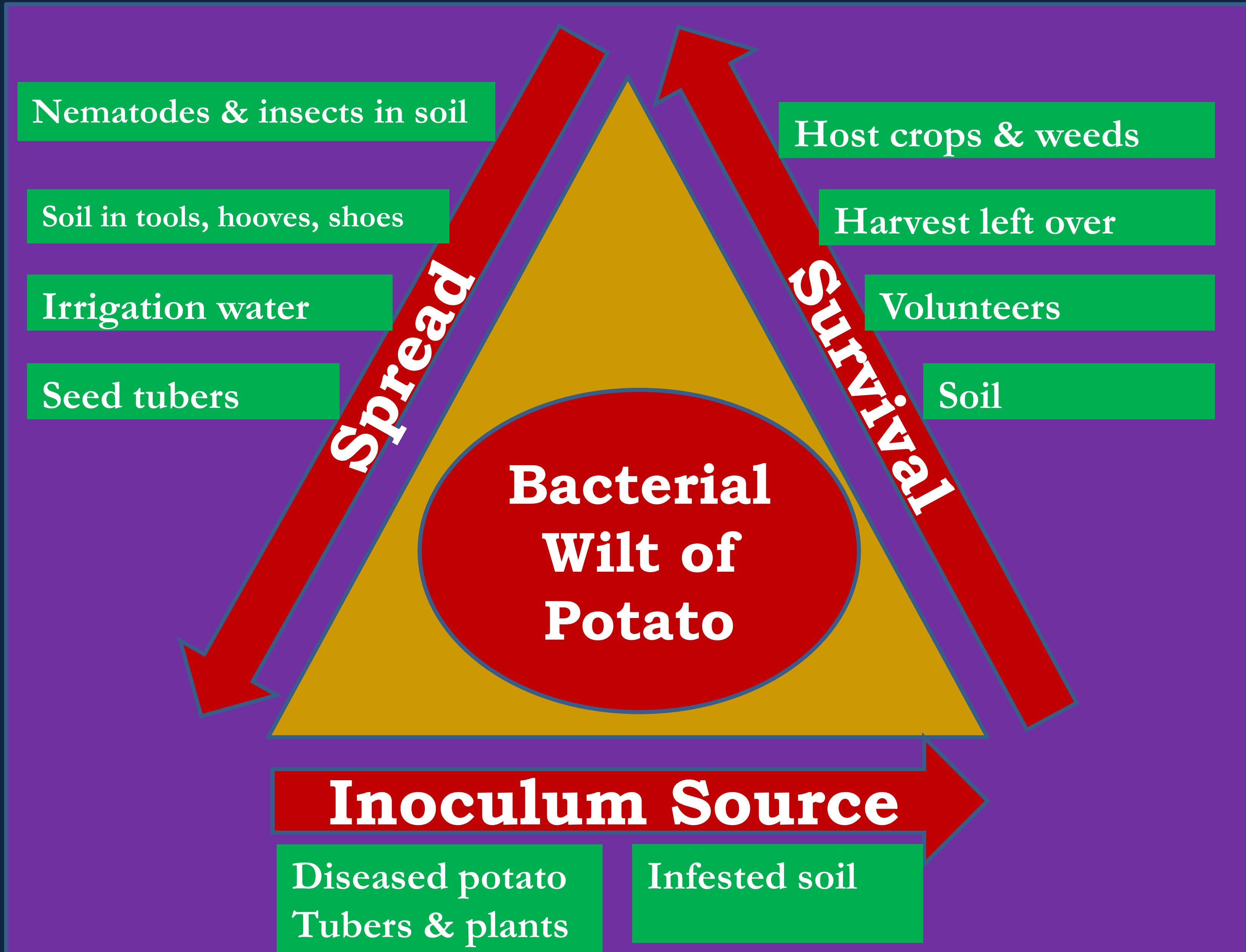

Nematodes & insects in soil
Soil in tools, hooves, shoes
Irrigation water
Seed tubers
Spread
Survival
Host crops & weeds
Harvest left over
Volunteers
Soil
Bacterial Wilt of Potato
Inoculum Source
Diseased potato Tubers & plants
Infested soil

Disease Management

- Use of healthy seed
- Do not cut seed tubers. Cutting spreads pathogen even to healthy tubers.
- Apply stable bleaching powder @12kg/ha mixed with fertilizer in furrows while planting. It reduces wilt incidence by 80%.
- 2-3 years crop rotation with maize, cereals, millet, garlic, lupin, onion, cabbage.
- Full earthing up. Deep ploughing twice at 20-30 days interval after harvest during summer in plains and in winter in hills.
- Early planting in February in NE hills reduces wilt incidence.

POTATO CROP WITH BACTERIAL WILT AND NO WILT

Common Scab (*Streptomyces scabies*)

Distribution: ubiquitous

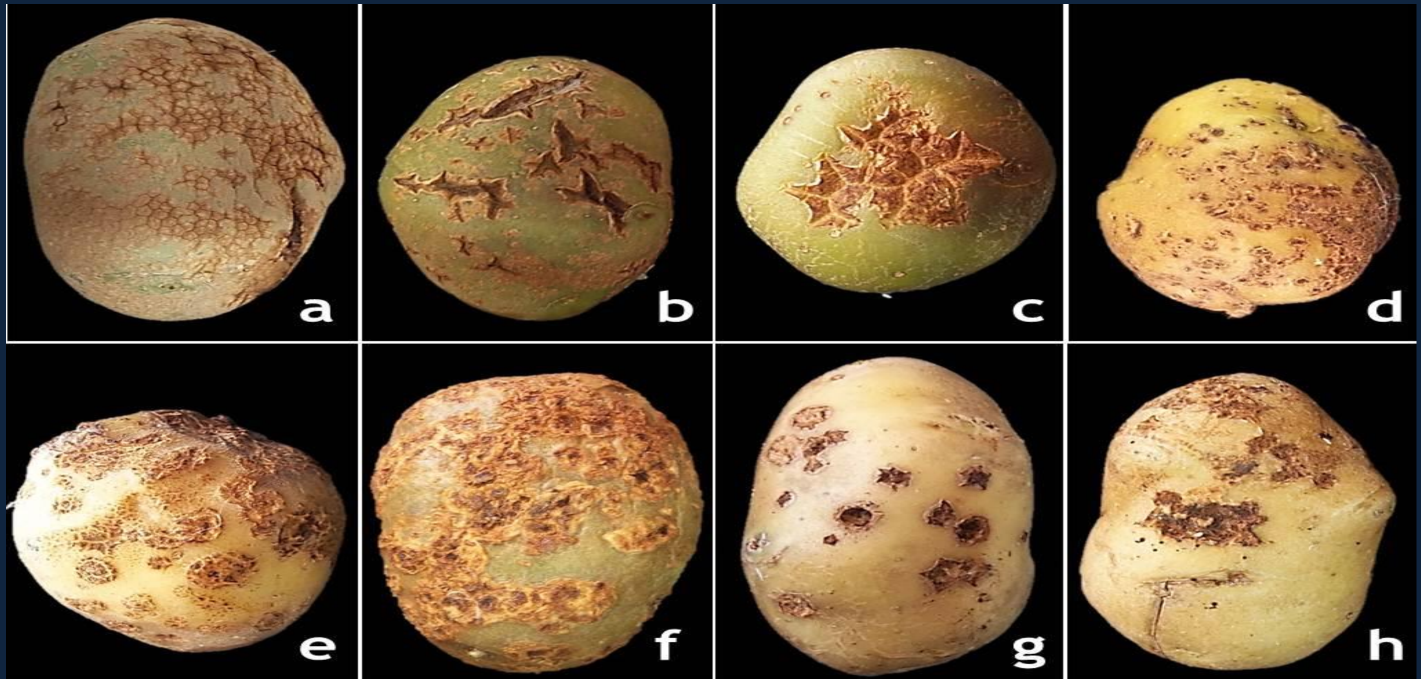
Scab types:

(i) Brownish roughening or abrasion of tuber skin (russet type).

(ii) Raised rough and corky pustules (erumpent type).

(iii) Deep (3-4) mm pits surrounded by hard corky tissue (pitted type).

(iv) Concentric series of wrinkled layers of cork around central black core caused by *Streptomyces* in association with *Fusarium oxysporum*.



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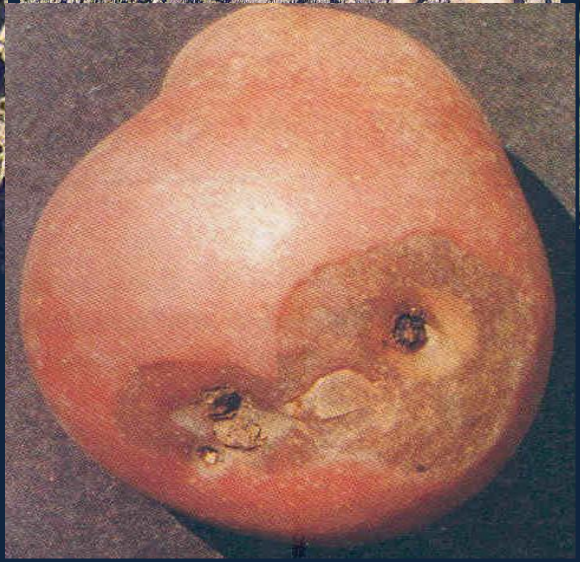
Disease Cycle

- Pathogen survives in tuber lesions and in soil
- It infects the young tubers in the field through lenticels.
- Infection is more in dry soils.
- High soil moisture prevents infection.

Black leg & Soft Rot



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Permissible Limits for Tuber Diseases

Grade	% incidence					
	Common scab	Black scurf	Brown rot	Late blight	Dry rot	Charcoal rot
FS-1	3.0	5.0	0.0	1.0	1.0	1.0
FS-II	3.0	5.0	0.0	1.0	1.0	1.0
Certified	5.0	5.0	0.0	1.0	1.0	1.0
Total tuber diseases			5.0			

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Potato Viruses

Potato is infected by over 30 virus and virus like agents

Viruses reported in India

Potato Virus Y
Potato Leaf Roll Virus
Potato virus X
Potato virus S
Potato virus A
Potato virus M
Stem Necrosis
Apical Leaf Curl

Transmission of Potato Viruses

Virus	Transmission
Potato virus S (PVS)	Contact/Aphid
Potato virus X (PVX)	Contact
Potato virus A (PVA)	Aphid/Mechanical
Potato virus M (PVM)	Contact/Aphid
Potato virus Y (PVY)	Aphids
Potato Leaf Roll (PLRV)	Aphids
Potato Apical Leaf Curl Virus	Whiteflies
Stem Necrosis	Thrips

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Potato Virus Y

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Potato Leaf Roll Virus






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Potato Virus A

Potato Virus X

Potato Virus S

Potato Virus M

Potato Stem Necrosis Disease

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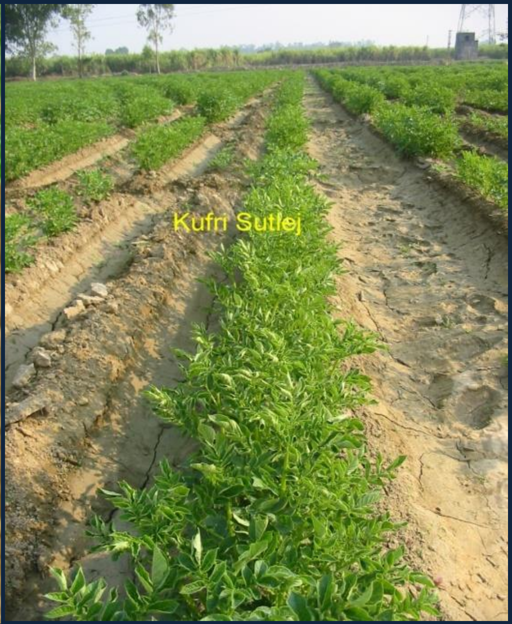
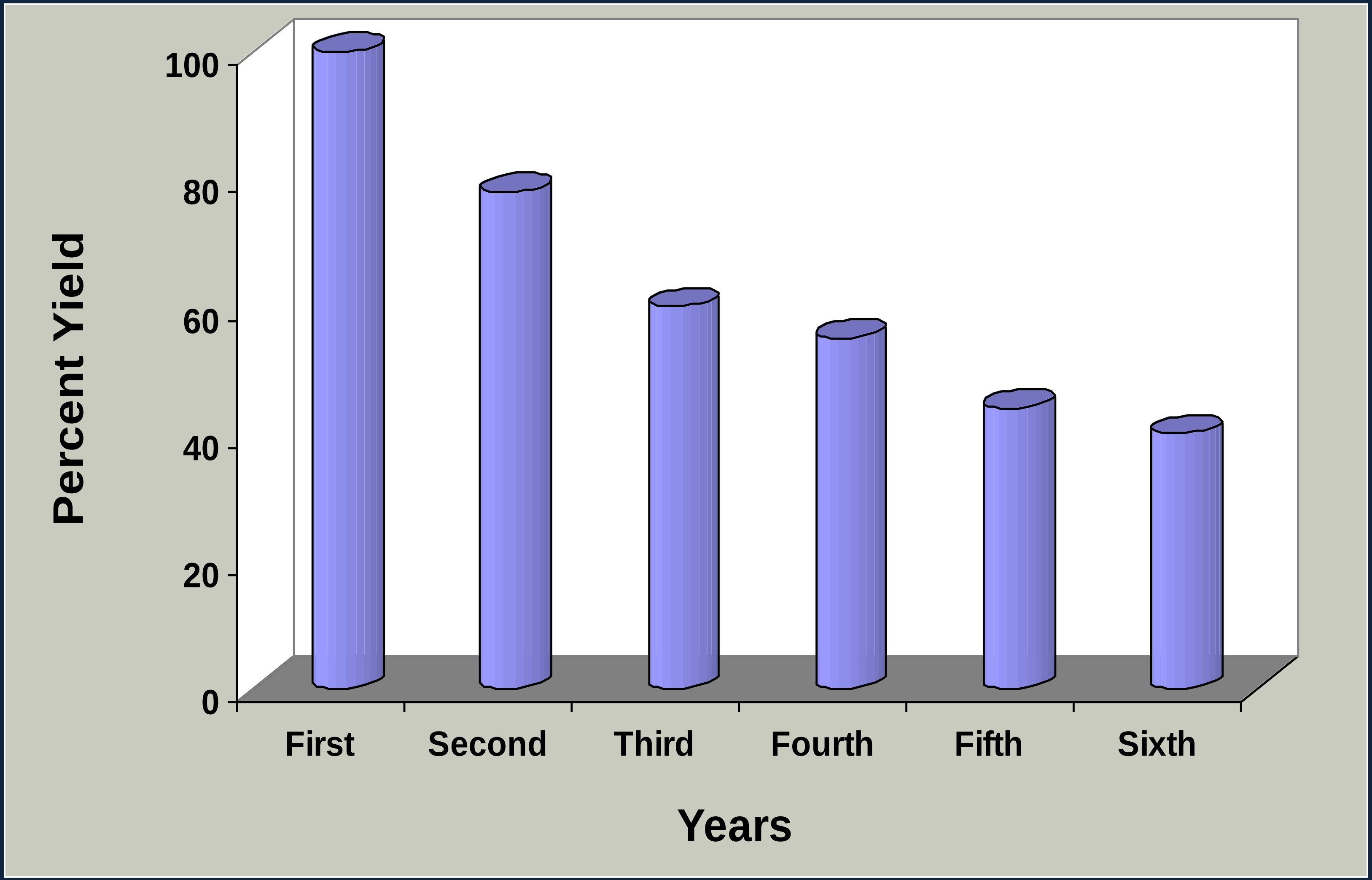
Tomato Leaf Curl Virus New Delhi Virus-Potato



Yield losses pattern in potato cultivars due to natural infection(s) of common potato viruses



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Virus Tolerance Limit in Potato Seed

Disease	Seed Class	Per cent Tolerance
Mild mosaic	Foundation 1	1.00
	Foundation II	2.00
	Certified	3.00
Severe mosaic, Leafroll etc.	Foundation I	0.50
	Foundation II	0.75
	Certified	1.00
Total viruses	Foundation I	1.00
	Foundation II	2.00
	Certified	3.00

Management Strategies

Priority I:	Seed health & certification
Priority II:	Tuber indexing
Priority III:	Quarantine
Priority IV:	a) Vector control
	b) Sanitation
	c) Stock cleaning
Priority V:	Host resistance

Integrated Management

Sanitation: strict sanitation in the field and also in stores, right from harvest to planting.

Essentially use disease-free seed stocks from approved or reliable sources.

Place yellow trap ($15X30cm^2$) just above the canopy height @ 60 traps/ha at equidistance from each other.

Rogue out the diseased plants carefully along with their tubers and dispose them.

De-haulming the crop before the aphids cross critical level to enforce rigid control of the insect vector

Seed treatment with imidacloprid (200SL) @ 0.04% (4ml/10lit) for 10 minutes before planting.

First spray with imidacloprid (200SL) @ 0.03% (3ml/10lit) at the time of emergence of crop.

Second spray with thiamethoxam (25WG) @0.05% after 15 days of crop emergence.

Combine thermo-and chemo-therapy followed by apical meristem culture for eliminating the viruses from seed tubers to produce pre-nucleus/mother seed stocks.

Aphids

- Install yellow water traps/yellow sticky traps for monitoring and mass trapping.
- Removal of all weeds, susceptible hosts and volunteer plants within and around the vicinity seed potato plots.
- Cut the haulms as the aphid number crosses the critical level i.e. 20 aphids/100 leaves.
- Spray imidacloprid 17.8% S.L @ 0.03% before aphids reaches critical level and repeat after 12-15 days.
- Application of mineral oils @1-3% protects potato plants from aphids and aphid transmitted potato viruses by interfering with the biology, physiology and feeding of aphids, and also makes the potato plants less attractive to aphids.
- In plains: Application of phorate 10G @ 1.5kg a.i./ha in furrows at planting time keeps the aphid vectors under check up to 45-60 days provided there is enough soil moisture. Followed by the need based application of any suitable systemic insecticides such as methyl demeton 25EC or dimethoate 30 EC @ 0.03 per cent, imidacloprid 17.8% S.L @ 0.03% and mineral oil @1-3%.
- Foliar spray of spiromesifen 240 SC at emergence @ 96 g a.i./ha (400 ml/ha) + second spray with Thiamethoxam (25 WG) @ 100 g a.i./ha after 15 days of first spray.




Whitefly

- Maintain field sanitation by removing and destroying the weeds, alternate hosts and crop residues of vectors and viruses.

- Place yellow sticky traps (15 x 30 cm^2) just above the canopy height @ 60 traps per hectare at equidistance from each other for mass trapping.

- Seed treatment with imidacloprid at 0.04% for 10 minutes and its foliar application at 0.03% at emergence with repeated application after 15 days is standard recommendation in seed potato crop. Foliar sprays of imidacloprid 17.8SL (0.03%) at 85% germination followed by Thiamethoxam 25WG (5gm/10 lit of water) after 10 days of the first spray.

- Foliar spray of spiromesifen 240 SC at emergence @ 96 g a.i./ha (400 ml/ha) + second spray with Thiamethoxam (25 WG) @ 100 g a.i./ha after 15 days of first spray.

Leaf hopper

Judicious use of nitrogenous fertilizers and balanced plant nutrition checks the hopper multiplication.

Early planted potato crop need to be protected from leafhoppers through foliar spray of insecticides. In seed crop, granular systemic insecticide, Phorate 10G@) 10kg/ ha can be applied at the time of planting or earthing up.

This is followed by application of oxydemeton methyl 25 EC @ 1 ml/ litre or dimethoate 30EC @ 2 ml/litre.

Spraying late in the day or in the evening gives better control than spraying early in the morning.

Mites

Spray dicofol 18.5 EC or quinolphos 25 EC @ 2 lit/ha or wettable sulphur @ 2.5 kg/ha.

The first application should be done on appearance of the pest crossing 5-10 mites per plant and repeated at 7 to 10 days interval
depending on the persistence of mite infestation.

Foliar spray of spiromesifen 240SC at emergence @ 96 gm a.i./ha (400ml/ha) followed by second spray with thiamethoxam (25 WG) @ 100 gm a.i./ha after 15 days of first spray and third spray of spiromesifen 240SC @ 96 gm a.i./ha (400ml/ha) after 15 days of second spray is recommended for the management of all sucking pests.

Mite infestation on potato crop can be avoided by delayed planting towards mid October in Indo- Gangetic plains.

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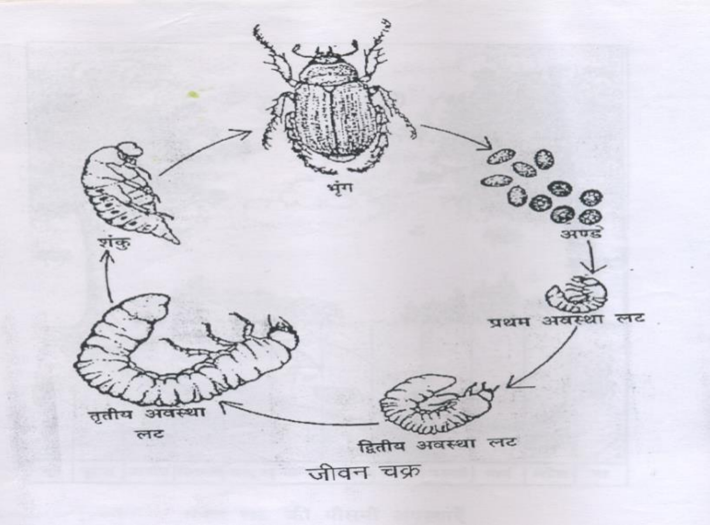
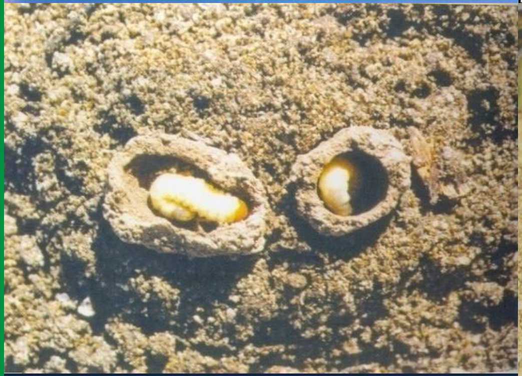
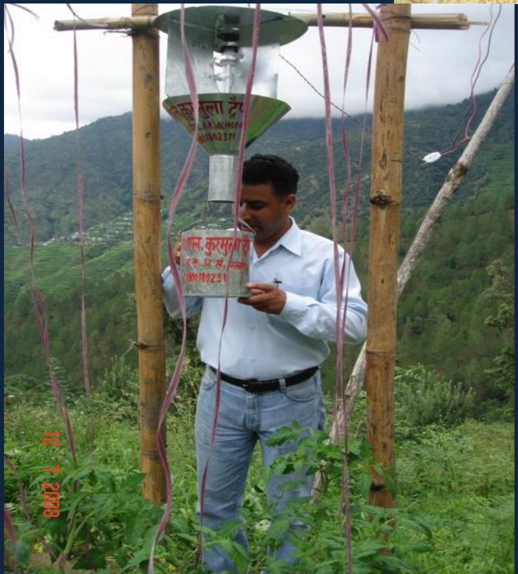
White grubs







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Potato Tuber Moth

Thank you