UNIVERSITY OF NAIROBI

SEED ENTERPRISE MANAGEMENT INSTITUTE (SEMIs) SHORT COURSES

2015 SERIES OF LECTURES, PRACTICALS AND FIELD TOURS

1.Seed Production

2.Seed Drying, Processing and Storage

3.Seed Business

4.Seed Marketing

5.National Plant Protection Organizations (NPPOs) and Seed Quality Regulators

6.Seed Production Field Diagnostics

7.Seed Quality Assurance and Seed Quality Management

Compiled By:

Mwang'ombe, A. W., Olubayo, F. M., Njoroge, K., Wasonga, D., Abook, B., Miringu, T. K., Kiwunja, F. and Amateshe, L.

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Acknowledgements:
School of Business, University of Nairobi
Seed Centre, Iowa State University
CYMMIT, Zimbabwe
International Consultants – Aline, F. O’Connor, Dilip Gokhale
KALRO
KEPHIS
Seed Companies: Kenya Seed, Leldet, Drylands Seed
University of Nairobi Library – Mugo, H. and Mioru, G.

SEED ENTERPRISE MANAGEMENT INSTITUTE (SEMIS)

OVERVIEW OF SEMIS TRAINING MODULES

Mwang'ombe, A. W., Olubayo, F. M., Njoroge, K.

AGRA
Growing Africa's Agriculture

IOWA STATE UNIVERSITY

CIMMYT
International Maize and Wheat Improvement Center

Project Implementation

Alliance for a Green Revolution in Africa-AGRA

Total funding:4,495,432.00 USD

Phase 1: 3 years (2010-2013),Phase 2-2014-2016

Institutions

University of Nairobi

PI: Prof. A.W. Mwang'ombe

Management: Prof. F. Olubayo, Prof. Kiarie Njoroge

Daniel Wasonga –Project Manager, Florence Kiwunja-Admin. Asst.,

Francis Maina, Caroline Ndumi, B. Kirangu -Field Assts

CIMMYT: Dr. John MacRobert (Author-Seed Business Mgt In Africa)	**KEPHIS:** DR. Esther Kimani-Director KEPHIS Mr. Kibet	**KARI:** Dr. Riungu and Dr. Ragwa	**Consultants** Aline O'Connor Funk Paul Seaward Paul Okete	**ISU** Dr. Misra Dr. Y. Shyy Dr. Joe Cortes Dr. Mike Stahr

SEED ENTERPRISE MANAGEMENT INSTITUTE (SEMIs)

Overall Goal

•Eradication of food and nutrition insecurity through capacity building of seed actors .

- •quality seed
- •affordable seed

Objectives:

1. To produce seed production and marketing management expertise in SSA region

2. To train seed industry practitioners on the best practices to efficiently produce adequate high quality seed for farmers.

3.To enhance production of seed of improved varieties for the SSA

- Efficient production
- Marketing
- Good distribution

4. To strengthen the capacity of the SSA region to train on seed production and marketing management strategies

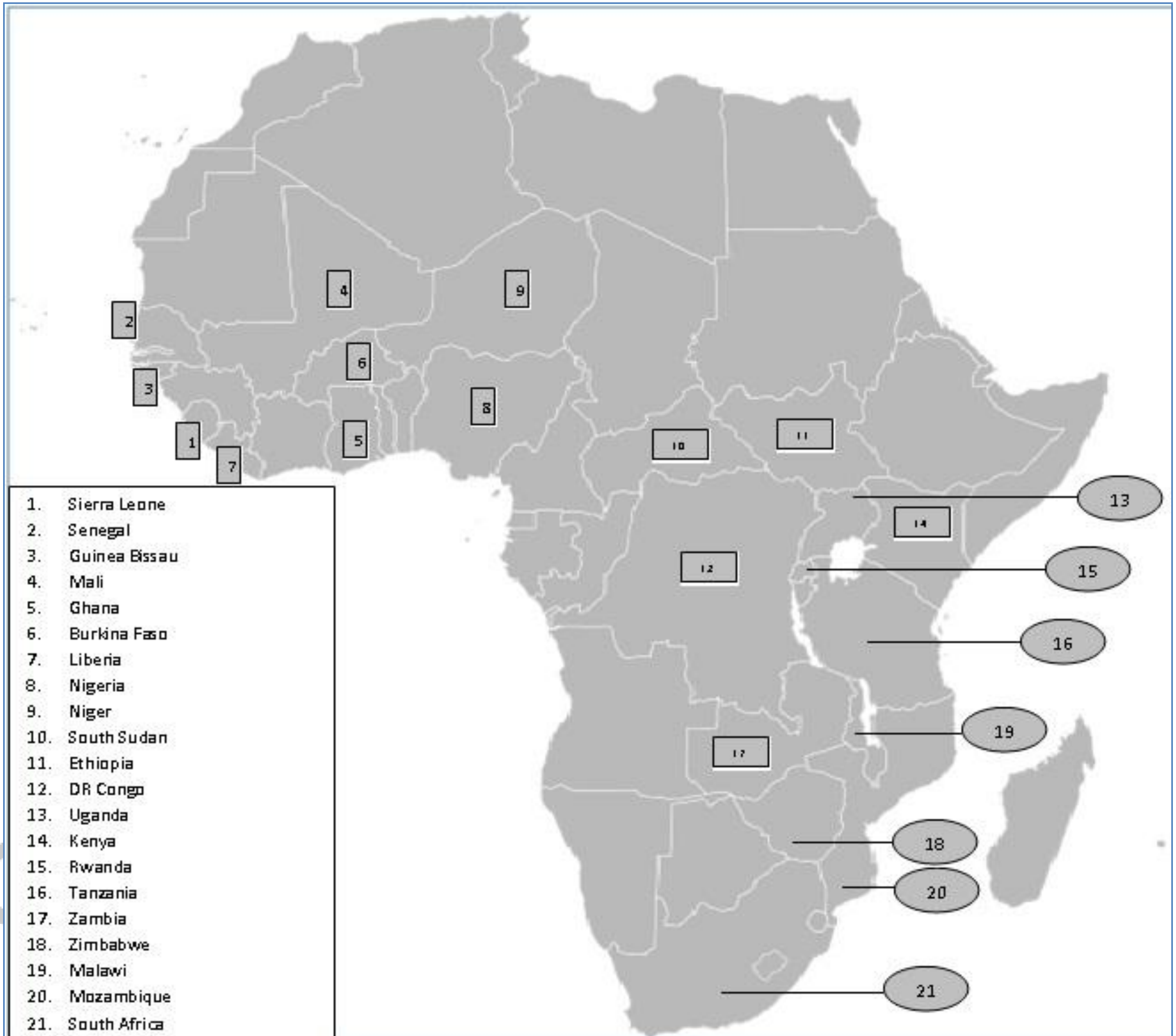
- Enhanced technology

5.To develop a regional capacity to facilitate information sharing on seed issues and related disciplines in SSA.

Growing the Seed Industry in Africa


SEMIs PARTNERSHIPS
SEMIs
UoN
ISU
IOWA STATE UNIVERSITY
KARI, KEPHIS
KENYA SEED
KARI
AGRA
CONSULTANTS
CIMMYT
agra-alliance.org
cimmyt.org
kephis.org
uonbi.ac.ke
iastate.edu
kenyaseed.com
HELPING STUDENTS SUCCEED
GROWING THE SEED INDUSTRY IN AFRICA

SEMIs in 21 African Countries!!!



SEMIs COURSES AT UON:

Course	Collaborators	Coordinators
Seed production	UoN, CIMMYT, KEPHIS, KALRO, Leldet seed co.	Prof. Kiarie Njoroge/ Prof. Olubayo
Seed drying processing and storage	UoN, ISU, KEPHIS, KALRO, Kenya seed Co.	Dr. Onyango Mbunge, Prof. Kiarie Njoroge, Prof. Olubayo
Seed marketing	UoN (sch of Bus), Aline O'Connor, Kenya seed Co.	Dr. Justus Munyoki, Prof. Kiarie ,
Seed Business Mgt.	UoN (Sch. Of Bus.) Aline O'Connor, Kenya seed Co.	Prof. Evans Aosa, Prof. Olubayo, Mr. Herick ondingo
Seed Quality assurance and Seed Enterprise Quality Management	UoN, ISU, KEPHIS, KALRO, Kenya Seed Co.	Prof. Olubayo, Prof. Muthomi, Prof. RD. Narla,
Seed Production Field Diagnostics	UoN, KEPHIS, KALRO, Kenya Seed Co.	Prof. Olubayo, Prof. Muthomi/Prof. Narla/Prof Mwang'ombe
National Plant Protection Organizations (NPPO)	UoN, KEPHIS, KALRO, Kenya Seed Co.	Prof. Kiarie, Prof. Olubayo

SUMMARY OF TRAINED PERSONNEL IN PHASE I – 2010-2013

Course	2010	2011	2012	2013	Total Per Course
Seed Production	29	27	30	0	**86**
Seed Drying Processing and Storage	31	28	30	0	**89**
Seed Business Management	29	26	29	25	**109**
Seed Marketing	28	25	30	27	**110**
Seed Quality Assurance	30				**30**
Seed Legislation and Accreditation	25				**25**
Seed Quality Assurance and seed Enterprise Quality Management		26	29	0	**55**
Total(Yearly)	**172**	**132**	**148**	**52**	**504**

SUMMARY OF TRAINED PERSONNEL IN PHASE II – 2014-2016

Course	2014	2015
Seed Production	23	26
Seed Drying Processing and Storage	23	25
Seed Business Management	19	30
Seed Marketing	20	31
Seed Quality Assurance and seed Enterprise Quality Management	19	30
National Plant Protection Organizations and Seed Quality Regulators	21	24
Seed Production Field Diagnostics	18	24
Total(Yearly)	**143**	**190**

Seed processing and drying

Seed production

Seed Marketing

Long Term courses in Seed Technology and Business:

Curriculum already in place for:

I. Certificate-Seed Technology and Business
II. Diploma -Seed Technology and Business
III. Post-graduate Diploma-Seed Technology and Business
IV. MSc.-Seed Technology and Business

15 Students have enrolled for the MSc. Seed Technology and Business program

SEMIs Curricula

- Involvement of stakeholders in the development;
- ISU, Consultants, CIMMYT, UON, KARI, Seed Companies
- Annual Review every year to keep abreast on seed Issues and changing trends in the seed industry

Result →

One of the best "thought-through" and relevant curricula in Africa focused on seed

World Class Facilitators:

John MacRobert-CIMMYT

Kiarie Njoroge-UON CAVS

Jenny Leakey-Leldet

Dr. Yuan Shyy-ISU

Aline O'Connor –Seed Business mgt

Dr. Joe Cortes-ISU

KEPHIS

TRAINED PERSONNEL ARE A GREAT ASSET FOR SEED COMPANIES:

The training at SEMIs is helping Scaling up production of high quality seed for farmers around Africa

Dry Land Seed co.

So far over 100 seed companies from 21 African Countries have benefited from training at SEMIs

Other Activities at SEMIs:

Foundation seed production at CAVS:

Varieties:

- Meizi mbili
- Kenya Wonder
- Kenya Red Kidney
- Kabete Super
- Kenya Sugar Bean
- Super Rosecocco

Provision of foundation seed for seed co.

White label seed produced at SEMIs

Year	Tonnage	Variety
2013	1.76 tonnes	Kenya Red Kidney, Meizi Mbili
2014	4.3 tonnes	Kenya Red Kidney, Kabete Super, Miezi Mbili

Presentation of White label breeder seed to Kenya seed company CEO. Mr. Soi at a ceremony at CAVS

"Seed companies all over Africa indicate foundation seed availability and access as a major contributor to low seed production"

SEMIs INFRASTRUCTURE DVPT

Modern Seed laboratory and Seed Processing facility being constructed at CAVS with SEMIs funds

Phase 1: Seed Processing Unit.

•Seed from UNISEED and other seed companies to be processed

Phase 2: Modern Seed Laboratory for Seed Quality Assurance

•Seed Quality Laboratory

Phase 1: Seed Processing Unit

Construction of Seed processing factory is complete. The factory to process over 5000 MT of seed

- Installation of seed processing machines ongoing.
- Expected handover date- Early August 2015



PHASE II: LABORATORY CONSTRUCTION

- Construction of seed laboratories is ongoing- 90% is complete
- Painting works and fittings ongoing with expected handover – End September, 2015

Participation in National and Regional Workshops and Meetings on Seed Issues

Agricultural Sector Development forum- Kibaki in attendance

Kenya-Agricultural transformation Day in Nairobi

Other meetings	Year
FARA Meeting	2011
KARI congress	2012
STAK congress	2013
ASK Show	2014

H.E. Mohamed Shein Pres. Of Zanzibar at the AFSTA-Congress Zanzibar

SEMIs at the ASK show in Nairobi

Rosebenna from SEMIs talks to farmers on the New Bean Varieties

SEMIs is a point of call for seed companies:

Seed company personnel with STAK officials call in at SEMIs

- Agricultural /Seed Institutions are using SEMIs as a port of call during meetings and visits

- Point of reference for seed trends.
- Need to platform this to become the leading seed reference point in Africa

Highlights ..

Experiential training-Visit to the seed industry

Training on Finance and capital Acquisition:

-Root capital and ASIF funding

Experts at SEMIs

Collaboration with Stakeholders and Experts:

Dr. Julius Kipng'etich-Director, Kenya Wildlife Services (KWS)

Guest lecture at the seed business module course

Observed Changing trends in the Seed Industry in Africa…..

"as I move across Africa, I see African Farmers have changed their strategy to improved seed"

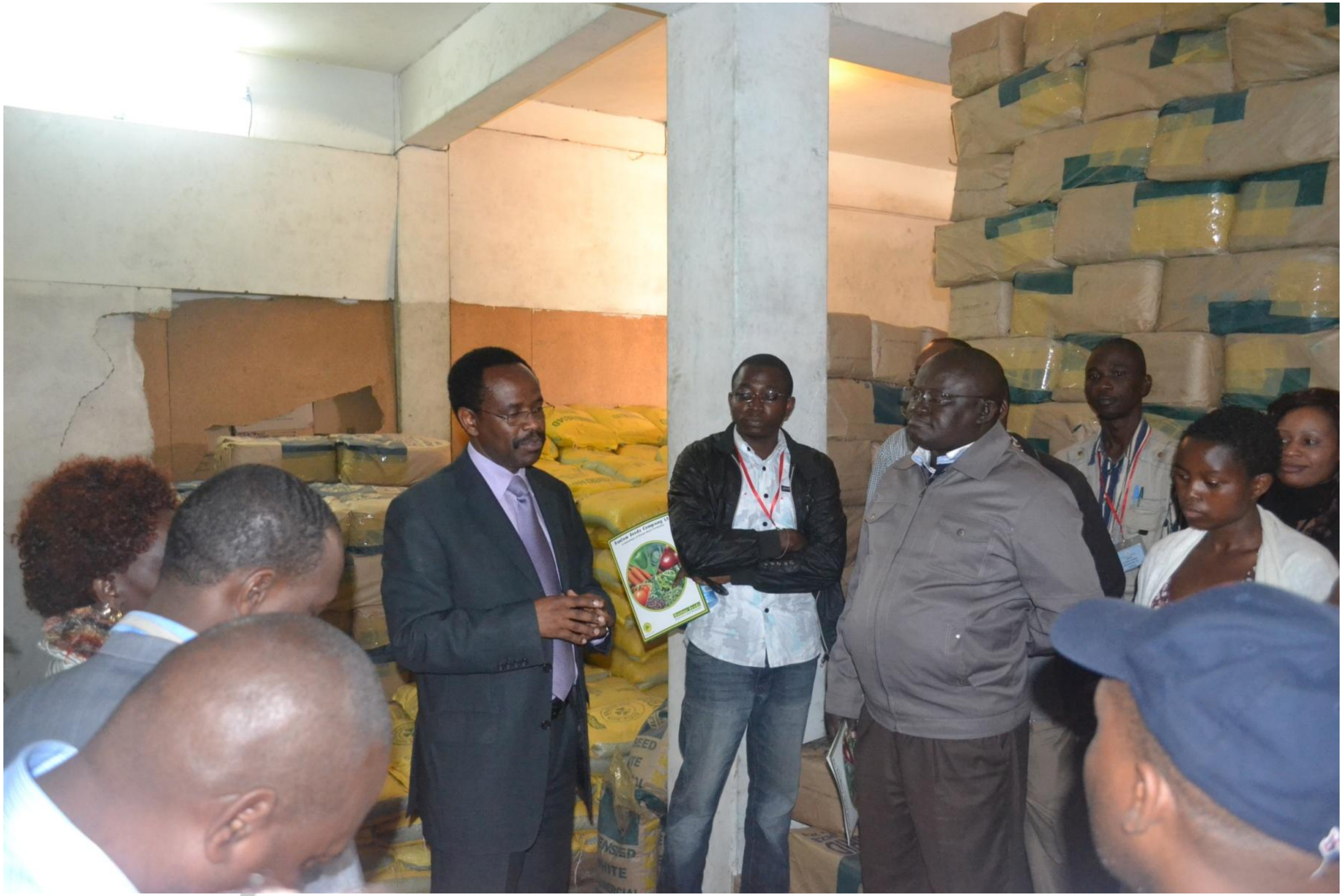
Dr. Joe DeVries-Director, PASS

Highlights contd:

Seed Production May 2012:

Visit to KARI Wheat Rust Resistance Breeding Station-Njoro

Seed Marketing Course-July 2012



Participants with the MD-Simlaw Seed company Mr. Soi

Seed Business Management-2013

Visit to Dry land Seed company seed store in Machakos

Seed Processing Course 2014

Familiarization with Certified seed packaging at a seed company in Kenya

Working with consultants to enhance capacity Building

Seed Business Class with Dilip Gokhale

Graduation –Certificate presentations:

Joe DeVries-Director Pass presents certificate and books to participants

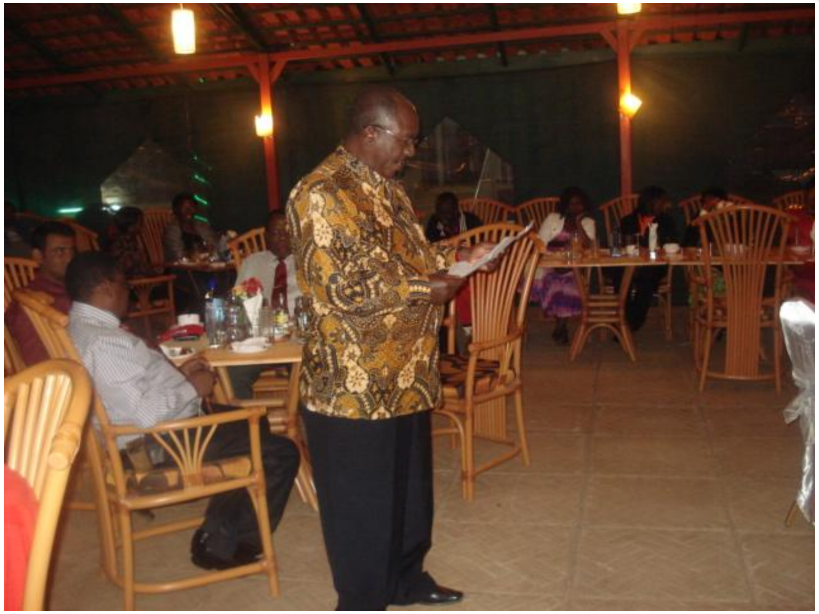
Prof. Mwang'ombe-SEMIs PI presenting a certificate to Janet Gyima from Ghana

Rewarding our Participants with certificates at the end of each course motivates them to be better "seed men"

Comments from Participants:

"I like every topic we did in this course especially seed certification and de-taselling "
Annonymous .

"The knowledge I have acquired through the course will be highly valued not only in our seed company but in the whole of Zambia"
Dorica Banda
Indigenous seed company Zambia

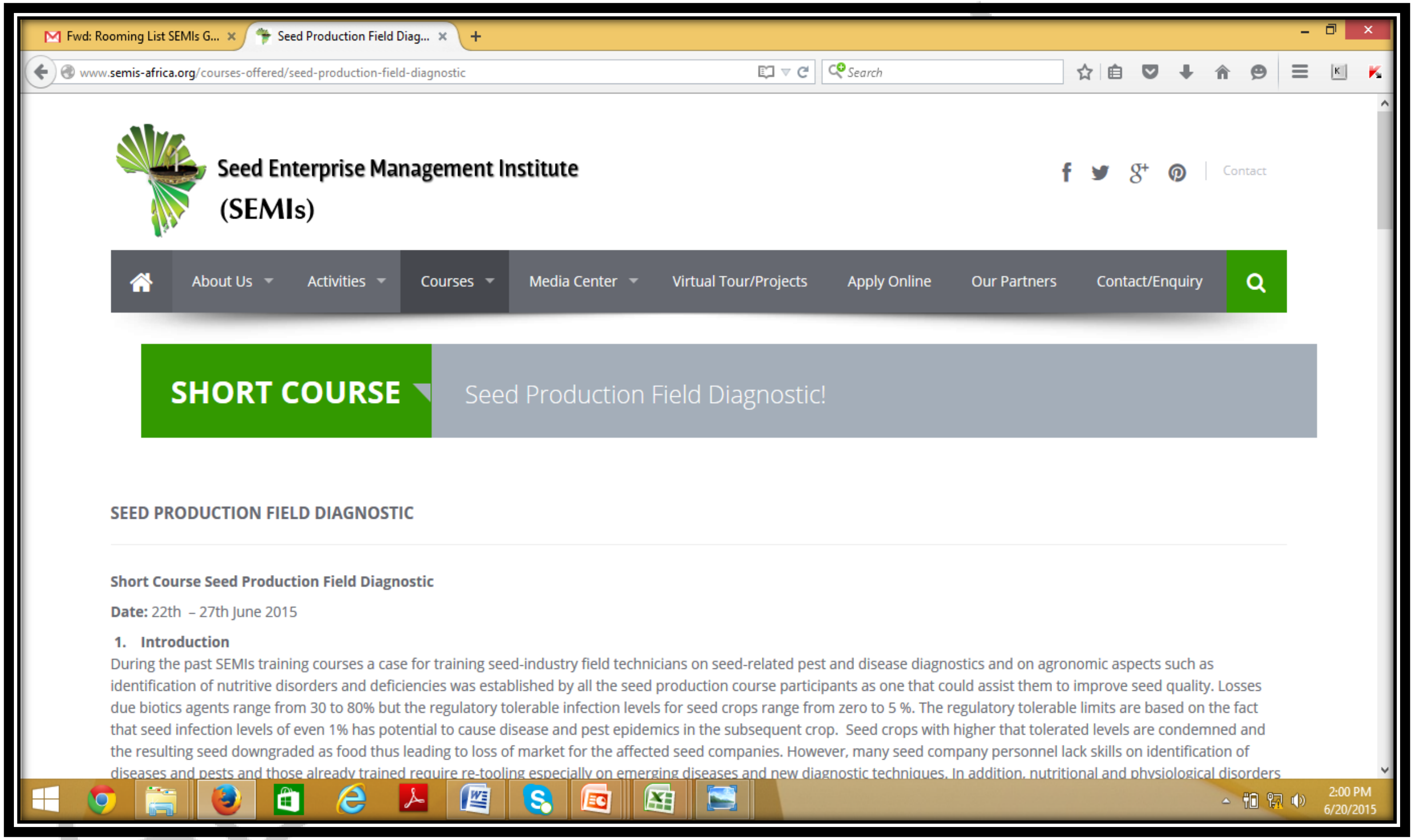


"Previously I did not know how to project seed requirements and co-ordinate backwards for procurement of basic, pre-basic seed…" Now I know"
Mr Omari Mduruma-Aminata seed company Tanzania

Monitoring and Evaluation:

A monitoring and Evaluation team from AGRA visited SEMIs on 19th February 2012 to assess the project

SEMIs Website: www.semis-africa.org



- Sharing information on seed issues, current happenings in the seed industry in Africa
- Staying in touch with SEMIs participants
- Online registration of Students

Thank you for your attention

Seed Production and Diagnostics

- By Prof. Emmanuel S. Ariga

Contents

UNIVERSITY OF NAIROBI

SEED ENTERPRISE MANAGEMENT INSTITUTE

SEED PRODUCTION FIELD DIAGNOSTICS

PROBLEMATIC WEEDS OF TARGET CROPS

PROF EMMANUEL S. ARIGA

WEED IDENTIFICATION

- Identification is important for successful control important for successful control
- Identify by Local name, common name and scientific name
- If in doubt collect intact samples and take to a herbarium for identification
- Include all plant parts (roots, shoots, flowers and fruits/dispersal unit
- Identify where Herbarium is in your country

Common name	Scientific name	Description	Dissemination	Economic importance
Oxalis, wood sorrel	*Oxalis latifolia*	Broad leaf, tap roots bulb, perennial	Ploughing, eaten as salad	Alternate host *Puccinia sorghi*, ornamental
Double thorn	*Oxygonum sinuatum*	Tap root, net veined leaf, stem herbacious, annual, has thorns	Attachment to Animals, man	Fodder, mulch, thorn injury
Wandering jew	*Commelina benghalensis*	Tap root, succulent stem, parallel veins, trailing, perennial	Stem cuttings at ploughing	Fodder, vegetable
Thorn apple	*Datura stramonium*	Errect, grows to 1m, tap root, broad leaf,, oval fruit with hooks	Shattering, water, animals	poisonous
Black jack	*Bidens pilosa*	Tap root, dicot, hooks,	Animals, man, equipments	Crop/wool contaminant
Lion's ear	*Leonotis nepetifolia*	Errect, annual, dicot, tap root, woody stem, spikes	Animals, man, water	Source of necta,

Commo n name	Scientific name	Description	Dissemination	Economic importance
Mexican marigold	*Tagetes minuta*	Erect, grows to 2m, yellowish flowers, seeds in capsule, pungent smell, tap root, dicot	Shattering, water, wind	Controls nematodes
Sowthisle	*Sonchus oleracious*	Dicot, has latex, annual, erect, stem hollow, tap root, serrated leaves, tuft of hair on fruit	Wind, water	Vegetable, fodder, medicinal
Black night shade	*Solanum nigrum*	Erect, dicot, tap root, branched stem, annual	water	vegetable
Ground cherry	*Physalis peruviana*	Erect, dicot, branching, fruit encased in membrane, tap root, soft wooded stem	Water, wind, man	Ripe fruits eaten, jam. Sauce. Unripe poisonous
Pig weed	*Amaranthus hybridus, spinosus, retroflexus*	Errect, spines (*spinosus*), dicot, tap root, sacculent stem	Animal, man, animals, water, medicine	Vegetable, fodder, green manure

Commo n name	*Scientific name*	Description	Dissemination	Economic importance
Galant soldier	*Galinsoga parviflora*	Dicot, tap root, erect, branches, soft stem, annual	Wind, cultivation	Fodder, medicinal
Devil's thorn	*Emex australis*	Prostate stem, dicot, tap root, has spines, seed propagation, leaves oval	Animals, man, water, implements	Fodder, green manure
Chinese lantern	*Nicandra physalodes*	Dicot, tap root, fruit encased in membrane	Water, wind	Green manure Aesthetic (Chinese)
Nogoora bur	*Xanthium pungens*	Tap root, dicots, rough green blotched purple leaves covered with stiff hair, fruits have burrs (thorns)	Animals, water, man	Contaminants in wool, poisonous to livestock
Fleabane	*Conyza sumatrensis, bonariensis*	Dicots, biennial, greenish stems with hair, erect, serrated leaves	Wind, water	Fodder, green manure
Kikuyu grass	*Pennisetum clandestinum*	Underground rhizomes, seeds, leaf blades, grass, perennial, roots at the node, roots fibrous	Cultivation, man as lawn	Lawn grass, fodder

Commo n name	Scientific name	Description	Dissemination	Economic importance
Couch grass	*Digitaria scalarum*	Perennial, grass fibrous roots, creeping grass, underground rhizomes, seeds	cultivation	Fodder, lawn
Love grass	*Setaria verticilata*	Annual, grass, linear leaf blades, has bristles	Animals, man, water, wind	Fodder, irritant
Purple/ Yellow nut sedge	*Cyperus rotundus/ esculentus*	Sedge, perennial, stem with triangular cross section, produce seeds and tubers	Cultivation, water	Agar batties (sweet scented sticks)
Wild oat	*Avena fatua*	Grass, parallel veins, fibrous roots, mimicry oat, errect	Crop contamination	fodder
Wild finger millet	*Eleusine indica*	Grass, annual, stems & leaves hairy, fibrous roots, erect, mimicy millet	Crop contamination	fodder
Purple & Red Witch weed	*Striga hermonthica asiatica*	Parasitic on maize, sorghum, sugarcane, upland rice, tap root	Wind, Crop contamination, water, livestock	Green manure

WEED CHARACTERISTICS

- High/some out put of seeds in good/bad environment
- Crop mimicry (vegetative, seed, biochemical)
- Seed dormancy (Striga up to 20 years)
- Thorns, hairy, hooks, allergenicity, poisonous
- High competitive ability (luxurious consumers)
- Self compatibility
- Power to regenerate
- Wide tolerance to environmental condition
- Allelopathy
- Dissemination capacity (Water, Wind, Animals, Shattering and Human activity)

EFFECT OF WEEDS ON SEEDS

- Low marketable seed yield (yield loss due to weeds in your country?)
- Shrivelled seeds, poor germination and emergence
- Low 1000 seed weight poor seed quality
- Weed/crop seed contamination- Quality criteria
- Alternate host to pests and diseases- indirect

WEED CONTROL OPTIONS

- Preventive (quarantine/law, education, research)
- Mechanical/Physical (roguing, hoeing, mowing, flooding, mulching, burning/flaming, tillage)
- Cultural (crop competition, allelopathy, spacing, intercropping, fertilizer placement, irrigation and drainage, early planting, liming, crop rotation)
- Biological control: insects, pathogen, allelopathy
- Chemical weed control (herbicides- pre and post emergence)
- Integrated weed control (most recommended)

- By Dr. Dora Kilalo, Prof. Florence Olubayo and Prof. R. D. Narla

Contents

TRANSMISSION AND SPREAD OF DISEASES AND ARTHROPOD PESTS

Dr. Dora Kilalo
Dept. of Plant Science and Crop Protection

Outline

- Definitions
- Methods of transmission/spread of diseases
- Methods of spread of insect pests

Definitions

- **Transmission:** ability to pick up a pathogen from one plant and pass it on to another plant. Insects /nematodes have that ability to obtain, carry and deliver a pathogen which without the presence of insects would not have been able to move
- **Spread**: movement from an infected/ infested plant /area to a non infected plant or area
- **Prevention**: keep from becoming a problem
- **Suppression**: reduce its increase and effect on the host plant
- **Eradication:** use methods and destroy pests

Introduction

- Most crops are subject to damage by pests and diseases
- All parts are affected and the genetic potential is interfered with
- All plant parts are damaged : seeds, roots, stems, leaves and fruits
- When plants are affected there is reduced plant vigour and in some cases plant death and crop loss occurs

Introduction

- Plants cannot move from one place to another except by being swayed by wind side to side
- Diseases and pests affecting plants must therefore be brought in to infect or infest (primary inoculation)
- Diseases and pests must have a way of moving from plant to plant within the field (secondary infection)
- There are different modes of movement of these pests and diseases

Modes for movement of pests and diseases

- Wind (weed seeds, fungi, insects/mites)
- Seed (weed seeds, fungi, bacteria, viruses, nematodes)
- Infected soils : with fungi, bacteria, nematodes or larval or pupae stages of an insects
- Rain splash /hailstorms (bacteria, fungi, nematodes)
- Infected irrigation water (fungi, bacteria, nematodes)

Modes for movement of pests and diseases

- Farm implements (soil, plant parts, left over seeds)
- Movement of vegetative plant parts
- Animals (birds, mammals (hair/fur), rodents)
- Man (trade, movement of seed, insects on farm working cloths, weed seeds attaching on cloth, shoes /boots from one field to another

Dispersal

- Dispersal of pathogen, pollen, and seed
  - Pathogen: effective dispersal depends on traits of spores (size, moisture, UV susceptibility) and threshold number needed for infection
  - Longer movement sometimes through stepping stones
  - Usually infection shows patterns of aggregation (clustering). It is an easy way to show infectious disease

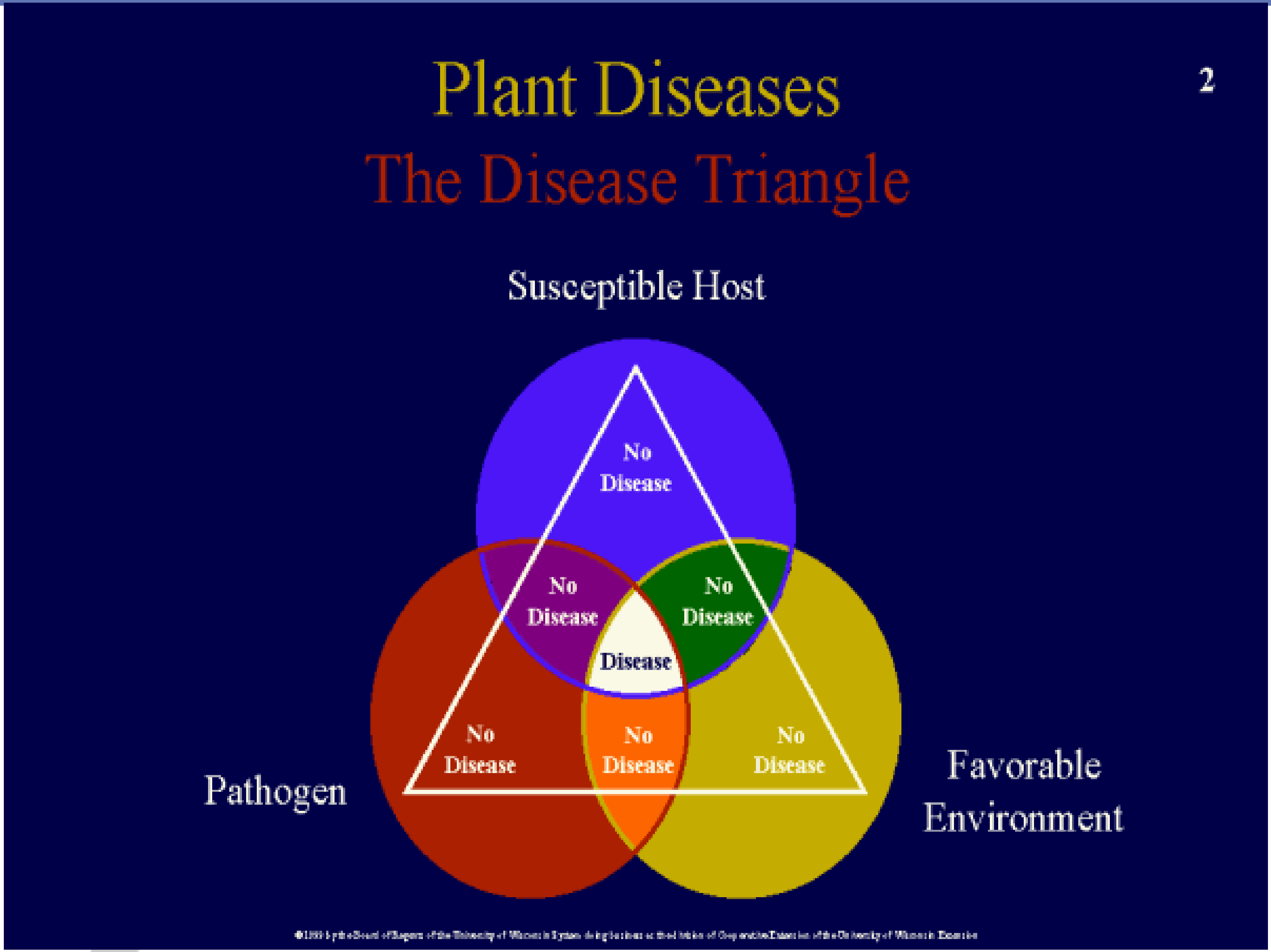
Determinants of spread

- Amount of inoculum or abundance of organisms(insects, PPNs, spores,)

- Location of inoculum

- Susceptibility of the host

- Favorable environmental conditions (temperatures (18-30^{o}C), RH% (50-95%), wind direction and speed, soil moisture, host stage (susceptible) and plenty of food resource



Disease triangle

Pathogen

Does it need a wound to infect a host?

Can it survive in the environment without a host?

- soil, water
- on alternate host

How does it move around?

- airborne/waterborne
- animal vectors
- humans

Virulence + reproductive potential=transmission

Host

Must be physically present with pathogen

Must be physically compatible with pathogen

Must provide window of opportunity for infection

Tolerance

losses where infected

but ability to redirect resources

What type of resistance?

simple= one gene

complex=several genes

Environment

Climatic changes

Climate patterns match pathogen biology (high RH, rainfall when needed, temperature range for growth: thermophilic vs. psychrophilic organisms, Max-min temperatures)

Host phenology: synchrony between pathogen and Host (is it the host's most susceptible time period)

Examples of diseases transmitted (bacterial pathogens)

Bacterial wilt

- seed borne (survives for many years), survives on plant debris and susceptible weeds
- Spread by surface irrigation, hailstorms, can infect host through wounds, through movement of infested soils

Other bacteria can be carried on insect legs and mouth parts, implements, mans movement passively

Common blight of beans

- Seed borne, spread via natural openings and wounds, wind driven rain, hailstorms, insects and farm implements

Halo blight

- Seed borne, spread by splattering rain water, hailstorms, wind blown rain

Examples of diseases spread (fungal pathogens)

- Fungi (Alternaria leaf spot):
  - Spores disseminated by wind,rain, insects, and fungus is also found in seed
- Fungi (Fusarium root rot):
  - Spread by drainage water or irrigation water, movement of infected soil, man, farm implements, soil in touch with seed
- White mould:
  - Spread by sclerotia on seed, air borne ascospores,
- Fungi (Rhizoctonia):
  - Soil borne fungus spread by soil movement from one place to another (shoes, potting soils)

Examples of diseases (nematodes and viruses)

Plant parasitic nematodes

- through infested soils, eggs on seeds or plant parts, vegetative planting materials, insects **e.g RKNs, Cyst ematode**

Common mosaic

- In weed hosts where inoculum is picked by insects (aphids) or mechanically spread by plants rubbing against one another or against weed hosts, through infected seed, can be spread in pollen

Golden mosaic of beans

- Not seed transmitted, but is mechanically transmitted, and by whitefly vectors

Plant pathogen spread by vectors

- This involves an interaction of
  - Plant (susceptible host)
  - Pathogen (inoculum –spores) ,
  - insect vector,
  - Environment (weather, cultural practices in the field, farming operations, agroecosytem)

(Remember disease triangle)

Contributing factors to the spread of diseases

- Environmental changes (Narok vs Naivasha MLND expts)
- Microbial adaptation
- Human populations and behaviour
- Technology and economic development
- International travel and commerce

Ways of disease spread by vectors

- Passive or mechanical : occurs when the insect/vector carries /transfer the pathogen from one plant to another. In this method the pathogen is kind of given a ride, there is no effect on the vector (legs, mouthparts, bodies)

- Active or biological transmission : in this method the pathogen undergoes some change within the vector. It may multiply or develop into infectious form after which it is transmitted to a new host

Contd ways of spreading disease by vectors

- Inoculation: the pathogen is injected onto the host in saliva while the vector is feeding,
- Regurgitation: the pathogen multiplies within the vectors gut to a point where it interferes with feeding and hence it is vomited into the new host,
- Feacal contamination: the insect deposits feacal matter with the pathogen on a wound on the host or the pathogen may infect a new wound created while the insect is ovipositing

Categories of insect vectored pathogens

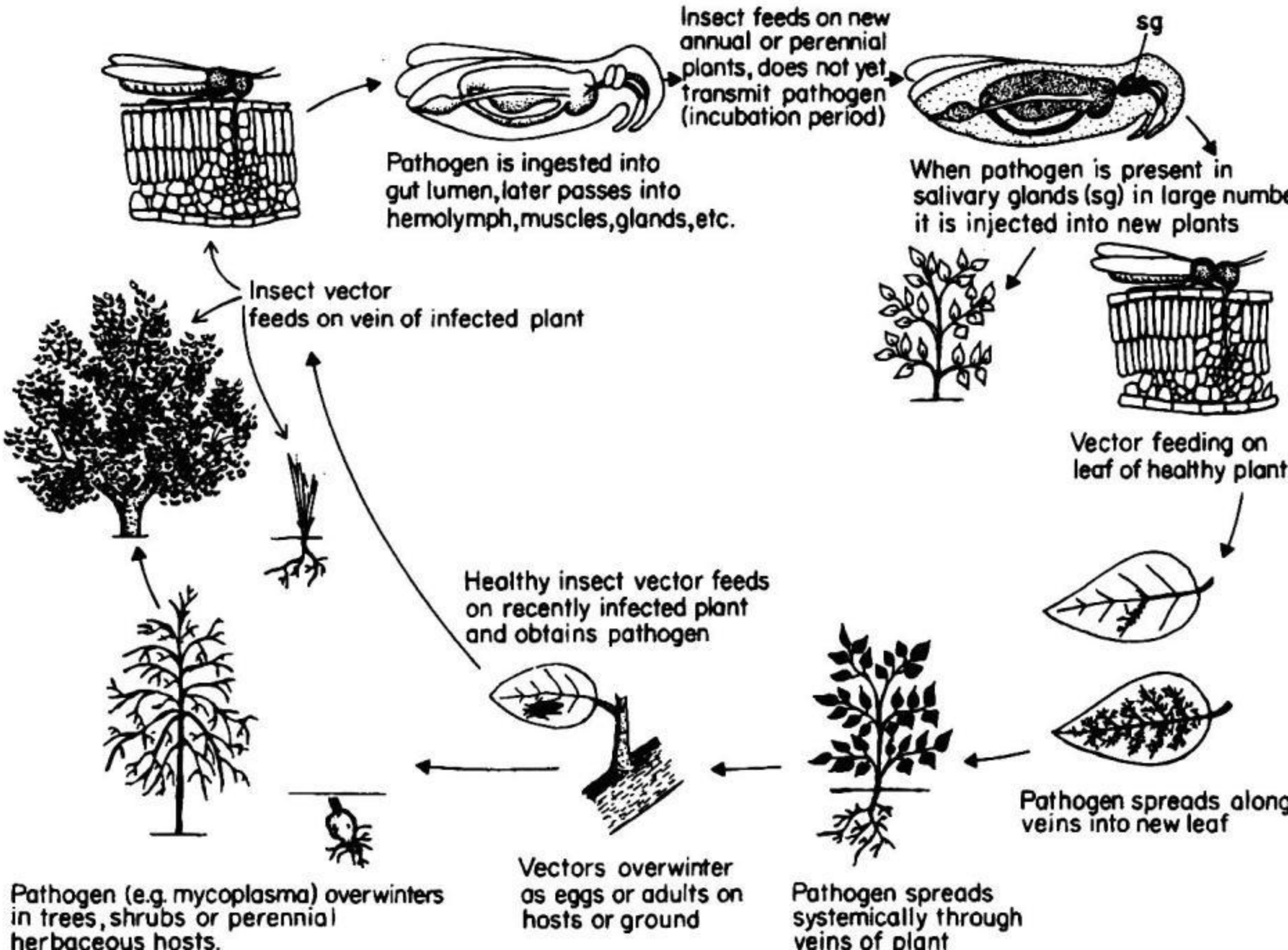
- Pathogen spread
  - Primary (brought into field first round) vs Secondary (spreads within field after the first innoculation)

Modes of primary infections:

Primary infection plant diseases are recognized as:-

- Soil borne (bacterial pathogens)
- Seed borne, including diseases carried with planting material e.g smuts on cereals especially maize, wheat, bacteria in tubers, viruses in seed, tubers.
- Wind borne
- Insect borne

Is also direct transmission which can be internal or external


Insect feeds on new
annual or perennial
plants, does not yet
transmit pathogen
(incubation period)
sg
Pathogen is ingested into
gut lumen, later passes into
hemolymph, muscles, glands, etc.
When pathogen is present in
salivary glands (sg) in large numbe
it is injected into new plants
Insect vector
feeds on vein of infected plant
Vector feeding on
leaf of healthy plant
Healthy insect vector feeds
on recently infected plant
and obtains pathogen
Pathogen spreads along
veins into new leaf
Pathogen (e.g. mycoplasma) overwinters
in trees, shrubs or perennial
herbaceous hosts.
Vectors overwinter
as eggs or adults on
hosts or ground
Pathogen spreads
systemically through
veins of plant

Secondary infections

- Pathogen spreads itself by way of its persistent growth or certain structures carried independently by natural agencies like wind, water, animals, insects, mites, nematodes, birds

- Pathogen spreads within the field

Categories of insect vectored pathogens

- Vector residency on plant
  - Transient (passing by) vs residential (settles down feeds and reproduces)

- Vector dispersal
  - Trivial (not organized and vector moves randomly searching for hosts to feed) vs migration (vector purpses to move into a new area to search for food or reproduce

Examples of insect vectors that spread disease

True bug, leaf hopper, plant hopper

Aphids, mealy bug, psyllid, whiteflies,

Homoptera pests

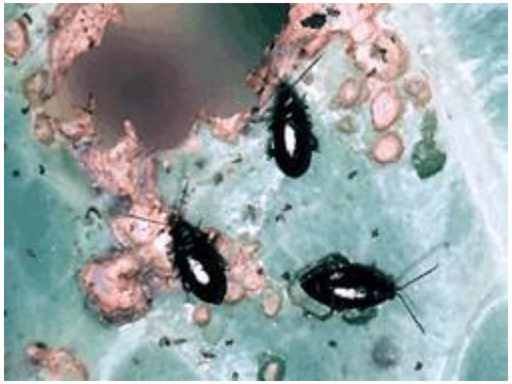
Insects pests of different orders


Fruit fly (*R. pomonella)*


thrips


Cabbage fly- maggot


leafminer


Leaf beetles


Bark beetles

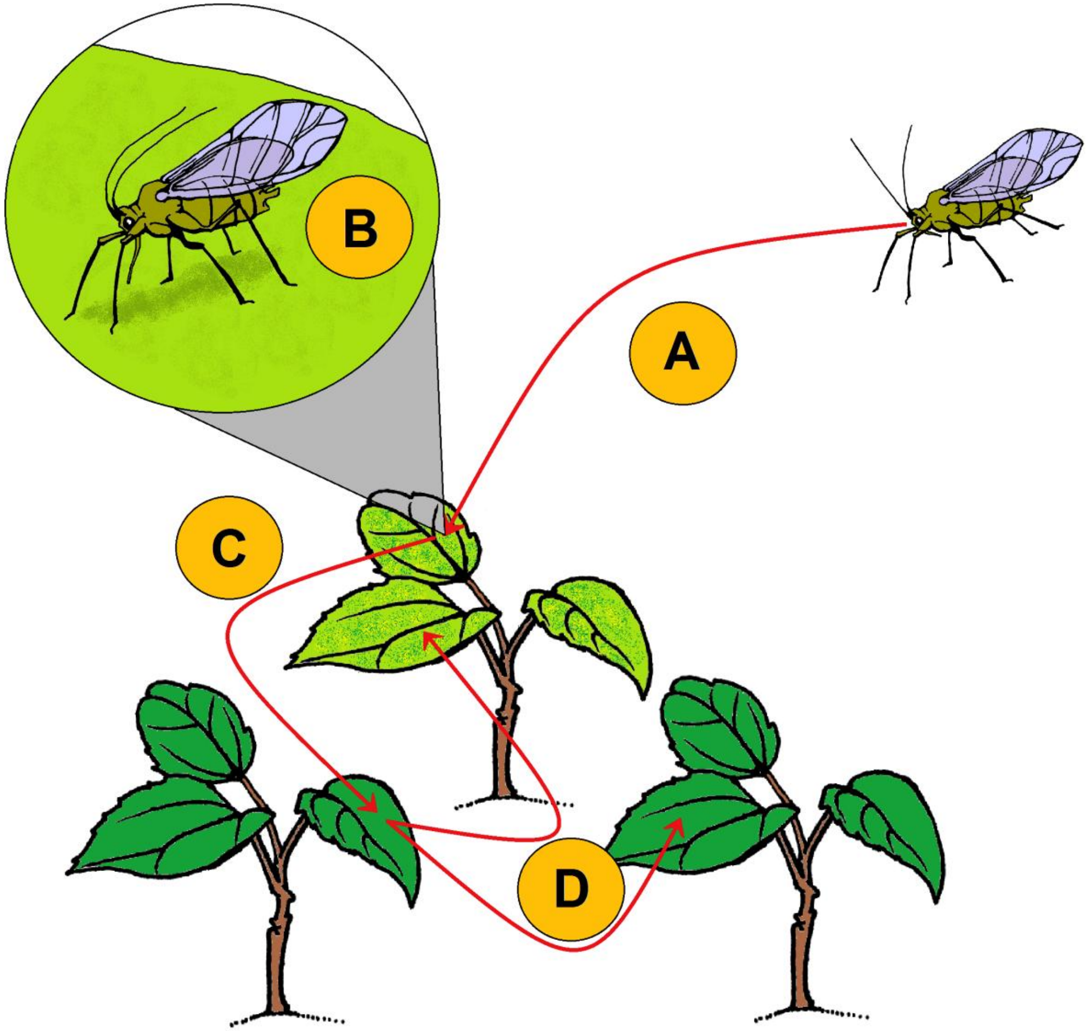
Insects pests of different orders

Plum beetle

Bee *Apis mellifera*

Ants

Plant Virus Infection and Vector Behavior



Types of interactions

- Circulative (2 forms)
  - Systemic :movement within body
  - Propagative :Replication within body – transovariol

- Non circulative (stylet borne)
  - No replication particles attached to mouth parts during feeding and pathogen released during feeding through saliva

Types of pathogen transmission

- Non persistent (Stylet borne)
- Persistent (circulative, propagative and transovariol)
- Semi persistent (partly circulative)

Non persistent vs persistent

Non persistent

- Acquisition time - short (seconds)
- Inoculation time –short
- Latent period –zero
- Retention time – minutes to hours

Persistent

- Acquisition time - minutes
- Inoculation time –minutes
- Latent period – one or more days
- Retention time – through moult or for life
- Vector specificity high

Categories of vectors

- **Transient vectors**
  - Do not colonize host
  - Non persistent spread of diseases
  - Not usually important for persistent disease spread

- **Resident vectors**
  - Colonize crop
  - Important for all types of disease spread
  - Most important for persistent transmission of diseases

To determine transient populations: use traps such as sticky traps, water pans, pheromone traps, etc

Vector dispersal

- **Trivial flights**
  - Random movement among selected hosts
  - Important for secondary spread
  - Important for non persistent spread of disease

- **Insect migration**
  - Long distant obligatory flights
  - Important for all transmissions

- Primary spread acquired from outside source and brought in to the field e.g through seed or immigrating insects such as thrips
- Secondary spread infections within the field

Thank you ! Questions

Scouting for insect pests, diseases and weeds of target crops

Dr. Dora Kilalo
Dept. of Plant Science and Crop Protection

Mealybugs

On leaves

On stems

On flowers

Death due to infestation

Clavigralla nymphs

Riptortus spp

Pod bugs

Nezara spp

Outline

- Importance of field scouting
- Definition and objectives
- Effect of biotic and abiotic factors
- Sampling pattern
- Sampling techniques and tools
- Limiting factors
- Time to scout

Introduction

What is scouting/surveillance/monitoring

- Regular visits to a crop field to make visual observations within the farm (growth and development, plant health, any happenings outside the expected) and estimate/measure pest levels

Objectives for scouting (two)

  - Short term: to determine the need for control, assess the effectiveness of actions taken
  - Long term: to collect information/data that is used to make future predictions and decisions or evaluate pest management strategies used

Introduction

- Scouting is key in a pest management programme

- It relies heavily on the ability to identify pest problems / or situations out of the ordinary which could be taking place in the field 'Hence the necessity of visual observation'

- Reminder: groups of pests that infest crops include fungi, bacteria, viruses, phytoplasmas, insects, mites, parasitic plants, weeds and animals (man included)

General Impact of Pests – Injury to plants

- Consumption of plant parts
- Chemical toxins, elicitors, and signals
- Physical damage
- Loss of harvest quality
- Cosmetic damage
- Vectoring of pathogens
- Direct contamination
- Low germination ability of seeds

Abiotic factors cause similar effects (altering growth and development of plants)

- Environment (climate/weather changes, temp, RH%, rainfall,)
- Nutrient deficiency (N, P, K, Mg, Ca, B, Mn, Fe, Cu, S,
- Cultural practices(plant debris left on soil, tillage methods, cropping systems,)
- Soil conditions (pH, moisture, OM content,)

Resultant effects of biotic and abiotic factors on plants

- Colour change
- Change in form and shape
- Growth disturbance
- Premature drop of leaves or fruits
- Appearance of premature ripening
- Localized death of tissue (necrosis, lesions, spots)
- Rots and eventual death

Scouting is meant to help

- Prevent serious plant health problems
- Determine the cause of the problem
- Determine where the problem occurs
- Decide on the most economic al control option
- Provide evidence for the effectiveness of pest management programme followed

Scouting :What is it?

- It involves walking through the field stopping at pre-determined locations and making observations (visual)/sampling
  - To identify yield limiting problems (pests and the damage being caused (accurate)
  - Recording vital information in the field
  - Analyzing the cause of the symptoms and/or damage
  - Making informed decisions for pest management decisions based on the data collected



Scouting :What is it?

Involves looking for physical evidence of :

- damage of insect feeding, symptoms/signs of disease , effect of weeds on crop; e.g Exit holes, fruss, webbing, lesions, necrosis, galls, spots, weak crop,
- Or presence of visible insects, fungi/pathogens, weeds
- Or general damages such as oozes of gum, bacteria
- Or other growths on crop/ trees (galling)

How is it done? Techniques

- In the field map out problematic areas and purpose to take samples from those positions **but** scouting only in the problem areas may give the wrong impression of infestation/infection

How is it done? Techniques

- Look at the field and move in a certain pattern to represent the whole farm and stop in the locations for visual observation
- If field is long and narrow: a Zig zag pattern is preferred
- If field is square /rectangular: can use diagnols or ‘M’/’W’/’U’ shapes
- Can also use transect or stepwise movement to pick representative samples
- In store, draw representative samples and weigh, look for physical damage, count insects if present dead or alive and the young

Remember: Scouting techniques vary with the pests involved/ stage of development AND Early detection of problem is key

At the locations

- Make counts/estimates to determine infestation rate, pest and degree of infestation/severity
- Make notes on crop/produce and environmental information
- Collect samples for identification

Sampling techniques

- Shake and beat method on white sheet or container that would enable one to observe and count
- Knock down (spray plant and collect all insects that fall
- Bait station e.g germinate grain and place them in soil to attract larvae (grubs, wireworms) and beetles,
- Mites : brush off from leaves
- Make observations of symptoms and pick samples , preserve and take to lab for identification
- For weeds count the numbers per given area (0.5m^2 or 1m^2) and identify species, plant height,

Sampling tools

- Sweep nets
- Traps (various)-sticky, coloured, light, pheromone
- Khaki paper bags
- Plastic polythene tubes
- Trays, sieves, spears for stored produce

Sweep net sampling for insects
Photo credit: Norman E. Rees

Yellow and blue traps for adult flying insects

Pheromone trap for trapping adult insects, specific to insect and sex

Pheromone trap in a pigeon pea crop

Sample Data Sheet

Date	Field #	Time	Crop	Growth Stage

Weather/field observations:

Plant #	1	2	3	4	5	6	7	8	9	10	Total
Pest 1 *[Name]*											
Larvae											
Adults											
Parasite/Predator *[Beneficial Insect Name]*											
Parasite/Predator *[Beneficial Insect Name]*											
Parasite/Predator *[Beneficial Insect Name]*											

Notes:

Plant #	1	2	3	4	5	6	7	8	9	10	Total
Pest 2 [Name]											
Larvae											
Adults											
Parasite/Predator *[Beneficial Insect Name]*											
Parasite/Predator *[Beneficial Insect Name]*											
Parasite/Predator *[Beneficial Insect Name]*											

Notes:

Record keeping sample data sheet

Influencing factors

- Timing when the sampling is done
- pest involved and its development
- Weather changes
- cultural practices

How often should it be done?

- For most pests and diseases it is weekly to provide early warning of problem and allow for making decisions for action
- For most pests it is weekly and season long because various pests attack at different times during the growing period
- Also gives a field record that can be used for early warning of pest problems

Management decisions are based on scouting results

- Pests present
- Pest numbers/population observed
- Is the population increasing or not?
- The damage taking place
- Is it acceptable or not?
- Effect of abiotic factors (weather patterns) on the pests
- Presence of the natural enemies and the effect/impact on the pest population

Choices of management to be made are:

1.Take no action

Take action only when crop is threatened

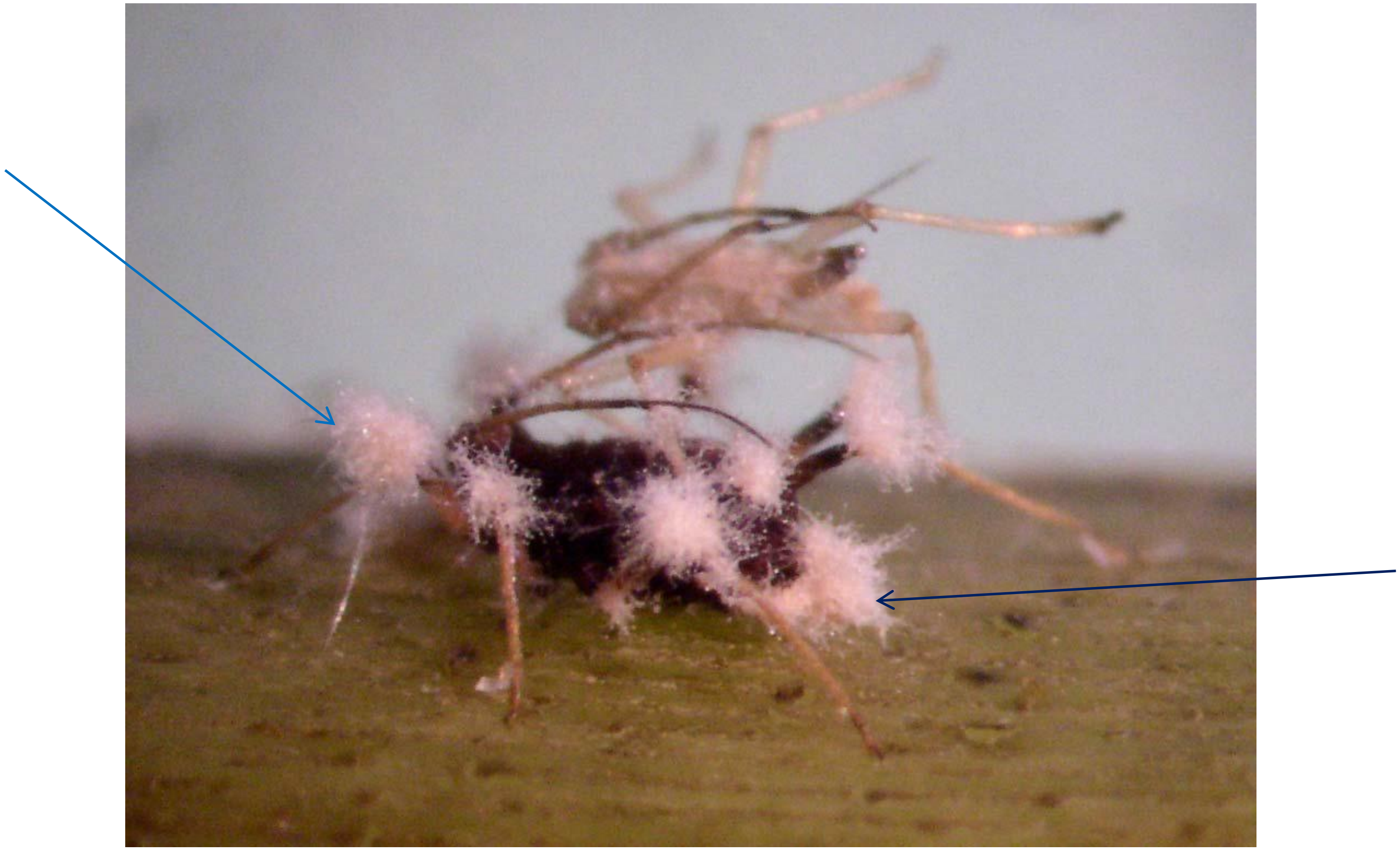
2. Reduce crop susceptibility

3. Reduce the abundance of the pest/disease

4. Combine reduction of crop susceptibility and reduction of the pest population /inoculum

Examples of insects

- Thrips: weekly field checks to observe population dynamics, sample 5 plants/ leaves or flowers and bag to count the numbers or use traps
- Whiteflies: weekly checks, use sticky traps , inspect leaves underneath and estimate nymph numbers
- Aphids: weekly field checks after planting, check hot spots along the margins, use traps(yellow water traps to determine flight activity



Aphids infected by a fungal pathogens can be detected while scouting

Examples of insects

- Can do destructive sampling for cereals such as sorghum , maize to look for the pest in stem such as the stem borers or the shoot fly larvae

Grass sawfly larvae

- Bean fly: first two weeks any yellowing seedlings should be uprooted and checked whether it is the insect or fungal problem

Diseases

- Blight/virus diseases

Weekly checks in the field, mark 5-10 randomly selected plants per location and estimate the disease progression. Use a scale (1-9) based on the percent area of leaf/plant affected to estimate and record the disease or the increase in infection within the field (severity)

- RKNs can also be done on a monthly basis in random spots within the problematic and non problematic areas and record the numbers
- but can also uproot plants (destructive sampling) and carry to lab and process the roots to count the numbers

Weeds

- Every two weeks or pre- determined time periods, using a quadrat of known measurements. One is able to count the number of weeds in the area and the species within identified , the plants can be dried and preserved for identification if unknown

- The quadrats are thrown in random locations to get representative samples for the field

- Can also measure target plant height to determine whether the crop is being affected by the presence of weeds

Pod fly adult

Aphids

Pod fly maggots

Pod fly pupae

Leaf webber

THANK YOU

Overview of options for managing insect pests, diseases and weeds

Dr. D. Kilalo and Prof. F. Olubayo
Plant science and Crop Protection Dept

Outline

- Reasons for management
- Approaches to management
- Options for management
- Action thresholds
- Summary of the management options available

Reasons for management

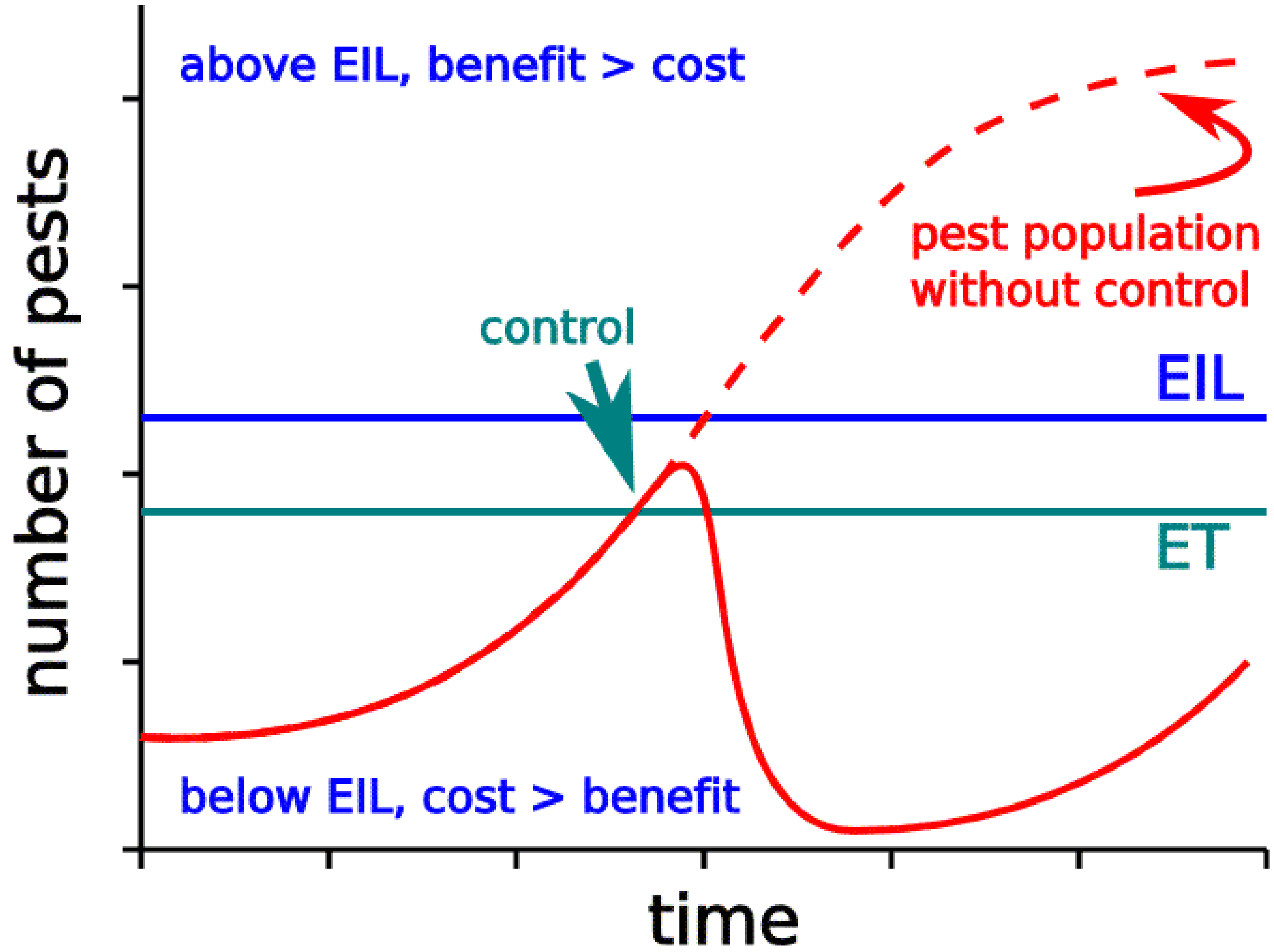
- To reduce crop losses incurred from the effects of pests
- To prevent /suppress damage
- To prevent / suppress disease spread
- To prevent /suppress weeds

Approaches to management

- Host plant manipulation - isolate crop in time and space
- Reduce pathogen sources
- Manipulate vector populations
- Block disease transfer

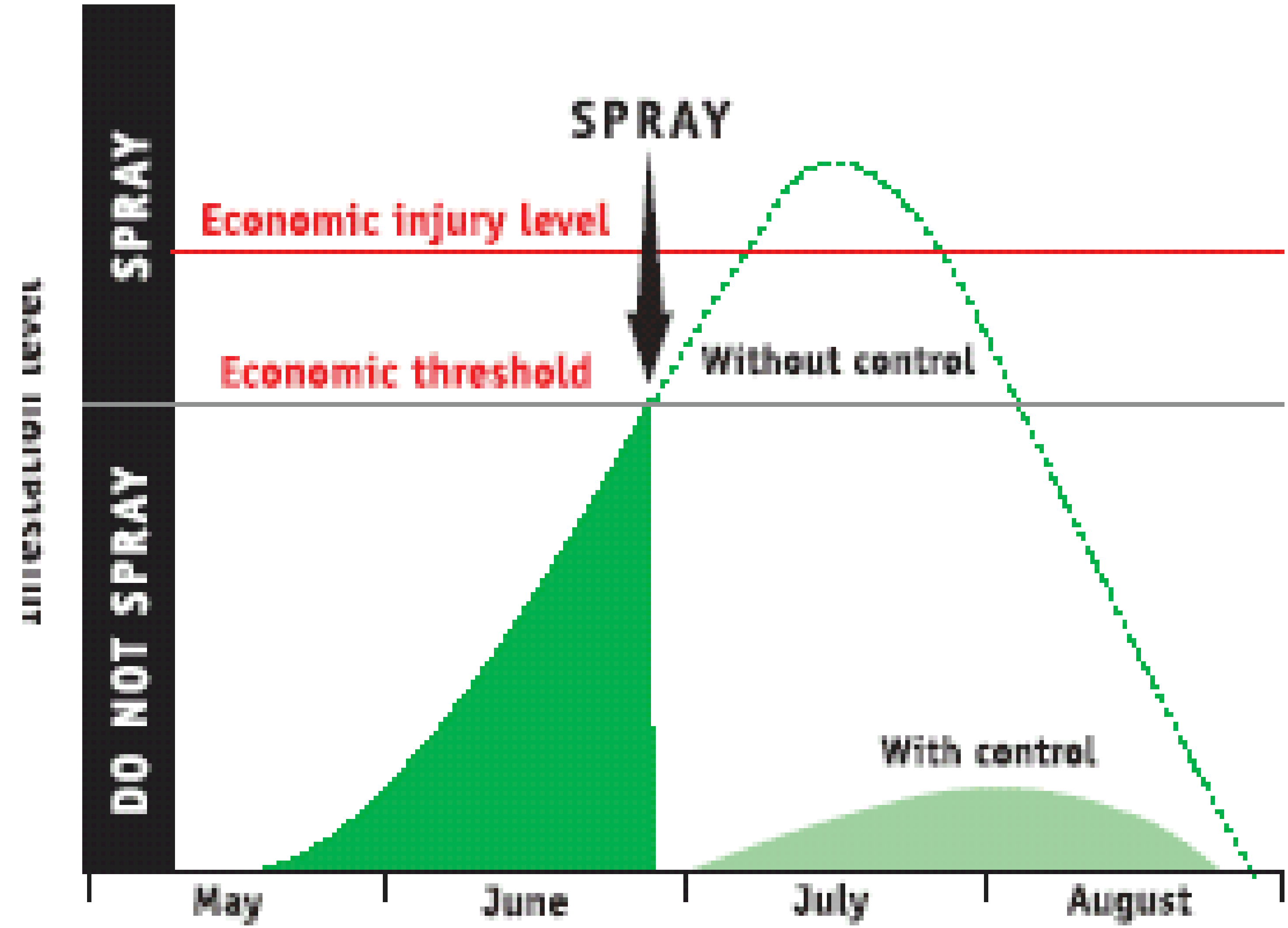
Options for management

- Cultural practices
- Physical/mechanical
- Biological
- Host plant resistance
- Chemical
- Genetic control
- Legislative



EIL definition “the pest population at which pest control measures must be taken to prevent the pest population from rising to the economic injury level."

Figure credit: Ed Zaborski



Relationship between the economic injury level (EIL), economic threshold (ETh), and seasonal pest population growth. The time to take control action (apply pesticide) is when pest density reaches the ETh value; pesticide application

Action threshold

Economic Injury Level (EIL) is defined as that pest population level at which the cost of crop yield loss to the pest begins to exceed the cost of the recommended control measures for the pest.

The Economic Threshold (ET) is that level of pest population at which the pest, if left untreated, is likely to reach or exceed the EIL. Therefore, the ET is always a little lower than the EIL, and is considered the point at which the farmer should take action against the pest. Therefore, the ET is sometimes called an Action Threshold (AT).

Action threshold can be set either through experience or experiments

Cultural practices

- Activities carried out in the farm to reduce the rate at which pests colonize or affect a crop in the field

OR

- Activities that make the crop environment less suitable for pest survival

- They are several: crop rotation, changing planting dates, mulching, cultivation/ tillage methods, irrigation, sanitation, soil amendment, nutrition

Host plant resistance

- The inherent ability of the crop to fight back diseases or pest infestation or withstand competition with weeds. Three levels are recognized under specified conditions
- Resistant – the crop will grow and produce acceptable yield under pressure of high pest abundance
- Moderately resistant/tolerant- the crop will grow and produce yield under pressure of high pest abundance
- Susceptible- the crop will succumb to pressure of high pest abundance with little or no yield
- **Resistance is relative. It is influenced by presence or absence of resistance genes and environmental conditions (temp, pest abundance)**
- In relation to weeds the crop is said to be competitive than the weed pressure it is exposed to

Approaches for breeding for resistance

- Antibiosis : suppression of pest growth and reproduction on a plant e.g aphids on soybean

- Antixenosis (non –preference): Inability of an insect to find and /or feed on a plant

- Tolerance: the ability of a plant to grow and yield despite pests feeding on it

AND NOW

- The ability to insert genes into plants, creating transgenic hybrids, giving a whole new meaning to plant resistance

Biological control

- Utilization of live organisms to manage pests and diseases. The organisms utilized are mainly insects, pathogens and entomopathogenic nematodes (All referred to as biological agents –BCAs). The insects are in two groups
- Parasitoids which are mainly parasites that lay eggs on/in host and develop within or on host and emerge as adults and in the process kill the host (pathogens for of parasites feed on plant to multiply)
- Predators which search and eat the prey (pests within the field)
- Pathogens : fungi able to control other fungi and insects e.g *Metarhizium, Beauvaria, Lecanicillium, Verticillium spp*, Bacteria able to control insects or other bacteria eg Bt, OR viruses able to control insects
- Nematodes: able to control insects e.g *Steinernema spp*

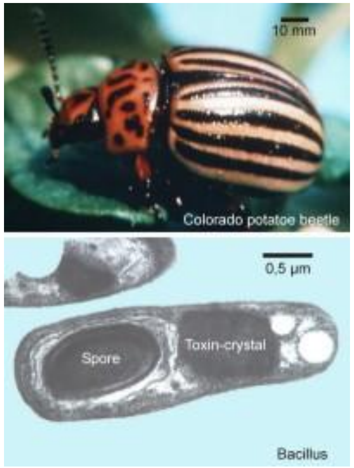
Biological control:

- Natural enemies of pests cause mortality;
- Can maintain pest population at below-threshold levels

Predators

Parasitoids

Pathogens







Chemical control

- Products/materials with inherent ability to poison and kill organisms (pathogens, insects , mites and nematodes). They are capable of causing harm such as Environmental pollution, harm to man and the non target organisms such as fish, bees, birds, wildlife

- Apart from causing harm, a resurgence of pests is likely to occur, resistance of pests to certain molecules is likely to occur,

Problems with insecticides:

- Kill or disrupt natural enemies
- may be the cause of Secondary pests
- Leave Residues on produce
- Build-up of resistance – insecticide "treadmill"
- Environmental concerns (health to man and non-targets)

Chemical control

Desired chemicals for use should have the following characteristics :

- Least toxicity to man and environment,
- Be most specific to the target pest and
- Least harmful to non-target organisms

Physical/mechanical

Use of physical means to prevent pests from reaching the target crops such as

- Border crops
- Nets,
- Trenches,
- Traps
- Pruning
- Sticky barriers
- Cover crops
- Change of temperature

Border cropping or strip cropping or habitat manipulation

Genetic control

- Changing the genes within the pest or pathogen to ensure that its survival rate and reproduction is minimal
- In insects there is a technique referred to as Sterile insect technique where the insects reared in the laboratory are sterilized using radiation or a special chemical.
- The sterile insects are then released in the environment (agro-ecosystem) to breed with others with a hope that no progeny will be produced thereby reducing the pest population. E.g. fruit flies infesting fruits, tsetse flies that bite and spread trypanosomiasis in animals especially cattle

Legislation

- Use the law of the land to prevent entry and spread of pests and diseases in an area.
- It is applied when certain pests are declared quarantine pests/invasive species
- Quarantine pests are those pests that are not within an area/ country and the introduction is likely to affect the economic standing of the area or country
- The pest is likely to invade and replace other s (biodiversity)
- The pest is likely to spread and replace others and change the whole environment where a country is unable to cope

Considerations for Choosing Control Methods

- Determine damage level you can withstand
- Determine desired control outcomes
  - Prevention of pest outbreaks
  - Suppression to acceptable level
  - Eradication of all pest organisms
- Manage pesticide resistance
- Estimated costs
  - Monetary
  - Environmental impacts

THANK YOU

Cultural practices for prevention and management; host plant resistance; biological and chemical

Dr. D. Kilalo /Prof R. D Narla
Dept of Plant Science and Crop Protection

CULTURAL PRACTICES

Cultural controls aim to keep plant healthy

To maintain a healthy crop:

- Develop healthy soil
- Choose the right variety/cultivar
- Mow high weeds
- Irrigate regularly and effectively
- Set realistic goals

Outline

- Cultural practices
  - (various)
- Host plant Resistance
- Biological
- Chemical control

TYPES OF CULTURAL

- Preventive
- Suppress

Use disease free seeds

Use disease /weed free seed to establish crop

Cultural practices for management

- Resistant cultivars
- Disease free seeds (certified)
- Crop rotation
- Intercropping
- Barrier cropping
- Mulching
- Hand weeding
- Sanitation
- Provision of nutrient and water
- Use of plant extracts
- Prevent spread or entry

Crop rotation

- The act of replacing growing crops in succession with unrelated or non-susceptible hosts, or with green manure crops or leaving the land fallow (in this case non cereal crops)
  - It breaks the pest cycle
    - e.g bacteria wilt (brocolii) , RKNs in lettuce (tomato or beans), MLND (leguminous crops during the closed season)
  - Recycles nutrients
  - Enhances soil quality by improving soil structure, balancing the accumulation and decomposition of organic matter and prevents soil erosion

Example of Combining several CPs to manage disease

Head smut

Use resistant varieties
Use certified seeds
Rotate with non-cereals
Plough deep

To control RKNS:
Use trap crops
Biocontrol or soil ammendment
Use resistant cultivars
Ensure adequate nutrition

Using cover crops

- To suppress weeds
- Attract natural enemies
- Increases nutrients
- Increases microbial activity
- Improve water penetration

Use of a trap crop to attract insects that can then be killed away from the target crop

USE OF RESISTANT CULTIVARS

To avoid severity of pest abundance

- The resistance may be inherent through genes (resistance genes) OR
- may be acquired by giving adequate nutrition, and adequate watering or spraying
  - The plant prepares defense as it grows, it may be induced as soon as it is attacked, can be localized only where it is attaked or can be systemic acquired resistance (SAR) . Can be overpowered by large initial innoculum /population

Resistance may be inherent or acquired

CULTIVATION

- Different ways of tilling the land help to manage the pests

e.g Deep ploughing

- will bury any plant debris that may be infested
- Will bring pupae to the top where they dry off and die or be buried deep and the adults are not able to emerge
- Will also bury weed seeds deep reducing early competition with target crops

E.g Conservation tillage will favour the increase of all insects that pupate on ground (thrips, leaf miner, fruit fly) for lack of disturbance of the soil

IRRIGATION METHODS

Influence the pest occurrence and abundance

- Overhead : washes away insects such as aphids, whiteflies and thrips and will prevent the egg laying activities of Potato tuber moth BUT
- Amount applied is important to allow leaves to dry because wetness does encourage fungal disease development if the area remains humid for long where moderate to warm temperatures will encourage spore germination
- Amount of water applied may also favour rots like bacterial soft rot and downy mildew
- Dry conditions and dust support abundance of mites

Sanitation

- Involves the removal of old plant debris/residue and weeds/alternate hosts from the field
  - Eliminates inoculum and areas for pest survival
  - The actions will keep away mites, aphids, thrips, scales, stem borer, fungal, bacterial and viral diseases (MCMV, *Ralstonia, Fusarium wilt*)
- Also involves cleaning farm equipment
  - to prevent spread of pest problems like, RKNs, bacterial wilt and post harvest pests which may infest grains left in the machines (planters, combine harvesters, mixing drums)

Other practices include

- Intercropping, Soil solarization, biofumigation, Mowing, mulching, flood irrigation all will reduce weed development and disease inoculum

- The cultural practices have to be used in combination to control foliar diseases,soil borne diseases and weeds

INTERCROPPING:
A CULTURAL PRACTICE THAT REDUCE PESTS

A field of maize and dry beans intercropping system
Photo credit: Howard F. Schwartz, CSU

Interferes with the searching ability of insect pests and where resistant varieties have been used Nematodes are controled but may favour fungus development such as white mould

Pigeon pea intercropped with mung bean

Pigeon pea intercropped with groundnuts

BIOLOGICAL CONTROL

Three forms

- Classical introducing natural enemies identified from the place where pest originated. It is assumed that the Natural enemies will establish and control the pest
- Augmentation : rear in insectary and release to increase the effect of what is existing in the field
- Inundative: identifying the NE s within the field and making conditions favorable for them to exert the effect on pests e.g border crops that will serve as refugia, cover crops whose flowers will provide food and refuge for the naural enemies





Northfield, Eigenbrode, Snyder 2012 (Ecology)

PLANT TYPE AND THE INSECT COMMUNITY

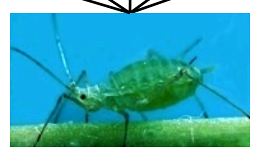
Geocoris pallens

Nabis alternatus

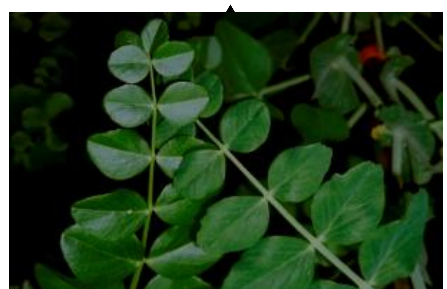
Hippodamia convergens

Coccinella septempuncata

Aphidius ervi



Acyrthosiphon pisum



Pisum sativum

Northfield, Eigenbrode, Snyder 2012 (Ecology)

Chemical control

- Use of natural or synthetic substances that cause the death /repulsion or attraction of pests and to be effective consider :
- Mode of action: the way it kills
  - Is it a repellant, disrupter, poison, eradicator, systemic
- Persistence: length of time it is active or it takes to break down after application
  - Non persistent: short period of activity within which it acts on the pests
  - Persistent: Takes long to break hence remains active for a linger period to act on the pests

Chemical control

- Non target effects: the effect it has on other insects (natural enemies), non insects in the environment such as man, wild life, fish. There are risks for:
  - Killing beneficial insects
  - Creating new pests after killing the enemies

- Resistance development: resistance lessens th effectiveness of a pesticide for reducing target populations. The pesticide only
  - kills susceptible pests,
  - Survivors pass the traits to the offsprings
  - Resistance develops over generations

CHEMICAL CONTROL

Resistance is brought about by

- The use of one pesticide molecule repeatedly
- The use of a pesticide over large areas landing in areas that may not have a population that requires management as opposed to hot spots
- The use of highly residual pesticides that allow for many insects getting into contact with exposed plant to be exposed to the pesticide

How to reduce the potential of resistance development

- Rotate pesticides, target applications, use persistent chemicals wisely

In case of herbicides it is important to consider :

- Foliar vs soil application

E.G MLND MANAGEMENT

- Plant in an area where maize was not grown previously or has not just been harvested
- Use disease free seeds
- Control vectors for MCMV from 2 wks after germination (use pesticide with residual effect)
- Deep ploughing
- Rogueing
- Practice closed season
- Plant in appropriate agro ecological zone/environment

THANK YOU

APPROVED CROP PROTECTION CHEMICALS AND BIOLOGICAL AGENTS; INTEGRATED INSECT PEST, DISEASE, WEEDS AND CROP MANAGEMENT METHODS;

Dr. D. Kilalo
Dept of Plant Science and Crop Protection

Outline

- Why approval?
- Key international agreements
- What is common among them
- How they support chemical management
- Laws, regulation and standards that control pesticide usage
- Concerns about pesticide use
- Restricted products
- Seed treatments
- IPM

Why approval?

- Pesticides used are approved for use after undergoing various checks guided by law of the land.
- There are regulations that guide the, manufacture, formulation, importation, packing, distribution and sale
- The scientific information, effect, value, quality of a pesticide must be affirmed by a regulator and registered before the product can be distributed for use in a country

Key international agreements on pesticides

Common thread among them

- Reduce harm to human health and environment
- Support pesticide management (labelling, trade and movement, ID of alternatives)
- Provide information about pesticides (hazards associated with them)
- List banned and restricted pesticides

Key international agreements on pesticides
They are:

- Stockholm convention: Persistent organic pollutants (POPs) -dirty 12
  - Chemicals that do not break down easily, stay long in environment and can move long distances
  - they bioaccumulate and biomagnify
- World health organization (WHO)
- Restricted pesticides that are highly hazardous to human health.
  - Classified pesticides into 1(R),II (Y) , III (B) and IV (G)

Red highly hazardous

KEY INTERNATIONAL AGREEMENTS ON PESTICIDES

- Rotterdam convention: Prior informed consent
  - Country intending to import must be informed of everything dangers and goodness alike about the product so that it can make a decision' It covers 33 pesticides and 11 industrial chemicals
- Montreal protocol: Chemicals that emit gas that is destroying the ozone layer
  - e.g methyl bromide (2015) and various fumigants
  - Refrigeration gases, foam foaming, industrial cleaning, fire safety (even gas released from animal rumen)

Laws and regulations

- These concern the use of chemicals under certain conditions and if they are not met, produce will not be marketed where these laws and regulations operate
- E.g E U

Standards (more for horticulture)

- Have sets of rules of production of a certain produce. They have to be met for the produce to obtain market in the area where the rules prevail. Rules take care of these concerns:
- Good agricultural practices- include keeping records about what has been used . Critical for chemicals where one has to indicate why it was used
- Traceability
- Workers health
- Safety for the workers in the field and when packing

CONCERNS ABOUT PESTICIDE DEPENDENCE

- **Pest resistance**
- **Environmental persistence**
- **Bioaccumulation:** when a chemical accumulates in animal fat (historical fact)
- **Biomagnification:** when an organism accumulates residues at higher concentrations than the organisms they consume

Concerns about pesticides and the hazards in the environment

- US Environmental Protection Agency (EPA) created in 1970
- Charged with protecting environment and health of humans and animals
  - DDT banned in 1972
- Public concern has led to stringent regulation of pesticides, as well as changes in types of pesticides used

Internationally restricted pesticides

2,4,5-T and its salts and esters	Chlormephos	Fenamiphos	Oxydemeton-methyl
3-Chloro-1,2-propanediol	Chlorobenzilate	Flocoumafen	Parathion
Acrolein	Chlorophacinone	Flucythrinate	Paris green
Alachlor	Coumaphos	Fluoroacetamide	Pentachlorobenzene
Aldicarb	Coumatetralyl	Formetanate	Pentachlorophenol and its salts and esters
Aldrin	Cyfluthrin	Furathiocarb	Perfluorooctane sulfonic acid
Allyl alcohol	DDT	Hexachlorocyclohexane (HCH)	Phenylmercury acetate
Alpha hexachlorocyclohexane	Demeton-S-methyl	Heptachlor	Phorate
Azinphos-ethyl	Dichlorvos	Heptenophos	Phosphamidon
Azinphos-methyl	Dicrotophos	Hexachlorobenzene	Propetamphos
Binapacryl	Dieldrin	Isoxathion	Sodium arsenite
Beta hexachlorocyclohexane	Difenacoum	Lead arsenate	Sodium cyanide
Beta-cyfluthrin	Difethialone	Lindane	Sodium fluoracetate
Blasticidin-S	Dinitro-ortho-cresol (DNOC)	Mecarbam	Strychnine
Brodifacoum	Dinoseb	Mercuric chloride	Sulfotep
Bromadiolone	Dinoterb	Mercuric oxide	Tebupirimfos
Bromethalin	Diphacinone	Mercury compounds	Tefluthrin
Butocarboxim	Disulfoton	Methamidophos	Terbufos
Butoxycarboxim	Dustable powder containing a combination of benomyl at or above 7%, carbofuran at or above 10% and thiram at or above 15%	Methidathion	Thallium sulfate
Cadusafos	EDB (1,2-dibromoethane)	Methiocarb	Thiram
Calcium arsenate	Edifenphos	Methomyl	Thiofanox
Calcium cyanide	Endosulfan	Methyl bromide	Thiometon
Captafol	Endrin	Methyl-parathion	Toxaphene
Carbofuran	Ethyl p-nitrophenyl phenylphosphorothioate (EPN)	Mevinphos	Triazophos
Chlordane	Ethiofencarb	Mirex	Tributyl tin compounds
Chlordecone	Ethoprophos	Monocrotophos	Vamidothion
Chlordimeform	Ethylene dichloride	Nicotine	Warfarin
Chlorethoxyfos	Ethylene oxide	Omethoate	Zeta-cypermethrin

No to restricted products!

- Pesticides subject to international restrictions should not be used to protect seed fields or protect seeds for sale
- Those that are in Class 1a and 1b restricted by WHO they should only be handled by trained and registered people
- Persistent organic pollutants
- Ozone depleting substances and
- Pesticides that require prior informed consent for movement

SEED TREATMENTS

Use only the chemicals that do not fall within those regulated by the international agreements or banned in the country

Captan-Widely used broad spectrum contact fungicide, however, poor on pythium and very dusty.

Metalaxyl-Narrow spectrum systemic fungicide with excellent activity against Pythium

Fludioxonil-broad spectrum contact fungicide, very effective against Fusarium, but poor Pythium activity.

Murtano- a combination product a mix of insecticide and fungicide

SEED TREATMENTS

- Thiram only that product with less than 15% qualifies for use, anything above should not be used
- Benomyl any product with more than 7% should not be used

INTEGRATED PEST MANAGEMENT

- IPM: a balanced, tactical approach
- Anticipates and prevents damage
- Uses several tactics in combination
- Improves effectiveness, reduces side effects
- Relies on identification, measurement, assessment, and knowledge

Why practice IPM?

- Maintains balanced ecosystems
- Pesticides alone may be ineffective
- Promotes a healthy environment
- Saves money
- Maintains a good public image

INTEGRATED PEST MANAGEMENT

IS DRIVEN BY DECISIONS

1. Identify the pest and know its biology
2. Monitor and survey for pests
3. Set IPM goal: prevent, suppress, eradicate
4. Implement
   1. Select control strategies
   2. Timing
   3. Economics
   4. Environmental impacts
   5. Regulatory restrictions
5. Evaluate

THANK YOU

Field Key to Insect, Mite Pests, & Diseases of Beans

Frank B. Peairs

Damage to Seeds, Seedlings and Roots

Discoloration on roots and hypocotyls:

Water-soaked areas on roots, hypocotyls and stems. Advanced infections show shrunken brown stem tissue, wilting and plant death.
-----Pythium damping off

Linear or circular reddish-brown shrunken lesions or cankers. Advanced infections show a brick-red discoloration in the central part of the lower stem. Seedlings and young plants may die or break off at infected part of stem. Often occurs in circular patterns in the field.
-----Rhizoctonia root rot

Stunted, yellowed plants scattered through field. Reddish brown streaks on roots and hypocotyl up to soil surface.
-----Fusarium root rot

Stunted, yellowed plants with tan to brown leaf margins. Infected plants also exhibit reddish-brown vascular discoloration.
-----Fusarium wilt or yellows

Seeds, seedlings, or roots chewed or tunneled:

Young plants chewed through at the base. Dull colored worms or caterpillars can be found under debris and in the soil around plants.
-----Cutworms (several species)

Seeds or young seedlings tunneled by small, legless, white worms. May be associated with reduced stands and wilted or dead seedlings. Damage to growing point may cause typical "snakehead" damage symptom. Mechanical damage may cause similar problems.
-----Seedcorn maggot

Seeds tunneled and roots damaged by yellowish, thin, hardbodied larvae up to 0.75" in length. May be associated with reduced stands and wilted or dead seedlings. More common in drier parts of irrigated fields.
-----Wireworms

Roots damaged by large white larvae with a typically "C"-shaped body. May be associated with reduced stands, wilted plants.
-----White grubs

Leaves cupped or distorted:

Seedlings with cupped and distorted leaves. Undersides of leaves with tiny, yellowish, cigarette-shaped insects. Problem most common in furrow irrigated fields and near maturing winter wheat.
-----Onion thrips

Damage to Foliage and Stems — Larger Plants Leaves with distinct lesions:

Small ($^{1}/_{16}$ inch in diameter), greasy, water-soaked spots on leaflets later become larger water-soaked spots surrounded by a $^{1}/_{16}$-$^{1}/_{2}$ inch greenish-yellow halo. Severe infections can lead to yellowing and death of new foliage.
-----Halo blight
Similar to halo blight, except mature lesions turn brown. Lesion center may fall out, causing a shothole appearance.
-----Bacterial brown spot
Small, irregularly shaped lesions which later enlarge to large dark brown lesions along the edge of the leaflet. Lesions often surrounded by a narrow, lemon-yellow margin.
-----Common bacterial blight
Wet, soft lesions on leaves, branches, stems and pods. These later become watery, rotten masses of tissue covered with white (not blue or grey) moldy growth. Infected parts wilt and die, and then take on a characteristic bleached appearance.
-----White mold
Small yellow or white spots on leaves which later enlarge to reddish-brown or rust- covered pustules, often bordered in yellow, about $^{1}/_{8}$ inch in diameter. Spores released from pustules give the leaf a rusty appearance. Severely infested leaves may curl upwards, turn brown, and drop prematurely.
-----Rust

Leaves with generalized discoloration:

Upper leaf surfaces show a reddish-brown flecking. Affected leaves can eventually turn yellow and drop. Similar in appearance to rust, but discoloration cannot be rubbed off and occurs only on upper leaf surfaces.
-----Ozone bronzing
Similar to above, except leaves are thickened and bronzing not limited to upper surfaces. Areas between leaf veins can turn brown and fall out. Plants can also be stunted and exhibit delayed maturity. Severely affected plants can have white leaves and eventually die. Symptoms may occur in spots or throughout field.
-----Zinc deficiency
Leaves have a silvery or bronzed appearance. Microscopic animals found on the undersides of leaves. Often associated with drought stress.
-----Spider mites

Leaves distorted and/or with discolored veins:

Plants with curled or cupped leaves. Leaves show a green to bluish green mottling or mosaic pattern. Leaf veins can be slightly darker than areas between veins.
-----Bean common mosaic virus

Similar to above, but no leaf cupping and mottling also involves yellow and white leaf tissue. Occurs in a very low percentage of plants in commercial varieties.
-----Leaf variegation (genetic)

Similar to above, with younger leaves showing green veins and yellow tissue between veins. Leaf may eventually become white. More common in older plants and after irrigation.
-----Iron deficiency

Young leaves on plants brittle, glossy and curled downward. Early symptoms are small yellow spots often surrounded by a yellow halo. Shortened internodes, excess branching, stunting and delayed maturity can also be observed.
-----Bean Yellow Mosaic Virus

Plants with downward curled or cupped leaves which are often greatly distorted or puckered. Leaves often become yellow and plants become stunted. In contrast to Bean Yellow Mosaic Virus, older leaves rather than younger are most likely to be curled and cupped.
-----Curly top virus

Plants with cupped and distorted leaves. Undersides of leaves with tiny, yellowish, cigarette-shaped insects. Problem most common in furrow irrigated fields and near maturing winter wheat.
-----Onion thrips

Leaves skeletonized or showing ragged feeding

Yellow grublike insects with branched spines which skeletonize leaves. Common on young plants and again during pod fill. May be associated with yellowish eggs and spineless immobile pupae.
-----Mexican bean beetle larvae

Bronze beetles with black spots on wings, similar in appearance to lady beetles, found skeletonizing bean leaves. May be associated with groups of yellowish eggs found on undersides of leaves.
-----Mexican bean beetle

Leaves with large, ragged feeding damage. Damage more common in edges of field. May be associated with large, active, jumping insects.
-----Grasshoppers

Discolored petiole nodes or wilted plants:

Nodes between leaf petioles and stems with reddish discoloration, often with reddish streaking of leaf veins and veinlets. Plants can be stunted or killed.
-----Tobacco streak virus

Groups of round or pear-shaped insects feeding on the undersides of leaves or on tenderstems. Variable in color. Often associated with virus diseases. Heavy infestations

may give plants a wilted appearance.
-----Aphids (several species)

Damage to Blossoms and Pods

Leaves or pods with distinct spots or lesions:

Wet, soft lesions on leaves, branches, stems and pods. These later become watery, rotten masses of tissue covered with white (not blue or grey) moldy growth. Infected parts wilt and die, and then take on a characteristic bleached appearance.
-----White mold
Small ($^{1}/_{16}$ inch in diameter), greasy, water-soaked spots on leaflets later become larger water-soaked spots surrounded by a $^{1}/_{16}$-$^{1}/_{2}$ inch greenish-yellow halo. Severe infections can lead to yellowing and death of new foliage. Pod lesions are small water soaked spots or streaks commonly associated with a light cream or silver-colored ooze.
-----Halo blight
Similar to halo blight, except mature lesions turn brown. Lesion center may fall out, causing a shothole appearance. Infected pods may be twisted and kinked with circular brownish water-soaked spots.
-----Bacterial brown spot
Small, irregularly shaped lesions which later enlarge to large dark brown lesions along the edge of the leaflet. Lesions often surrounded by a narrow, lemon-yellow margin.
Infected pods have circular water-soaked areas often associated with yellow masses of ooze.
-----Common bacterial blight
Pods with reddish-brown concentric rings. Infected pods can be shriveled and puffy and not produce seeds. Nodes between leaf petioles and stems with reddish discoloration, often with reddish streaking of leaf veins and veinlets. Plants can be stunted or killed.
-----Tobacco streak virus

Blossoms contain tiny, active insects:

Blossoms contain tiny, brown, cigarette-shaped, rapid moving insects. Large numbers of insects may be associated with flower and pod abortion.
-----Flower thrips

Holes chewed in pods and developing seeds:

Holes chewed in pods and developing seeds. Brown caterpillars with a distinct brown band across the body just behind the head may be found hiding in soil and under debris around the plant on sunny days. At night and on cloudy days caterpillars may be found feeding on plan.
-----Western bean cutworm

Categories: Bean field key, Bean Diseases, Bean Pests, Pythium Damping Off, Rhizoctonia Root Rot, Fusarium Root Rot, Fusarium Wilt, Fusarium Yellows, Cutworms, Seedcorn Maggot, Wireworms, White Grubs, Onion Thrips, White Mold, Rust, Halo Blight, Bacterial Brown Spot, Common Bacterial Blight, Ozone Bronzing, Zinc Defliciency, Spider Mites, Mosaic Virus, Onion Thrips, Grasshoppers, Mexican Bean Beetle, Tobacco Streak, Aphids, Cutworm

Date: 06/13/2002

- By W. M. Mwiru

Contents

BIOSAFETY AND ENVIRONMENTAL ISSUES IN PEST AND DISEASE MANAGEMENT

Muiru, W.M

University of Nairobi

Department of Plant Science & Crop Protection

Definitions

Biosafety

The avoidance of risk to human health and safety, and to the conservation of the environment, as a result of the use for research and commerce of infectious or genetically modified organisms

The need to protect human and animal health and environment from the possible adverse effects of the products of modern biotechnology

Environment

The whole complex of climatic, edaphic and biotic factors that act upon an organism or an ecological community and ultimately determines its form and survival

Ecosystem

Plants, animals and microorganisms that live in a defined zone and the physical factors present e.g. soil, water and air

Pesticide

A Pesticide is a chemical used to prevent, destroy or repel pests

Introduction

- Crop pests (plant pathogens, vertebrate and invertebrate crop pests, weeds) 30% of crop loss

- Qualitative and quantitative yield losses
- Loss is at field level or at post harvest level

- Loss a major challenge to attainment of food security and even food safety

- An adequate, reliable food supply cannot be guaranteed without the use of crop protection products.

- world population has doubled in the last 40 years, the area of land devoted to food production has remained virtually constant; crop protection products have enabled farmers to produce higher yields of their crops on more or less the same land

Introduction continued

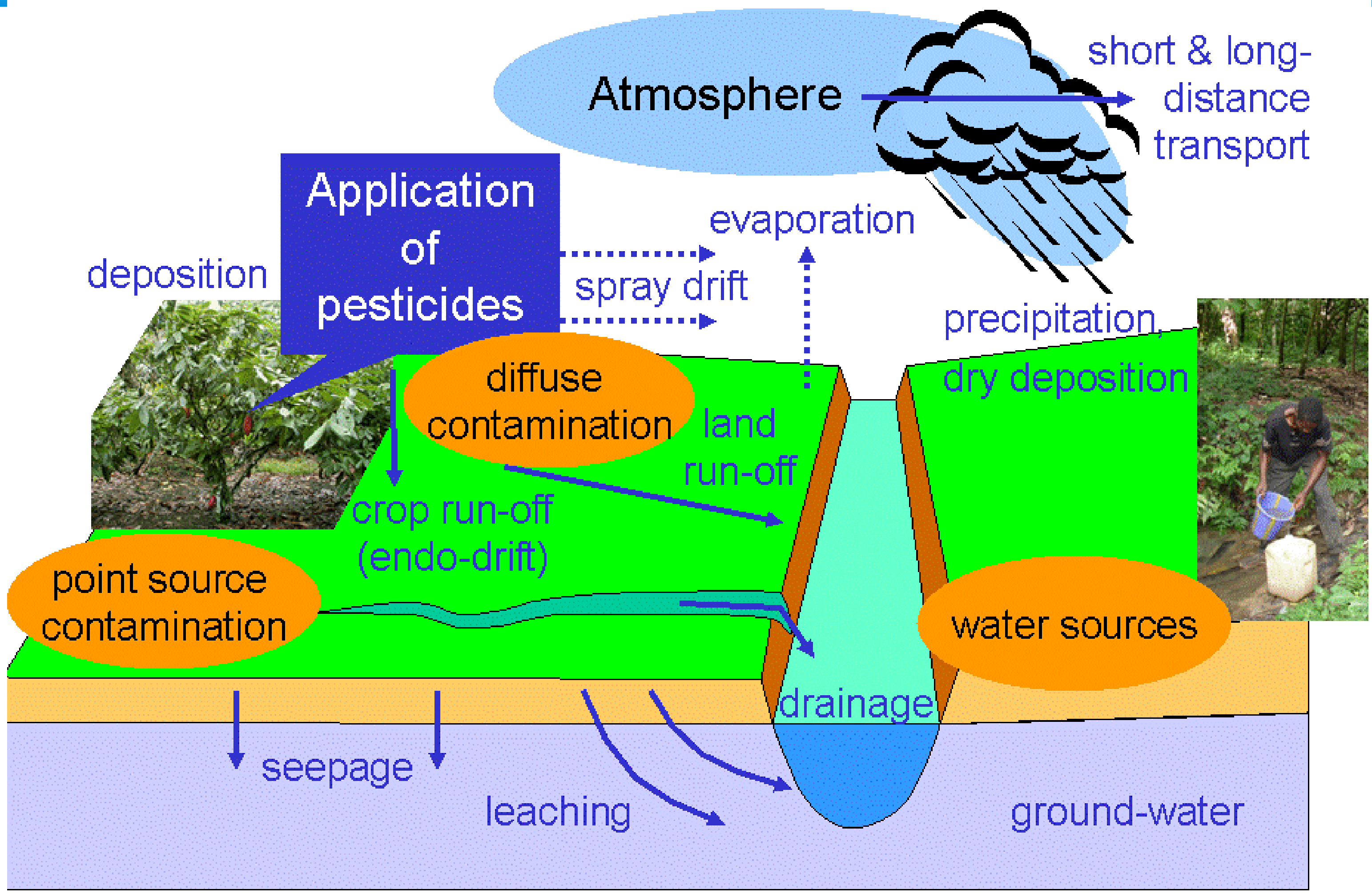
- Due to the losses growers apply various measures. Pesticides are preferred more

- There has been overreliance in the use of chemical pesticides and this is due to

i. Pesticides have fast knockdown effect
ii. Pressure from agro-chemical firms (advertisements). Ease of availability/access

iii. Lack of alternatives such as access to resistant varieties, biological control agents
iv. Lack of technical knowhow on the most appropriate management strategies (such as IPM strategies)

Pesticide pathways



Safety issues

- Pesticides are poisons- potential to cause harm
- All pesticides are toxic. Toxicity is measured in terms of Lethal Dose 50
- Toxicity depends on the chemical properties, routes of exposure and duration of exposure
- Use of pesticides presents a hazard to the user, consumer, non-target organisms and the environment

Categories of recipients due to pesticide pollution

(a) **User or agricultural workers**

- Exposure to the pesticide during mixing and application (acute and chronic effects)

Safety issues

(b) **Consumer**

- Exposed to chronic poisoning
- Chemical residues
- (maximum residue levels)
- Acceptable Daily Intake

(c) **Non-target organisms**

- Affects beneficials especially non-selective pesticides e.g. Fumigants
- Pest resurgence and secondary pest outbreak

Safety issues

(d) **Environment**

- ➢Pollution-pesticides degrade the environment
- ➢Effect on environmental pollution depends on toxicity, formulation, persistence

Various components of the environment are affected

I. **Air**- due to spraying- pesticide formulations

II. **Water**- Spillage, wash out from the atmosphere, surface run-off

III. **Land**- disposal of empty pesticide containers and unwanted pesticides

crop protection activities with biosafety issues

Introduction

▪GMO is an organism whose genetic characteristics have been altered using the techniques of genetic engineering. (transgenic)

▪organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by crossing and/or natural recombination

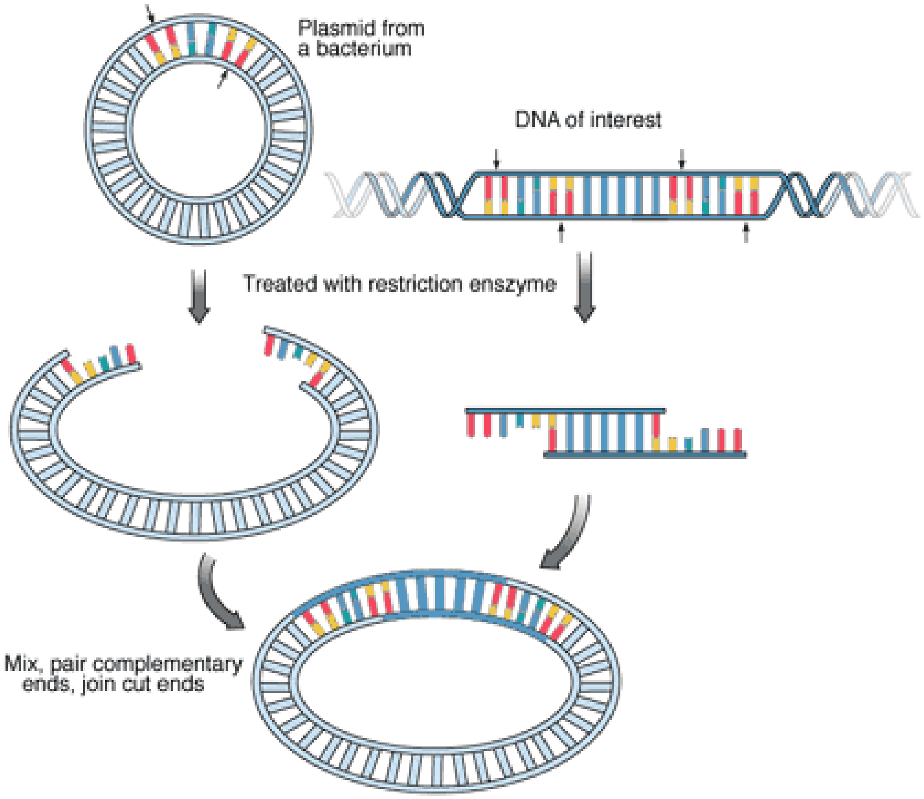
▪The technology is often called "modern biotechnology" or "gene technology" or "recombinant technology" or "genetic engineering

▪ allows selected individual genes to be transferred from one organism into another, also between nonrelated species

▪ Foods produced from or using GM organisms are often referred to as GM foods.

▪ LMO is any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology.

Illustration of this process



Biosafety continued

Use of genetically modified organisms

- Is governed by cartagena protocol on biosafety
- Is a supplement to the convention on biological diversity
- Seeks to protect biological diversity from the potential risks posed by genetically modified organisms resulting from modern biotechnology
- Ensuring an adequate level of protection and safe transfer (transboundary movements), handling and use of GMOs
- Biosafety seeks to avoid adverse effects on the conservation and sustainable use of biological diversity, taking into account risks to human health
- Basic premises on CBD (Decision on the basis of scientific risk assessment and Precautionary Principle)

Convention of Biodiversity (CBD)

- Recognizes the potential of modern biotechnology in causing harm to human well being (health)

- Takes cognizance that modern biotechnology could have serious effects on environment

- Article 8 (g) emphasized the need to regulate the risks associated with the use of LMOS.

- Article 19 (3) set the stage for a legally binding international instrument about biosafety.

Biosafety issues associated with GMOs

Risks for animal and human health:

- Toxicity & food/feed quality/safety- Plants may produce secondary metabolites that may be toxic to humans or livestock
- Allergies/triggering of allergies due to genetic modification - allergenic properties of food from a donor plant might be conserved on the host resulting to genetically modified food containing a new allergic protein
- (human safety) due to pathogen drug resistance from vectors used for transforming plant cells

Risks for agriculture:

- Resistance/tolerance of target organisms (super pests)
- Alteration of nutritional value (attractiveness of the organism to pests)
- Loss of familiarity/changes in agricultural practice

Risks for the environment:

- gene flow; invasiveness (of GMOs might become predominant)
- susceptibility of non-target organisms
- changes to biodiversity- resulting mainly to loss of biodiversity

- genetic pollution through pollen or seed dispersal & transfer of foreign gene to micro-organisms (DNA uptake) or generation of new live viruses by recombination
- Development of herbicide resistant plants may encourage the use of greater amounts of herbicides, with harmful effects on environment.

ethical issues

- risk assessment/risk management –feeling that is not adequately being addressed
- public attitudes, perception-blurring of species, religious views
- socio- economics- patenting GMOs and users e.g. farmers will have to pay royalties to sow the crops.
- Additional of terminator genes in crops to render the seeds sterile forcing farmers to buy seeds every time since they cannot replant.
- GM traceability / commodity segregation –consumers want information explicitly as to whether the food stuff is GMO to address their preferences

Mitigation of safety and environmental issues -pesticides

- Adoption of IPM approaches
- Good agricultural practices (GAP) (selection of pesticides based on toxicity category, PHI, safe re-entry intervals among other considerations)
- Safe use-handling (storage application)
- Ensuring sustainable and safe use of pesticides- avoid routine application but follow threshold levels
- Strengthening regulatory framework of crop protection products (national, regional, and international legislation that helps ensure safety for users, consumers and the environment)
- Education and training programs that inform how products can be used safely and efficiently

Mitigation cont'd

- Regulation on the introduction of GMOs- regulatory framework

Needed (In kenya National Biosafety Authority)

- Rigorous Scientific Assessment
- Adoption of precautionary principle

- Prevention of the spread of genetically engineered material outside lab/field--biocontainment

Conclusions

- Pesticides though toxic have a role to play in crop protection
- Judicious use of pesticides is needed to reduce/eliminate harmful effects on the non-target organisms and the environment
- Knowledge on IPM approaches, availability of the various strategies, GAP information integral in the safe use and protection of non-target organisms and the environment
- Goals of responsible pesticide users follow good practices that achieve effective pest control and little risk to environment

Conclusions cont'd

- Biosafety is integral to modern biotechnology
- The adoption of modern biotech products needs to be balanced with adequate biosafety safeguards
- Case by case scientific risk assessment and cost benefit analysis
- modern biotechnology has potential for improvement of human well being and the environment

- By Simeon Kibet

Contents

1. Seed Crop Inspection Processes
2. Seed Certification Processes For Different Countries

SEED CROP INSPECTION PROCESSES

Presented at:

The Seed Production Field Diagnostics Course, SEMIS, University of Nairobi, 22nd – 27th June, 2015

Simeon Kibet,
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Kenya Plant Health Inspectorate Service
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Objectives of Crop Inspection

1. Ensure that seed sold to farmers meets minimum set quality standards so as to maximize their crop production.

2. Promote seed trade (local and international) by complying with set regulations/agreements

Seed Systems

- Seed is the repository of the genetic potential of crop species and their varieties resulting from the continuous improvement and selection over time.
- It is one of the most crucial elements in the livelihoods of agricultural communities.
- The potential benefits of seed to crop productivity and food security can be enormous.
- Food security is heavily dependent on the seed security of the farming community.

Seed Systems

Different Seed Systems exist:

- Formal and Informal
- Voluntary and Compulsory certification

The principles of inspection are the same for different countries.

- It is the approach that varies

Seed Inspection in Different Countries

Examples

Canadian Seed Crop Inspection

- The Canadian Food Inspection Agency (CFIA) is Canada's seed certification authority and administers the *Seeds Act* and the *Seeds Regulations*.
- The CFIA is the National Designated Authority for the implementation of the Organisation for Economic Co-operation and Development (OECD) Seed Schemes in Canada.
- The Canadian Seed Growers' Association (CSGA) is identified in the *Seeds Regulations* as the seed crop certification authority for all crop kinds grown in Canada **except seed potatoes.**

Canadian Food Inspection Agency (CFIA)

- Canada's national seed authority involved in activities in support of seed crop inspection and certification, including **licensing and oversight of private sector** delivery of seed crop inspection.
- As part of the process of authorization, CFIA has allowed formation of Authorized Seed Crop Inspection Services (ASCIS).

Authorized Seed Crop Inspection Services (ASCIS)

- This initiative focuses on the direct delivery of seed crop inspection by the private sector.
- Licensed Seed Crop Inspectors (LSCI) appointed to provide direct delivery of inspection.
- Before licensing, CFIA hosts training sessions (combination of classroom and practical field training) for individuals who want to be a LSCI.
- This process is under initial stages of implementation

Authorized Seed Crop Inspection Services (ASCIS)

- The CFIA will maintain an oversight and audit role to ensure the effectiveness of the overall program.
- This initiative does not apply to seed potatoes.
- Five percent of pedigreed seed is already inspected through alternative service delivery in Canada, with the remainder carried out by the CFIA.

Authorized Seed Crop Inspection Services (ASCIS)

- Once fully implemented, most growers of seed will obtain crop inspection services for the purposes of seed certification from authorized seed crop inspection service providers.
- The CFIA may, on an exceptional basis only, be required to continue to provide for delivery of seed crop inspections in those cases where an authorized service provider is not available or where it is not possible to use private inspectors.

Seed Crop Inspection

- Seed crop inspection primarily involves confirming that seed production procedures for seed purity and quality are met.
- It also helps verify that the seed crop is free from prohibited noxious weeds.
- It is the largest component of the seed certification system.

Inspection Procedure

- The seed crop inspector (CFIA inspector or LSCI) must be certified or licensed by the CFIA as evidence of their proficiency in seed crop inspection.
- Seed crop inspectors must pass written and practical evaluations prior to certification or licensing by the CFIA to demonstrate their competence to inspect pedigreed seed crops.

Inspection Procedure

Application for Seeds Crop Inspection

- The grower must indicate the name of the ASCIS that will be responsible for the inspection on the application for seed crop inspection submitted to the CSGA.
- If the grower had an inspection the previous year, the application form will be sent to the grower automatically by the CSGA.

Inspection Procedure

Application for Seeds Crop Inspection

- A first time or returning seed grower should request an application from the CSGA.
- The completed application form contains the information relevant to the inspection and verification of the crop's varietal purity.
- All accepted applicants become members of the CSGA.
- Applications for assigned crops are made in the name of the grower of the crop

Inspection Procedure

Application for Seeds Crop Inspection

- Applications for crop inspection of Breeder status plots should be applied for under the name of the plant breeder or breeding institution.
- Fees for crop inspections conducted by an LSCI are collected by the ASCIS to which the LSCI reports. Crop inspections conducted by CFIA inspectors are charged to the CSGA.
- The CSGA reviews the application and forwards the inspection assignment to the appropriate ASCIS or CFIA office to assign a seed crop inspector to conduct the inspection.

Inspection Procedure

Crop inspection involves the performance of three major tasks:

- identification of crops;
- crop impurity counts; and
- checking isolation distances.

Inspection Procedure

Standard inspections required for the crop to be certified as pedigreed seed;

- land use inspections; and
- re-inspections to verify border removal.

Other inspections may be requested to meet a specific need:

- second inspections requested by the grower; and
- any other crop inspection not previously described.

Inspection Procedure

Report of Seed Crop Inspection

- The Report of Seed Crop Inspection should be completed during or immediately after the inspection.
- Reports of Seed Crop Inspection completed by LSCI should be reviewed by the Lead Inspector of the ASCIS to which the LSCI reports prior to submission to the CSGA.

Inspection Procedure

Report of Seed Crop Inspection

- The grower is provided a copy of the report by the ASCIS after verification.
- The ASCIS should maintain any originals or copies of rough notes taken by the seed crop inspector.
- Completed and reviewed Reports of Seed Crop Inspection must be submitted to the CSGA within two business days of the inspection.

Inspection Procedure

Report of Seed Crop Inspection

- For crops which require more than one inspection during the growing season, the seed crop inspector should only submit the completed report after the final inspection is completed unless issues are identified during the first inspection.
- In this case the seed crop inspector must make the CSGA aware of the issue by submitting the Report of Seed Crop Inspection immediately following the first inspection.

Inspection Procedure

- LSCI and CFIA Official Inspectors must keep a record of the time, date and method used to provide the completed Report of Seed Crop Inspection to the grower.
- The seed crop inspector may wish to communicate any observations made during the inspection that may cause the CSGA to decline the crop or that may require remedial action on the part of the grower in order to obtain a crop certificate.

Inspection Procedure

Inspection of Varieties Not Registered in Canada

- Varieties that are not registered in Canada should not be inspected unless the seed crop inspector has a Description of Variety (DoV) for the variety.
- If the DoV is not readily available through the CSGA, it is the responsibility of the grower/applicant to make it available in one of Canada's two official languages.

Inspection Procedure

Inspection of Varieties Not Registered in Canada

- If it is not at all possible to obtain the DoV, the seed crop inspector should advise the grower/applicant that the crop could be declined pedigreed status. The seed crop inspector may perform the inspection based on the uniformity of the crop, providing that it is noted on the Report of Seed Crop Inspection that no DoV was available.

South Africa Seed Inspection

National Seed Certification

- South African National Seed Organization (SANSOR) is the designated authority to manage and execute all functions pertaining to seed certification on behalf of the government.
- This includes not only the National Seed Certification Scheme, but all international seed schemes such as AOSCA, OECD and SADC.
- SANSOR incorporates all noteworthy role players in the seed industry

South Africa Seed Inspection

- This is achieved by means of a core administrative staff and the use of more than 160 private seed inspectors who are trained, examined and authorized to conduct specific functions.
- Seed Certification is voluntary in South Africa, except for specific varieties.
- SANSOR issues Certificates, seals and labels as a guarantee of varietal purity and seed quality.

South Africa Seed Inspection

- The inspection process exercises control from breeder seed, through Pre-Basic to Basic and finally to Certified seed and aims specifically to guarantee varietal purity, as well as seed with good physical qualities.
- SANSOR will only certify seed lots produced on fields registered with SANSOR.
- During the registration process the origin of the seed is verified.

South Africa Seed Inspection

- Field inspections are conducted by trained and authorized seed inspectors.
- After harvest, processing and packaging the seed is sampled and tested by registered seed testing laboratories for germination and physical purity, as well as for varietal purity and identity through post control grow-outs done by government.

South Africa Seed Inspection

Other seed related functions of SANSOR include:

- Training of seed inspectors by presenting courses, workshops and seminars.
- Assistance with the maintenance of national variety lists ;
- Assistance with the development of national variety lists in the case of new crops, as well as the collection of seed samples and variety descriptions;

South Africa Seed Inspection

- Arrangement for the execution of post – control tests by the Registrar of Plant Improvement with the aim of monitoring the efficiency of seed certification for maintaining varietal purity;
- Collection, codification and submission of samples from all seed units under certification for post control tests by the Registrar of Plant Improvement;
- Promotion of liaison between private laboratories and the Official Seed Testing Laboratory.

END

- THANK YOU

SEED CERTIFICATION PROCESSES FOR DIFFERENT COUNTRIES

SEMIS INTERNATIONAL TRAINING COURSE AT CAVS

By SIMEON KIBET

SEED CERTIFICATION PROCESSES

- Formal
- Intermediate
- informal

Informal seed certification

- Farmer saved seeds
- Farmer exchange
- Barter trade
- Local markets
- Seeds not certified

Note; This is a farmer and community based seed system

Intermediate Seed Certification

Done by

- NGO's
- Famers Associations through local Seed Business development.
- Has a short value chain
- Deals with locally important food crops
- Certification ascertained through truthful labelling and QDS(Quality Declared Seeds)

Formal seed certification

Involves a complete seed value chain which include;

- Genetic Resource management
- Variety Development
- Early generation production
- Seed Multiplication
- Dissemination
- Consumption of seed

Cont'

Its is composed of;

- National Public Companies e.g Kenya seed
- Private Companies e.g Kenya Highlands Seeds
- Multinational Companies e.g Monsanto

It is characterised by a Closed value chain

In Kenya we have a total of 133 seed companies registered.

Cont'

Advantages of Formal Seed system include

- Assured seed quality due to laid down regulations
- Traceability thus sustainability and reliability
- Regional Marketing due to international and Regional standardized quality
- Access to different Varieties from different regions

Note- In Kenya only formal seed system is recognized by Law

SEED CERTIFICATION In Kenya

- Seed is the basic input that sets the potential for crop yield hence requires defined processes in its production, processing and marketing

- Seed Quality Assurance Services operate within the guidelines and procedures stipulated in The Seeds and Plant Varieties Act (Cap 326) of the laws of Kenya .

- Inspections (both in the field and factory processing) is undertaken as per the OECD set standards. Laboratory seed tests/analysis are carried out as per the ISTA standards/rules

SEED CERTIFICATION

- Legally sanctioned system for quality control for seed multiplication and production.
- Aims to control the varietal identity and purity throughout the seed chain
- Eligible variety for certification must be officially released varieties in case of schedule II crops
- In Kenya seed companies and growers requires registration

Quantity Of Seed Certified

- The average quantity of seed certified annually is about 37509 tons(2012-2013 annual report)
- About 89% of certified seed are locally produced and the remaining 11% imported

Seed Certification Process

Steps in seed certification

1. Registration of seed crop and Verification of seed source
2. **Field inspection**
3. **Seed processing inspection and sampling**
4. **Seed testing**
5. **Leballing and sealing**
6. **Post control**

Registration of seed crop

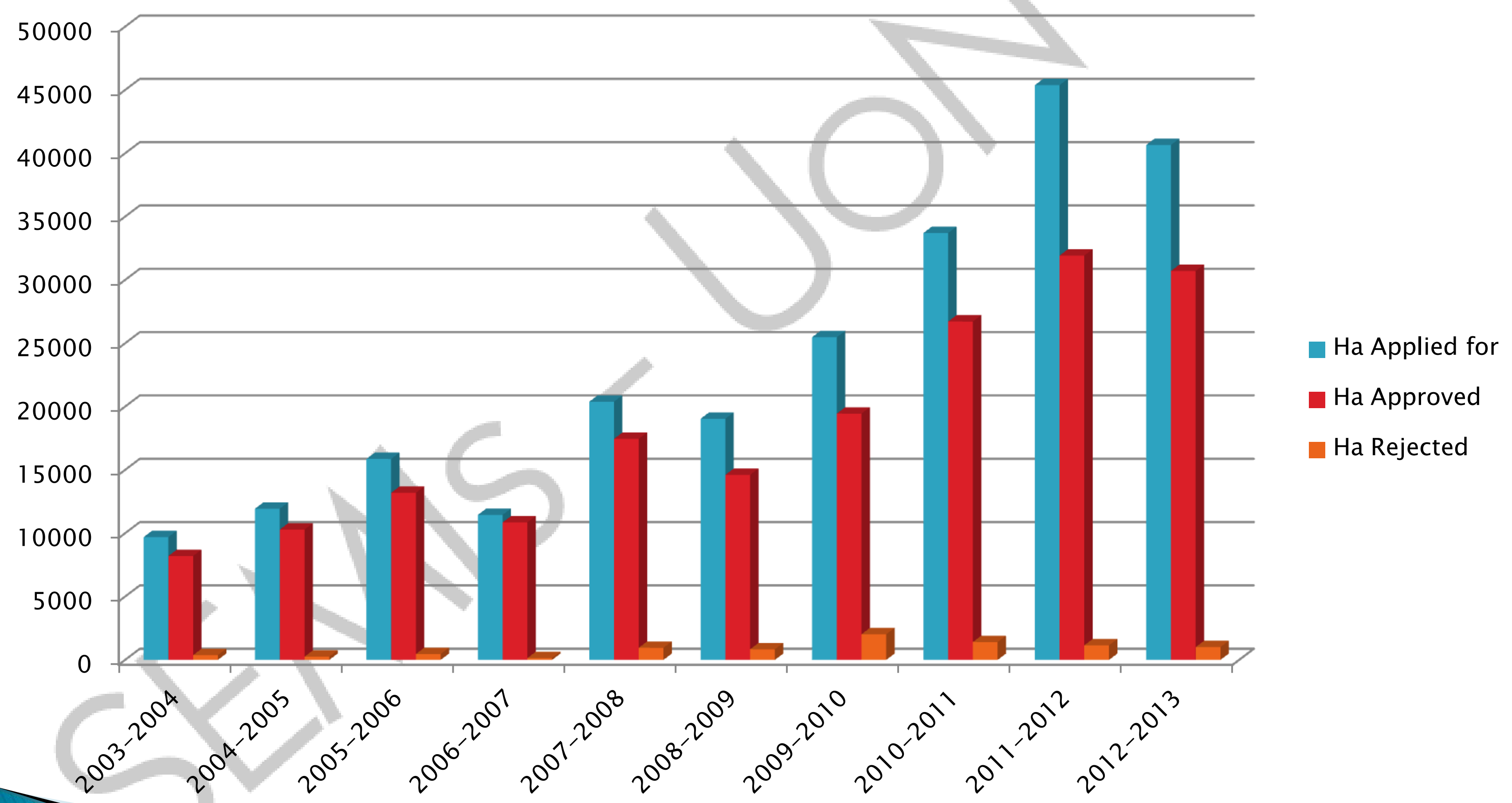
- Submission of application for field inspection of seed crop on prescribed form Seed Regulation (SR) 5
- Verification of seed of seed source
  - ✓ Prove of origin

Field inspection

Objective: To verify factors that can cause irreversible damage to the genetic purity or seed health. .

- Confirmation of acreage given in the report
- Cropping history of the farm
- Isolation distance
- Varietal purity
- Diseases

Field inspections of seed cont'd



Seed processing inspection and sampling

This involves:

- **The separation of desired, good, healthy seed from inferior seed and impurities**
- **Dividing good seeds into uniform grades of size and shape**
- **Treating seed with chemical Protectants, colorants and or growth promoters**

Seed processing inspection and sampling continued

- Sampling processed seed lot after dressing for quality testing in the seed laboratory

Seed testing

Conducted to determine seed's

- Physical purity
- Germination capacity
- Moisture content
- Health status of seed lots
- Vigor

Seed must meet the minimum purity and germination standards set in CAP 326

Seed quality testing Cont'

- On average the seed laboratory tests 3143 samples annually
- The seed samples that meet quality standards average 2648 and that fail 495 (2012-2013)
- Failed seed lots should never be offered for sale

Post control

- Ascertain that the scheme is working satisfactory
- Determine if varietal characteristics remain unchanged in the multiplication process (Varietal identity and purity)

Failed Seed lot in post control – Sorghum variety Gadam

Post control cont'd

Fig 6: round fruits of the off-types on the left, fruit of Rio grande on the right

Fig 7: Elliptic shape of Rio grande (left) compared with circular shape of off-type (right) in both photos

Seed Importation and Exportation

Requirements

In order to import or export seed into Kenya one must:-

1. Be a **registered** seed merchant.
2. **Notice to import/export** seed by filling form **SR 14** provided by KEPHIS.
3. Obtain a **Phytosanitary Certificate** or a **Plant Import Permit** (PIP) from KEPHIS or the corresponding Seed Certifying body in the country of origin for imports.
4. Obtain an international orange (International Seed Testing Association (**ISTA**) certificate from the official seed tester (KEPHIS) or the corresponding seed certifying body in the country of origin for imports. This will accompany the seeds.
5. **Seed is inspected** by KEPHIS at the port of exit/entry.

REGISTRATION AS A SEED STOCKIST

- Duly fill application forms (SR 12) and return them to the KEPHIS regional office.

- Pay Kshs. 1000/= annual registration fees per application.

REGISTRATION AS A SEED STOCKIST

- KEPHIS seed inspectors will then inspect the premises of the applicant to establish whether they:-

  - Have adequate storage capacity for seed quantities that one may desire to store.
  - Is clean, vermin proof, and waterproof.
  - Has enough lighting and is well ventilated.
  - Have suitable display (e.g. not in direct sunlight)

Schedule VI:

- Form (SR.1) – Application for registration as seed grower
- Form (SR.2) – Certification of registration as seed flower
- Form (SR.3) – Application for registration as seed merchant
- Form (SR.4) – Application for registration as seed merchant / processor
- Form (SR.5) – Application for field inspection of a seed crop
- Form (SR.6) – Field Inspection result
- Form (SR.7) – Seeds Transport Order

Schedule VI: Cont

- Form (SR.8) – Work order
- Form (SR.9) – Request for testing a seed sample
- Form (SR.10) – Seed Testing Certificate
- Form (SR.11) – Stop-Sale-Order
- Form (SR.12) – Application for seed sellers licence
- Form (SR.13) – Seed Sellers Licence
- Form (SR.14) – Notice to Import / Export

Thank you

- By W. M. Munyao

Contents

1. Obligations And Ethical Issues For Seed Growers Presented
2. Reporting Of Inspection Results, Consequences And Options For Rejected Crops
3. Definitions Of Threshold Levels; Acceptable Threshold Levels And Regulatory Tolerance Levels For Targeted Seed Crops

SEED PRODUCTION FIELD DIAGNOSTICS COURSE HELD FROM 22ND TO 26TH JUNE 2015 AT UoN KABETE CAMPUS

SEED GROWERS

- Seed Growers are skilled producers who transfer the technology contained in seed from one generation to the next without allowing impurities or contamination from other varieties or crops

SEED GROWERS Cont'd

- Seed growers may fall into one of the following three classes:
  - Smallholder growers – mainly contracted in groups
  - Small scale growers – contracted individually and/or in groups
  - Large scale growers – contracted individually

Selection of seed growers

- The criteria used by seed companies to selection farmers to contract are based on the following:
  - Reliability,
  - knowledge,
  - resourcefulness,
  - willingness to cooperate

Selection of seed growers

- Location of farm relative to the seed company
- Farm size
- Infrastructure of the farm
- Labour availability

OBLIGATIONS OF SEED GROWERS

- Should be familiar with the seed certification requirements in all stages of seed production, conditioning and handling
- Obligation of seed growers fall in all seed production stages and they include:

OBLIGATIONS OF SEED GROWERS

a. Agreement to produce a particular crop and variety exclusively for a seed company

b. Quantity of seed to be produced

- planted area

OBLIGATIONS OF SEED GROWERS Cont'd

- the minimum yield

c. Crop management specification

d. Certification requirements

- the highest level of integrity
- Genetic purity – Isolation, roguing of off-type plants from seed fields
- Physical purity - protected from varietal mixture and other crop species

OBLIGATIONS OF SEED GROWERS Cont'd

- Freedom from pests and diseases
- Germination capacity
- Moisture content
- Traceability of harvested seed
- Ensuring that all equipments and storage facilities are cleaned and disinfected before storing harvested seed

OBLIGATIONS OF SEED GROWERS Cont'd

- Cropping history of the farm

e. Allow freedom of inspection of seed fields by company representatives and certifying agencies

f. Seed delivery form, methods and schedules

g. Keep record of the farm operation eg planting dates

OBLIGATIONS OF SEED COMPANIES

- Seed company obligations includes
  a. Supply parent seed
  b. Specify services to be rendered to the grower
  c. Pay for the agreed price, including any applicable bonuses or penalties
  d. Follow the payment schedule

ETHICALS ISSUES OF SEED GROWERS

- **Ethics** are standards of conduct (or social norms) that prescribe behavior
- ***Ethics*** are general standards of conduct of a particular profession, occupation, institution, or group with in a society
- ***Morality*** consists of a society's most general standards

ETHICALS ISSUES OF SEED GROWERS

- **Code of Ethics**

Is a set of principles and rules used by companies, organizations or individuals to govern their decision-making in choosing what is right and wrong.

-Depending on the context of a given code of ethics, penalties and or sanctions may be applied.

ETHICALS ISSUES OF SEED GROWERS

- ***The basis of ethics***

  a. Don’t harm others or yourself.

  b. Help others and yourself.

  c. Respect truth: do not lie, cheat, deceive.

  d. Be faithful: keep promises and agreements.

  e. Be fair: treat equals equally.

UNETHICAL ISSUES PRACTICES OF SEED GROWERS

- The growers' actions that are unethical include:
  a. Tendency not to plant all the seed supplied
  b. Diversion of inputs
  c. Non conformity to agronomic practices and seed certification requirements

UNETHICAL ISSUES PRACTICES OF SEED GROWERS

d. Tendency of farmers to keep part of the contracted crop to eat at home

e. Selling of harvested seed to third party

f. Yield fraud – Adding uncertified seed to certified to increase the yield

UNETHICAL PRACTICES OF SEED COMPANIES

- Seed company unethical practices include
  a. Failure to collect produce
  b. Late payment
  c. Buying seed from non-contracted growers

THANKS

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SEED PRODUCTION FIELD DIAGNOSTICS COURSE HELD FROM 22ND TO 26TH JUNE 2015 AT UoN KABETE CAMPUS

Reporting of inspection results, consequences and options for rejected crops presented by Munyao W.M

REPORTING OF INSPECTION RESULTS

- Field inspection results should be reported immediately after inspection
- Report is made on a standard format
- The report should details:
  a. varietal impurities,

REPORTING OF INSPECTION RESULTS

- Field inspection report should be made immediately after inspection
- The report is made on a standard format
- The report details:
  a. varietal impurities

REPORTING OF INSPECTION RESULTS

b. difficult-to-separate other crop kinds

c. isolation

d. objectionable weed content

e. diseases and the pedigree of the parent seed planted separate

The report general information

- General information to include in the report should include:
  a. Name of seed grower
  b. Grower number
  c. Field name
  d. Field number
  e. Location of the farm
  f. Name of Crop

The report general information cont’d

g. Variety name
h. Seed lot used Sour of Seed
i. Class and Quantity of Seed
j. Class of seed
k. Total acreage under seed production.
l. Acreage of field Inspection

Inspection result

- **Inspection results**
  1. Stage of seed crop during inspection
  2. Inspection (1. 2, 3 etc)
  3. Isolation distance (M)
     a. North
     b. South
     c. East

Inspection result

a. West

4. Name and stage of growth of contaminants

5. Crop Condition

6. Estimated seed yield(Qts/ha)

7. Remarks

Inspection result - Count

COUNT NO.	OFF TYPES	OTHER CROPS	WEEDS	AFFECTED BY SEED BORNE DISEASES	REMARKS I.E NAMES OF CONTAMINANTS
1					
2					
3					
4					
5					
6					
Total					
Average					
%					

Inspection result for hybrid seed crop- Count

	SEED PARENT					POLLEN PARENT			
Count	with receptive silks	shedding pollen	Offtyes	Offtypes shedding	Affected by seed borne diseases	No. shedding pollen	No. of offtypes	Offtypes shedding pollen	Affected by seed borne diseases
1									
2									
3									
4									
5									
6									
Total									
%									

Inspection result

- The results should be signed by both inspector and the growers
- A decision should be made whether to pass or reject the crop based on the inspection standards

Consequences and options for rejected crops

- Crop not meeting the certification standard is rejected for certification
- A rejected crop can be downgrade where applicable
- Rejected seed crop should be deposed in other way but not seed

THANKS

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SEED PRODUCTION FIELD DIAGNOSTICS COURSE HELD FROM 22nd to 27th June 2015 AT UoN Kabete campus

DEFINITIONS OF THRESHOLD LEVELS; ACCEPTABLE THRESHOLD LEVELS AND REGULATORY TOLERANCE LEVELS FOR TARGETED SEED CROPS PRESENTED BY

Munyao W. M

PRESENTATION OUTLINE

- Introduction
- Thresholds levels of diseases
  - Defination
  - Types of thresholds
- Tolerance levels of disease

INTRODUCTION

- Total eradication of a pest is impossible and undesirable because it can spell the demise of the pests natural enemies and can upset the broader economic balance.
- It's usually better to determine the level of pest presence or pest related damage that can be tolerated without harm to health and plants.
- Determining these levels or thresholds goes hand and hand with field monitoring

THRESHOLD LEVEL

- Defination
  - It is a boundary where something starts or ends
- Characteristics of threshold
  - changes throughout the season at different stages of crop development

THRESHOLD

- vary from variety to variety
- must be constantly revised to account for new pests, new varieties, new management practices, new marketing standards and variation in commodity prices
- developed by the grower to suit their IPM needs

Types of thresholds

- **Economic Thresholds (action thresholds)**
  - The pest density at which some control should be exerted to prevent a pest population from increasing further and causing economic loss

Types of thresholds

- Can also be defined as the break-even pest density.
- It is simply the operational criteria for administering pest control action.
- Normal lower than economic injury level

Types of thresholds cont'd

- Economic threshold depends on:
  a. Economic injury level
  b. Pest and host phenology
  c. Population growth and injury rates
  d. Time delays associated with integrated pest management tactics utilized

Types of thresholds cont'd

- Examples of economic threshold:
  - bean leaf beetles in soybeans: "When defoliation reaches 30 percent (before bloom) and there are 5 or more beetles per foot of row".
  - black cutworms in corn: " apply a post emergence rescue treatment when 3 percent or more of the plants are cut and the larvae are still present.
  - leaf miners in melons: chemical treatment is recommended if an average of 15 to 20 un-parasitized larvae per leaf are found

Types of thresholds cont'd

Damage Thresholds

- The maximum damage a crop can sustain without yield loss
  - Generally used for plant diseases. Since disease pathogens are too small to be easily seen, counting their numbers is impractical, so an estimate is made of the amount of damage caused by them.

Types of thresholds cont'd

Examples of damage threshold

- counting diseased leaf petioles for soybean pod and stem blight
- estimating the percentage of whole plant infection caused by fungal leaf blights in corn

Types of thresholds cont'd

- **Economic Injury Thresholds (EIL)**
  - The lowest pest density at which economic damage occurs, where the cost of the control measure is equal to the loss likely to be inflicted by the pest.
  - EIL is above the economic threshold
- Example:
  - beet army worm on melons: if army worms begin feeding on fruits

Example of EIL for sorghum

Economic injury level for sorghum midge-susceptible hybrids											
Per acre control cost ($)	Crop market value ($) per acre										
	100	120	140	160	180	200	220	240	260	280	300
3	1.2*	1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.4	0.4
4	1.6	1.3	1.1	1.0	0.9	0.8	0.7	0.7	0.6	0.6	0.5
5	2.0	1.7	1.4	1.3	1.1	1.0	0.9	0.8	0.8	0.7	0.7
6	2.4	2.0	1.8	1.5	1.3	1.2	1.1	1.0	0.9	0.9	0.8
7	2.7	2.3	2.0	1.8	1.6	1.4	1.3	1.2	1.1	1.0	0.9
8	3.0	2.7	2.3	2.0	1.8	1.6	1.5	1.3	1.2	1.1	1.1
*Number of sorghum midges per panicle											

Examples of EIL for sorghum

Economic injury levels for sorghum midge-resistant hybrids											
Per acre control cost ($)	Crop market value ($) per acre										
3	6	5	5	4	4	3	3	3	3	2	2
4	8	7	6	5	5	4	4	4	3	3	3
5	10	9	7	7	6	5	5	4	4	4	4
6	12	10	9	8	7	6	6	5	5	5	4
7	14	12	10	9	8	7	7	6	6	5	5
8	15	14	12	10	9	8	8	7	6	6	6
*Number of sorghum midges per panicle											

Types of thresholds cont'd

- The concept of EIL aims to:
  a. promote rational use of pesticides
  b. avoid pesticide resistance
  c. Reduces pesticide residues on agricultural products
  d. Reduce negative effects of pesticides on non-target pests
-

Types of thresholds cont'd

- EIL is governed by five primary variables
  1. cost of the management tactic per production unit, (C)
  2. market value per production unit (V)
  3. injury units per pest (I),
  4. damage per injury unit (D)
  5. the proportional reduction in pest attack (K)

Types of thresholds cont'd

- **Aesthetic Thresholds**
  - The level at which a pest causes an undesirable change in the appearance of something, typically ornamental plants

How thresholds are developed

- Thresholds can be developed from the following factors among others
    a. Amount of physical damage related to various pest densities;
    b. Monetary value and production costs of the crop at various levels of physical damage
    c. Monetary loss associated with various levels of physical damage

Units of thresholds

- Thresholds are expressed as:
  a. damage to leaves, plants, foliage,
  b. Number of plants showing damage; or Number adults or larvae/stem / plant.
  c. Number adult insects or larvae / m2
  d. Number adult insects or larvae/sweep

Importance of Thresholds

- Decision making on scheduling of control and control methods
- Establishment of optimal amount of control which can be used to minimize risk of economic damage and environmental hazards

PEST AND DISEASE TOLERANCE

- Tolerance means the allowable upper limit of observed disease during
  - field inspection
  - post-harvest test and
  - laboratory evaluation

PEST AND DISEASE TOLERANCE

- Zero tolerance means no allowable limit
- Disease tolerance levels for infected seed crops and seed in seed certification are part of legislative measures for seed health management.

Pest and disease tolerance cont'd

- In assessing pests and disease in a seed field for allowable tolerances, five rules are generally applied
  - Examine every field
  - Sample randomly

Pest and disease tolerance cont'd

- Sample across the entire field
- Take enough samples
- Keep records of inspection Data and Management Actions

Disease tolerance levels

CROP	DISEASE	%TOLERANCE	
		Basic	Certified 1
Bean	Bean common mosaic virus	0	0.1
	Anthracnose of bean %	0.02	0.02
	Halo blight %	0	0.05
	Bacterial canker	0	0.05
	Angular bean leaf spot	0.02	0.05
	Bacterial blight of bean	0	0.05
Maize	Head smut (at final inspection)	0	0
	Common smut (at final inspection)	0	0
	Loose smut (at final inspection)	0	0
Rice	Rice blast (piricularia)%	0.1	0.5
	White tip nematode	0	0

Disease tolerance levels

CROP	DISEASE	%TOLERANCE	
Groundnut	Ralstonia solanacearum	0	0
	Rosette virus	1/1000 plants	5/1000 plants
Wheat	Kernel bunt	0	1/100m2
	Loose smut	1/100m2	1/100m2
Sunflower	Color rot (At final inspection)	0	0
	Verticillium wilt	0	0
	Downy mildew %	0	0.2
	Leaf blight of sunflower (%)	0	0.2
	Grey mould of sunflower (%)	0.5	1
Sorghum	Covered kernel smut (%)	0.1	0.2
	Mildew	0.1	0.2

Disease tolerance levels

CROP	DISEASE	%TOLERANCE	
Soybean	Soybean mosaic virus SMV %	0	0.02
	Purple stain %	2.5	2.5
	Bacterial pustule	0	0
	Pseudomonas savastanoi	0	0
Cassava	African cassava mosaic	0	0
	Cassava Bacterial Blight	0	0
	Cassava brown streak disease	0	0
Irish potato	Bacterial wilt of potato, Black leg %, Golden nematode	0	0
	Fusarium wilt	0	2/1000
	Verticillium wilt	0	0.5
	Potato virus Y	0.1	1
	Potato virus X	0.3	2

THANKS FOR LISTENING

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- By Prof. James Muthomi

Contents

SEED ENTERPRISE MANAGEMENT INSTITUTE (SEMIs)

Seed Production Field Diagnostics

Short Course

22nd – 27th June 2015

Abiotic Disorders In Seed Production

Prof. James W. Muthomi

Department of Plant Science and Crop Protection

University of Nairobi

- Abiotic plant problems are sometimes termed “physiological disorders
- Abiotic disorders” refers to a wide array of plant problem
- “Abiotic” to indicate that the symptom is not caused by a biological agent such as an insect, mite or pathogen.
- Abiotic disorders are associated with non-living causal factors such as weather, soils, chemicals, mechanical injuries, prolonged drought, cultural practices and, in some cases, a genetic predisposition
- Abiotic stressors can also predispose plants to pathogens

- Genetic mutations and reversions
- Chimeras - Leaf variegation
- Low-temperature injury
- Sunscald and frost cracking
- Frost injury
- Drought and heat
- Flooding

- Lightning and hail
- Nutrient deficiencies and excesses
- Salt injury
- Herbicides
- Pesticides
- Air pollution

- Plants suffering from nutrient or physiological disorders, the plant exhibits disease-like symptoms
- Nutrient disorders are sometimes mistaken for a disease
- Nutrient deficiencies lack visible signs, they are often mistaken for virus diseases
- Nutrient disorders may result in a reduction in yield

Soil nutrients

Macro-nutrients
Constitute main elements required by plant for basic functioning

- Phosphorous (P),
- Potassium (K),
- Nitrogen (N),
- Calcium (Ca),
- Magnesium (Mg)
- Sulfur (S).

Micro-nutrients (trace elements)
Required in very small amounts but are essential for normal growth

- Iron (Fe),
- Zinc (Zn),
- Manganese (Mn),
- Boron (B),
- Molybdenum (Mo)
- Copper (Cu)

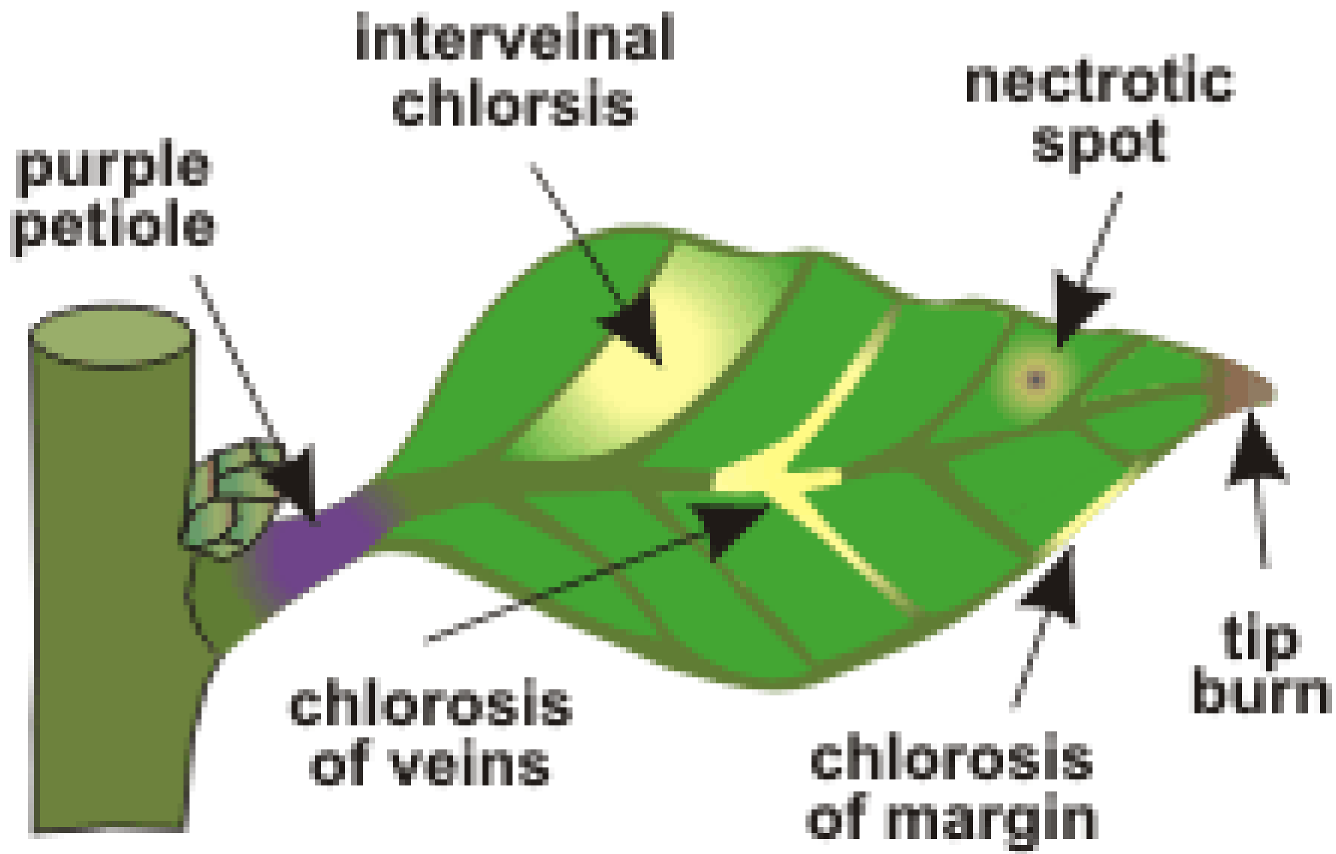


Fig 15.1 Some common leaf abnormalities resulting from nutrient deficiencies.

Nutrient deficiencies

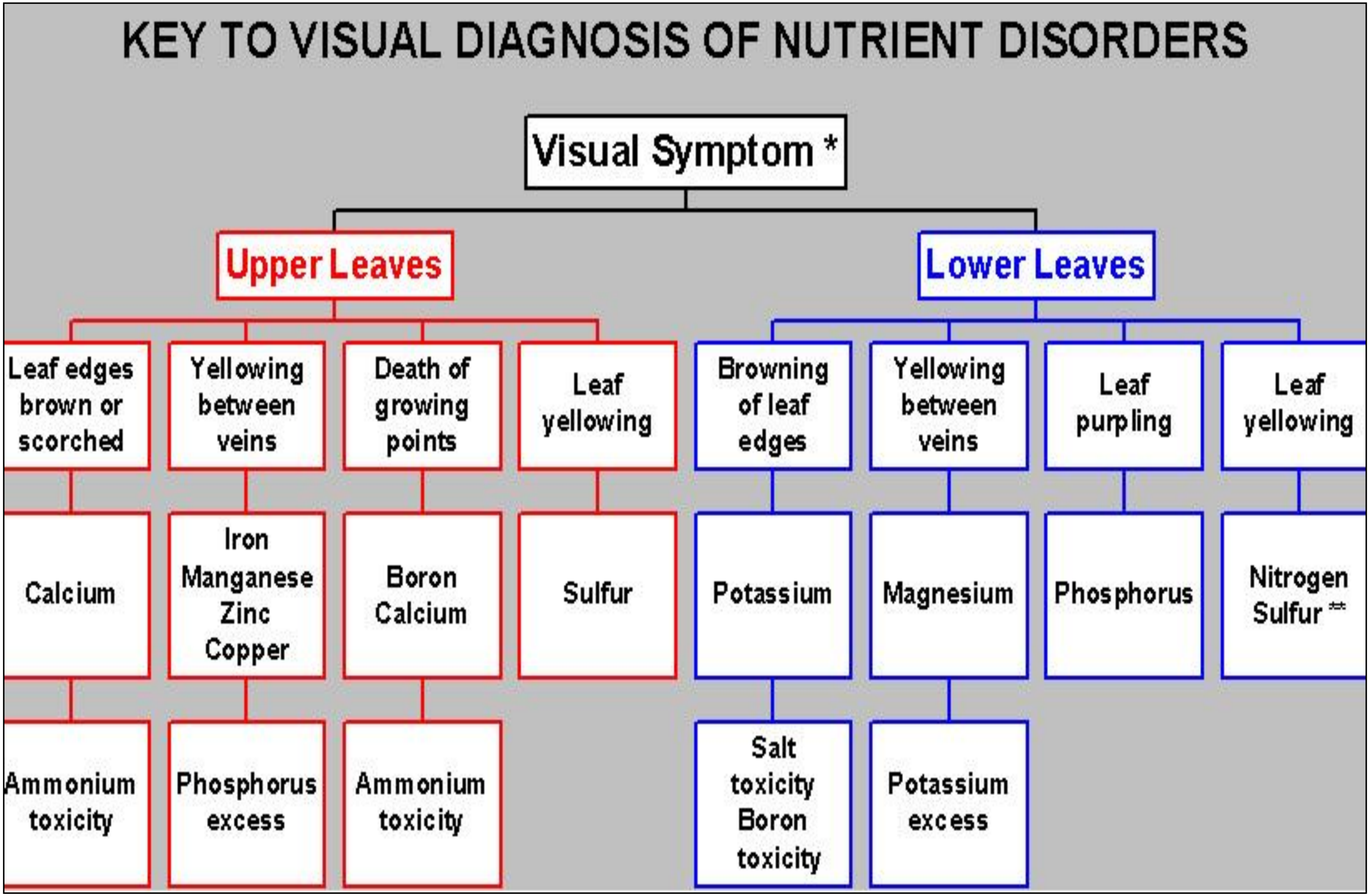
- Symptoms of nutritional disorders occur in defined patterns and are specific for each nutrient
- Symptoms are first seen in older leaves for some deficiencies, and in young leaves and/or tissues for others
- Mobile nutrients (n, p, k and mg) deficiencies are first seen in older leaves;
- Immobile nutrients (ca, b, cu, zn and fe) deficiencies are first seen in youngest leaves and/or growing tissue

Pesticide toxicity or disease symptoms may resemble nutrient deficiencies or toxicities

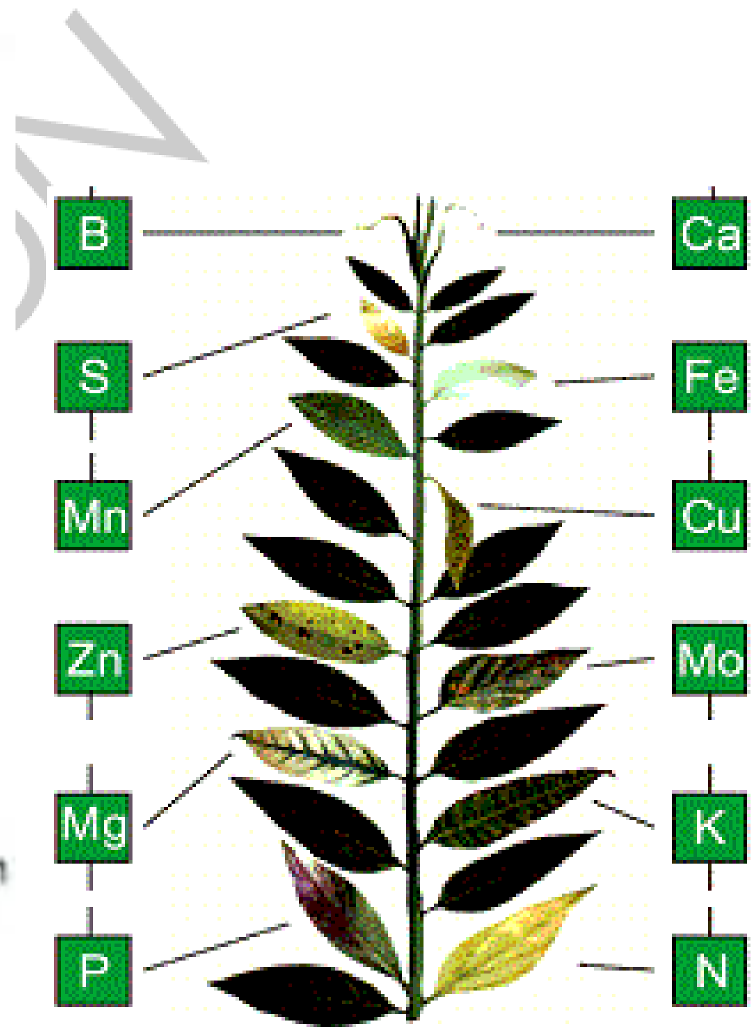
Symptoms of nutritional disorders are often species or variety dependent

Soil and plant tissue analysis should be used to help confirm whether the symptoms truly are nutritional

Magnesium deficiencies are often confused with viruses and other nutrient problems. However, symptoms of viruses are typically manifested in the young, growing part of the plant.


KEY TO VISUAL DIAGNOSIS OF NUTRIENT DISORDERS
Visual Symptom *
Upper Leaves
Lower Leaves
Leaf edges brown or scorched
Yellowing between veins
Death of growing points
Leaf yellowing
Browning of leaf edges
Yellowing between veins
Leaf purpling
Leaf yellowing
Calcium
Iron Manganese Zinc Copper
Boron Calcium
Sulfur
Potassium
Magnesium
Phosphorus
Nitrogen Sulfur **
Ammonium toxicity
Phosphorus excess
Ammonium toxicity
Salt toxicity Boron toxicity
Potassium excess


Calcium
Iron
Nitrogen
Potassium
Carbondioxide
Manganes
Phosphate
Magnesium


B
Ca
S
Fe
Mn
Cu
Zn
Mo
Mg
K
P
N

SYMPTOMS OF ABIOTIC DISORDERS

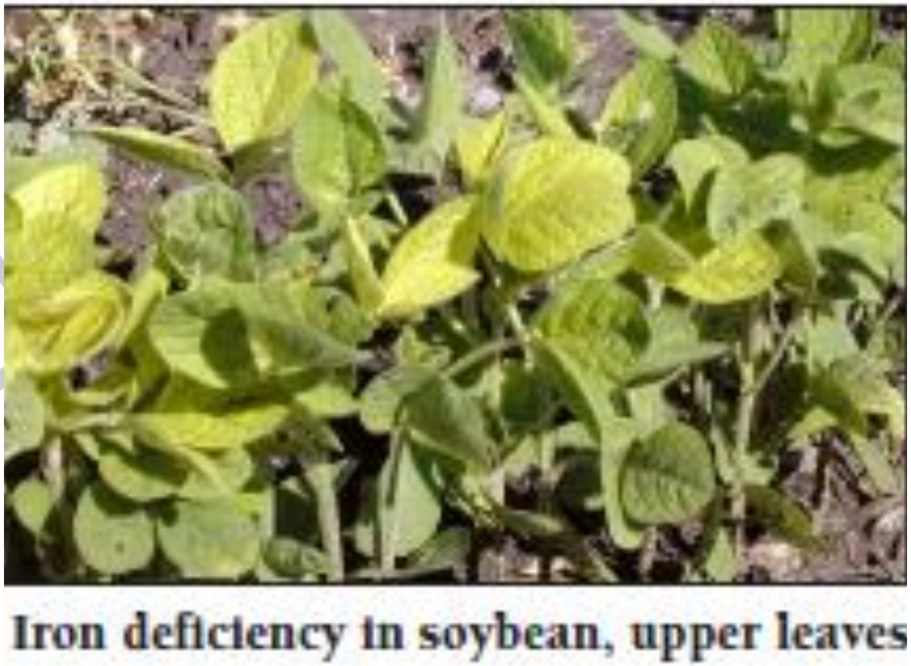
LEGUMES

Iron Deficiency of Peanut

Iron deficiency in cowpea

Iron

Iron deficiency



Manganese Deficient Soybean

Manganese Deficiency of Peanut

Molybdenum

Molybdenum Deficiency of Peanut (Right) Grown in Strongly Acid Soil (PH

Molybdenum Deficiency of Peanut (Right) Grown in Strongly Acid Soil (PH 4.5)

SYMPTOMS ON CEREALS

a healthy corn plant leaf is deep green and glossy

a leaf from a plant with nitrogen deficiency yellows down the midvein starting at the tip and moving back towards the stem

a leaf displaying phosphorus deficiency turns red-purple along the leaf margins

a leaf from a potassium-deprived plant features firing and yellowing along the leaf margins

Phosphorus

Potassium

Potassium

Potassium deficiency in corn, lower leave

Potassium deficiency
Not chiseled (left), chiseled (right)

Potassium

Nitrogen

Nitrogen

Wheat

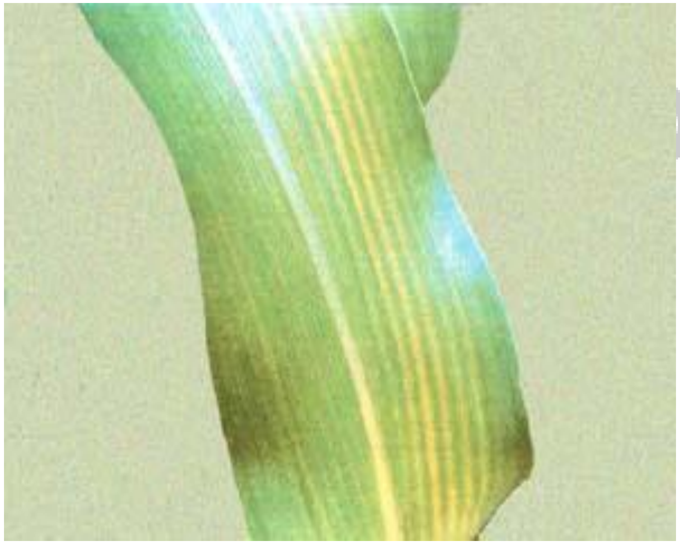
Nitrogen deficiency

Potassium deficiency

Phosphorus deficiency

Magnesium

Sulphur



Boron

Manganese

Manganese deficiency

Zinc

Zinc Deficiency of Rice

Zinc Deficiency of maize

Zinc

Iron

Copper

Calcium

Boron Deficiency in Papaya

MANAGEMENT OF NUTRIENT DEFICIENCIES

Conditions leading to nutrient deficiency

Nitrogen –

- Infection by root pathogens such as root-knot nematodes
- Nitrogen deficiencies can cause increased susceptibility to certain leaf pathogens such as *alternaria solani,*
- Excessive plant N levels may result in increased susceptibility to other pathogens

Phosphorus –

- Acid and clay soils are particularly prone to P deficiency.
- Cool conditions or poor oxygen availability to the roots can lead to p deficiency

Iron (Fe) –

- Most soils have adequate supplies of fe;
- Availability decreases as soil ph increase

Potassium (K) –

- Availability reduced by presence of competing cations such as ca)$^{2+}$ and NH_4^{+};
- Potassium can also be readily leached from sandy soils.
- Plant uptake of k may be reduced by certain environmental conditions including temperature, soil moisture, and oxygen availability.

Deficiency	Symptoms	Remedies
Phosphorous (P)	Poor germination, seedling establishment & plant growth; leaves may be dull bluish/greyish-green or have red pigment in leaf bases and dying leaves; oldest leaves may turn yellow & drop.	Apply phosphorus fertilisers & manure
Potassium (K)	Yellowing on older leaves; scorching of edges and/or interveinal region	Apply K fertilizer rate
Nitrogen (N)	Poor plant growth; older leaves are pale green to yellow and they eventually dry and drop; fruit and tubers are small.	Add N fertilizer improve irrigation management.

Calcium (Ca)	**Retarded growth; yellowing & distortion of young leaves; blossom end rot in cucurbits and tomatoes**	**Side dress with a Ca fertilizer**
Magnesium (Mg)	Growth retarded; chlorotic patches between the veins of older leaves; a triangle of green remains at base of leaf; leaf margins may burn.	Application of fertilizer or weekly foliar sprays
Sulfur (S)	Yellowing of young leaves while older leaves remain dark green; growth stunted.	Application of sulfate compounds.
Boron (B)	Bushy stunted growth & dying growing tips; internal brown rot; brittle plant tissue & split easily; hollow areas in stems.	Application of boron-fertilizers

Iron (Fe)	**Leaves turn yellow/bleached between vein margins; stunting & abnormal growth; fruit may not mature.**	**Spray iron sulphate; reduce soil pH below 7.5**
Manganese (Mn)	Yellow patches between veins; reduced flower formation.	Foliar sprays with manganese sulphate
Molybdenum (Mo)	stunted, pale green or yellow stunting & pale green or yellowish green colour between the veins & along edges of leaves; leaf tissue of margins dies;	Liming to increase soil pH to 6.5; foliar applications of sodium or ammonium molybdate.
Zinc (Zn)	Stunted & pale with creamy yellow interveinal area; distorted young leaves.	Application of Zn foliar spray
Copper (Cu)	Chlorosis in young leaves; tips of leaves distorted; stunted growth.	Apply a copper fertiliser

NUTRIENT TOXICITIES AND CHEMICAL INJURY

Nutrient toxicities

- Chloride toxicity – Caused by saline water and soil conditions; plants wilt when soil moisture seems adequate; test and monitor irrigation water quality; plants vary in their tolerance to salinity.
- Manganese toxicity – Yellowing of margins of older leaves; poor root development; favoured by acidic, waterlogged soil; lime soil to correct pH.
- Ammonium toxicity "jelly butt" – Poor emergence followed by wilting and death of seedlings; browning of the central root tissue; favoured by excess ammonium from fertiliser or poultry manure in cold wet soil.

Nutrient toxicity

Broadcast nitrogen solution

Broadcast solution nitrogen

Nutrient toxicity


Seed-placed urea stand loss and biuret damage

Granular urea

Nutrient toxicity

Two examples of improper use of non-selective herbicide.

Salt injury on taxus.

Leaf cupping/ curling due to a growth regulator herbicide.

Physiological disorders

- Tipburn (physiological/nutritional) – a result of a calcium transport problem within the plant.
- Blossom end rot (physiological/nutritional) – caused by a deficiency of calcium or insufficient calcium uptake and translocation to growing points.
- Riciness of cauliflower.
- Gomasho (grey speck) of cabbage and Chinese cabbage.
- Measles on smooth skinned melons and cucumbers.

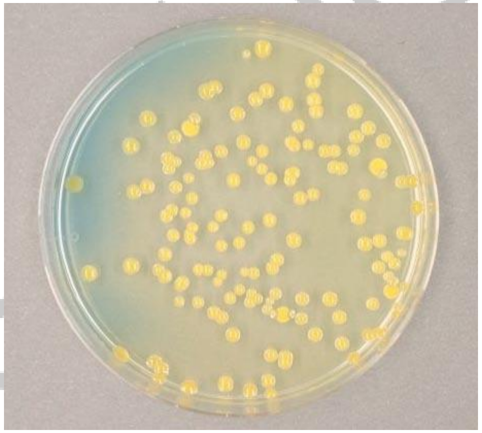
Management of abiotic disorders

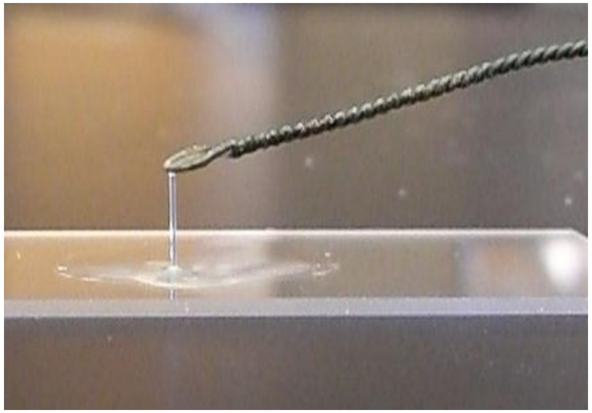
- Investigate weather patterns
- Analyze plant nutrient status
- Look for drainage and compaction
- Check for irrigation problems

- Get a chemical use history
- Plant nutrient deficiencies are best diagnosed using plant tissue analysis.
- As opposed to soil nutrient analysis, plant tissue analysis allows one to determine plant nutrient uptake rather than plant nutrient availability

THANK YOU FOR THE AUDIENCE

DIAGNOSIS OF PLANT DISEASES





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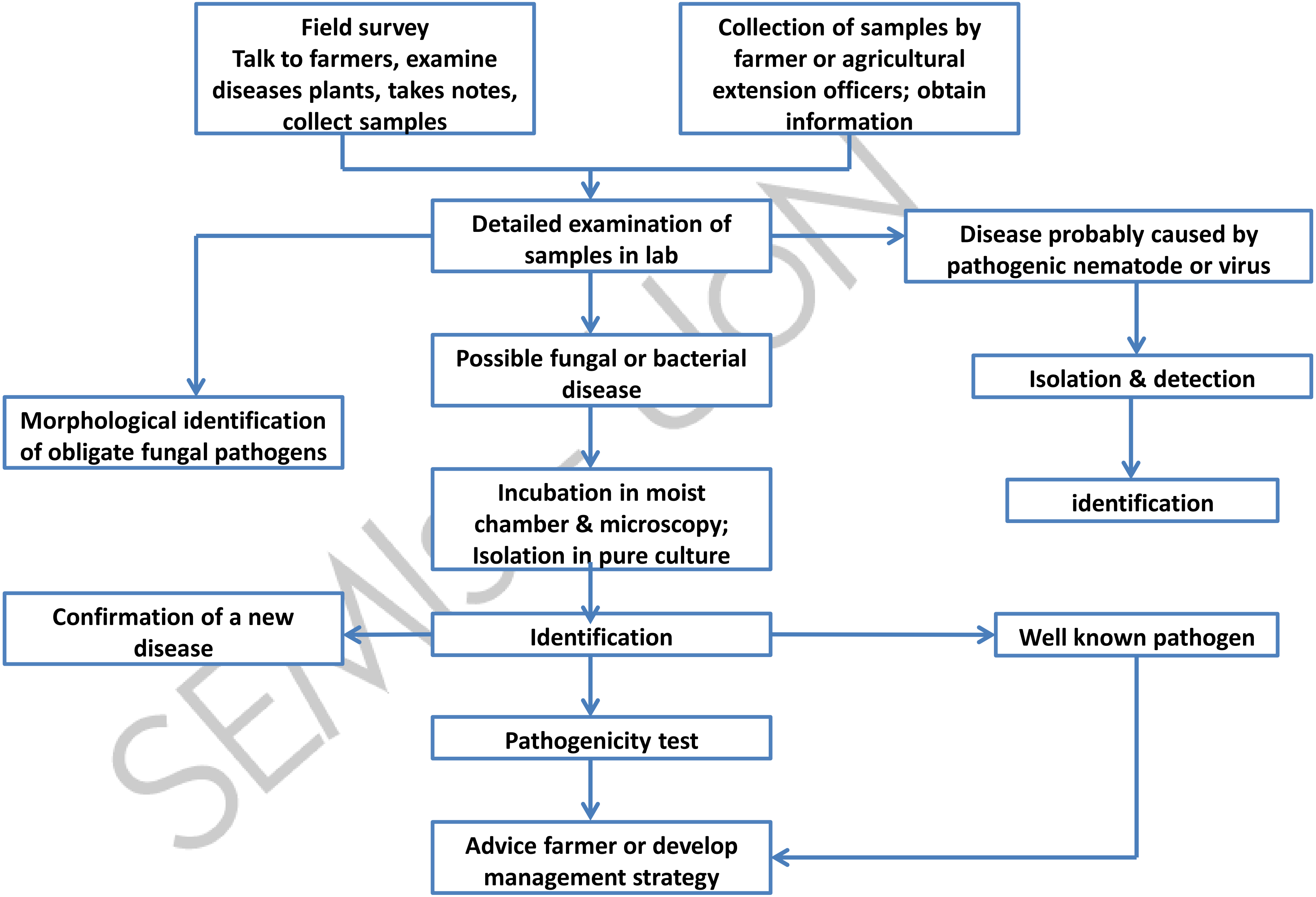
Process in Diagnosis of plant diseases



Diagnosis of diseases of plants

1. Check for symptoms and signs of the disease (Preliminary diagnosis)

signs - physical evidence of the pathogen e.g. fungal fruiting bodies (spores, sclerotia, perithecia, cleistothecia, mycelia); bacterial exudates.. Examples of plant diseases showing signs – leaf rust, stem rust, powdery mildew; bacterial wilt

symptoms - visible effect of disease on the plant e.g. detectable change in color, shape or function of the plant (wilting yellowing, scab, stunting, mosaic, malformations). Examples of plant diseases showing symptoms – damping off, leaf spot, chlorosis

i. **Look for signs of biotic causal agents**

ii. **Identify Plant Part Affected - Are symptoms associated with specific plant parts?**

iii. **Observe Patterns - Check distribution of symptoms; Check for host specificity; Review the cultural practices and growing environment**

2. Laboratory Tests

Sometimes neither symptoms nor signs provide enough specific or characteristic information to decide the cause of an infectious plant disease. In such cases, it may be necessary to bring a sample back to the laboratory for further tests to isolate and identify the causal agent.

i. **Incubation of plant material**

ii. **Isolation and identification of biotic plant disease causal agents – Koch's postulates**

iii. **Diagnostic tests for identification of biotic causal agents – selective media, serological & biochemical tests, PCR**

iv. **Diagnostic tests for identification of abiotic plant disease causal agents – soil & water tests (pH, nutrient composition, salinity, pesticide residues)**

USE OF SERIAL DILUTION IN ISOLATION AND ENUMERATION OF BACTERIA IN SOIL SAMPLES

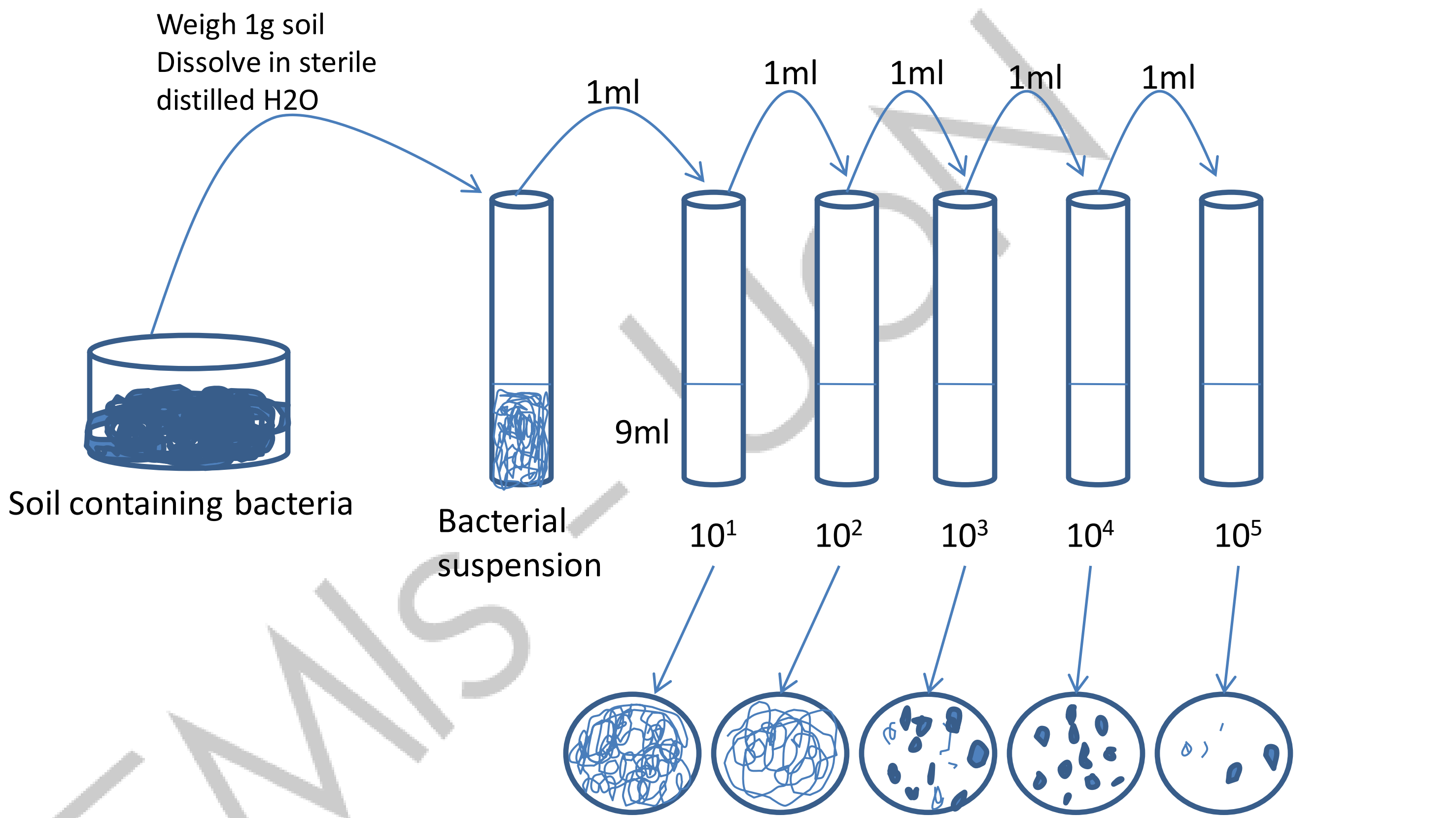
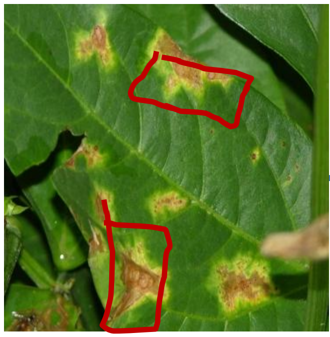


Plate 1ml of each dilution in molten agar medium. Incubate and count the number of colonies for each dilution. Determine bacterial population by multiplying the number of colonies by the dilution factor

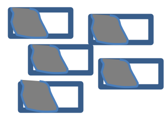
Diagnosis of diseases of plants – look for characteristic symptoms

Diagnosis of diseases of plants – isolation & purification of fungi

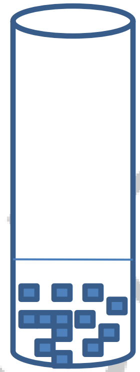
ISOLATION OF PLANT PATHOGENIC FUNGI



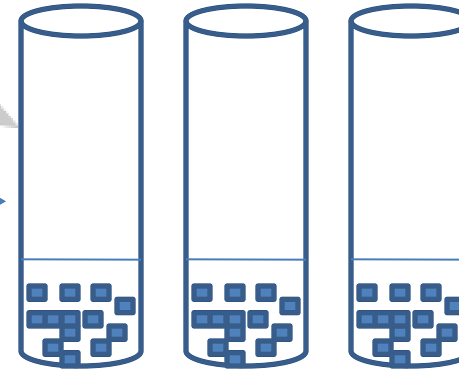
Diseased plant



Cut 5mm^2 tissue pieces at edge of lesion to include diseased and healthy tissues



Surface sterilize in 3% NaoCl for 3min



Rinse in 3 changes of sterile distilled water

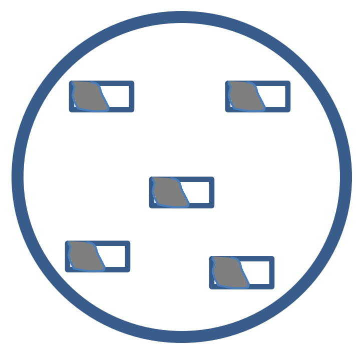
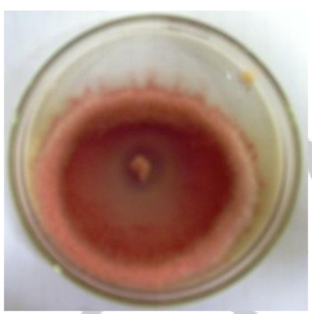


Plate the surface sterilized plant tissues on appropriate agar medium

Incubate for 5 to 14 days. Observe growth of fungal colonies around the plated plant tissues



Subculture by teasing out mycelial fragments from advancing edges of the colonies on fresh agar media to obtain

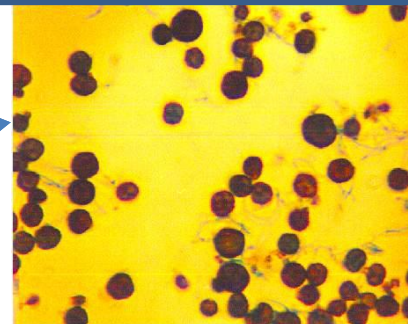
FRUITING STRUCTURES

Induction of perithecia in culture

Perithecia on carnation leaves on agar

Diagnosis of diseases of plants – microscopic examination of fungi

ISOLATION AND MICROSCOPY

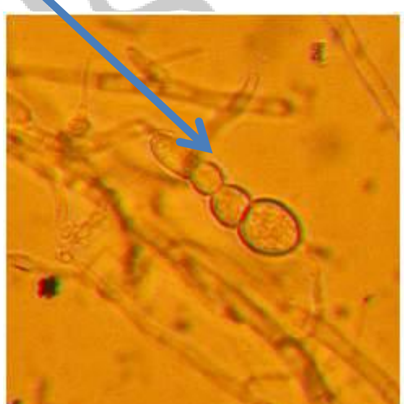


Epicoccum

Penicillium

Fusarium

Spores

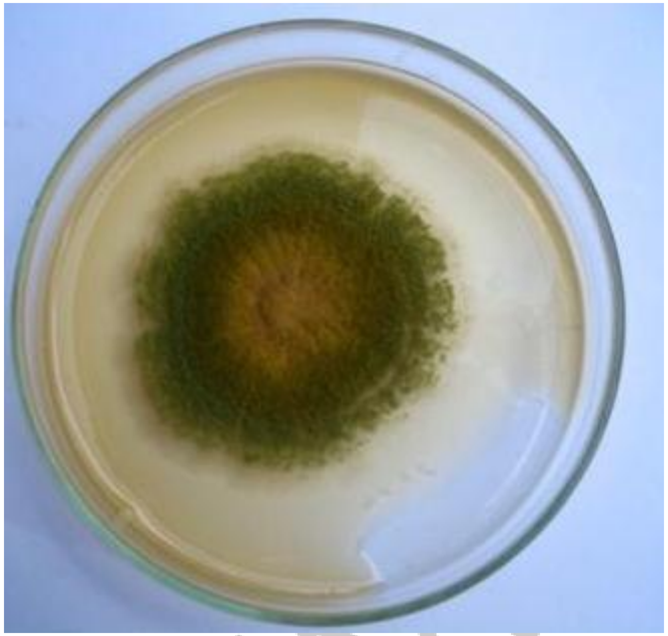


Chlamydospores

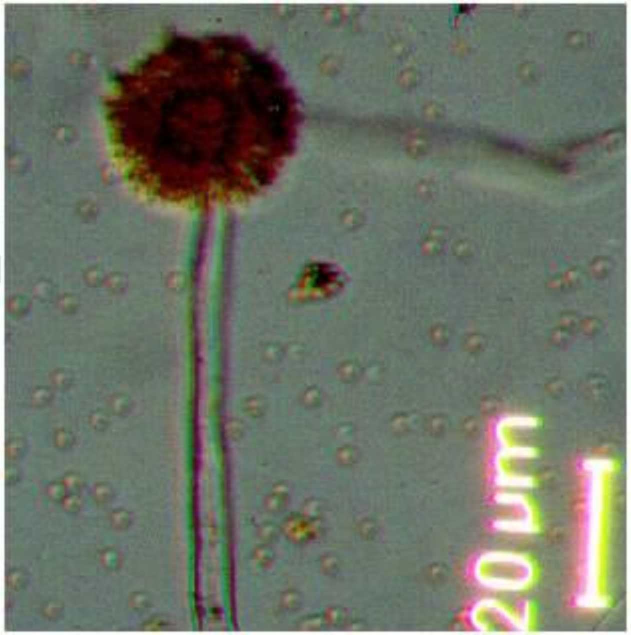
Alternaria

Aspergillus flavus

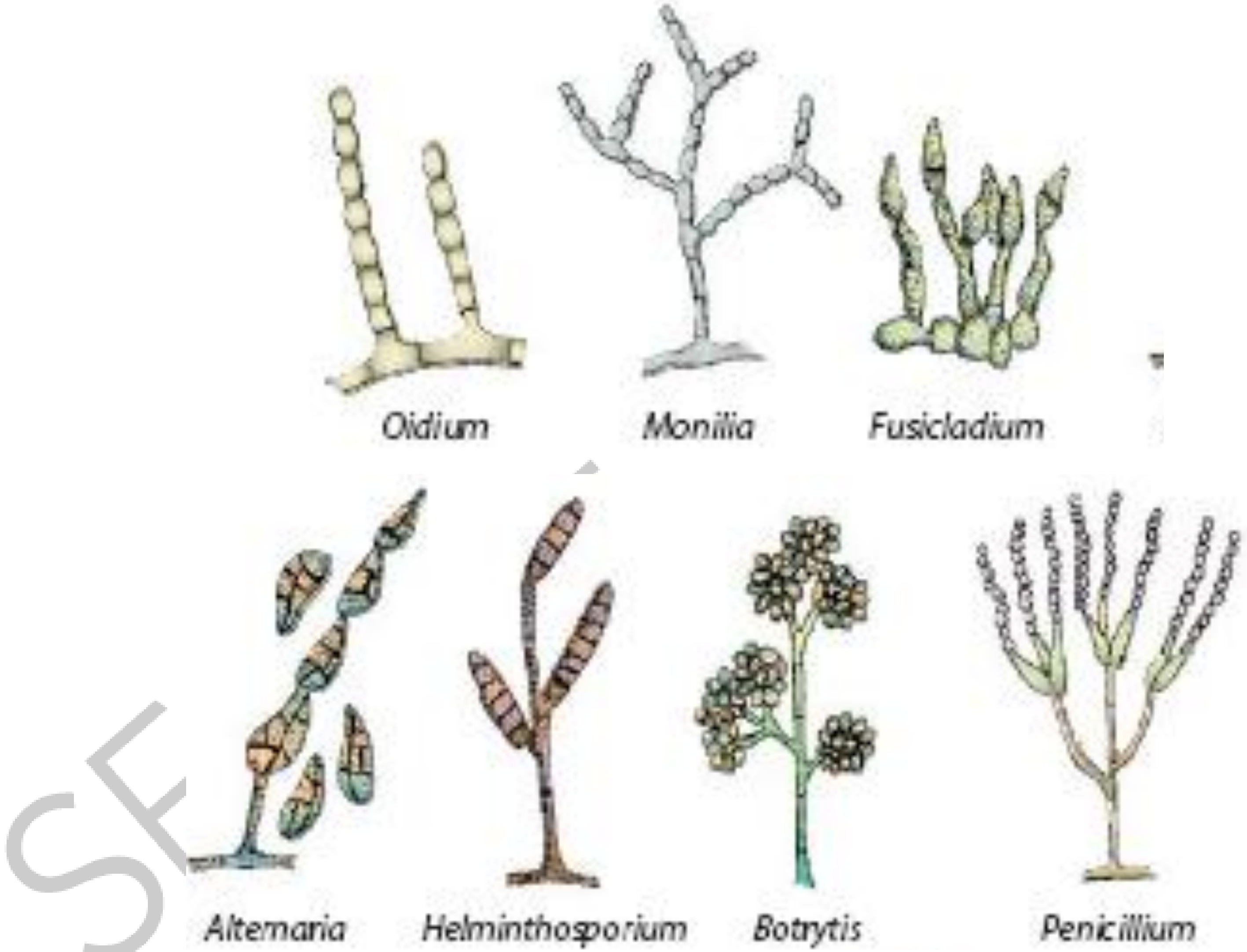
Culture



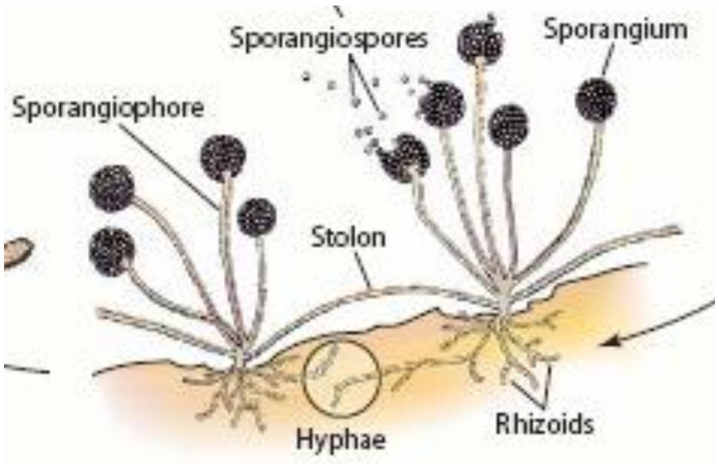
Conidial head



Micro-morphological characteristics of fungi



Micro-morphological characteristics of fungi

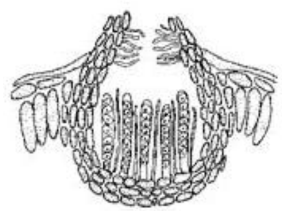


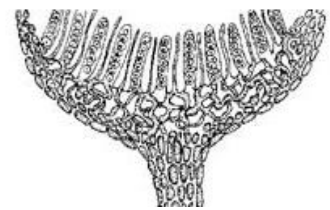
Structure of fungi

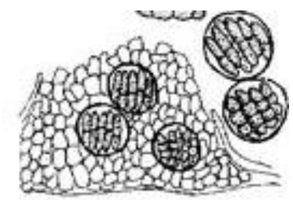

Ascus containing ascospores


Naked asci


Cleistothecium


Perithecium


Apothecium


Ascostroma

Fruiting structures

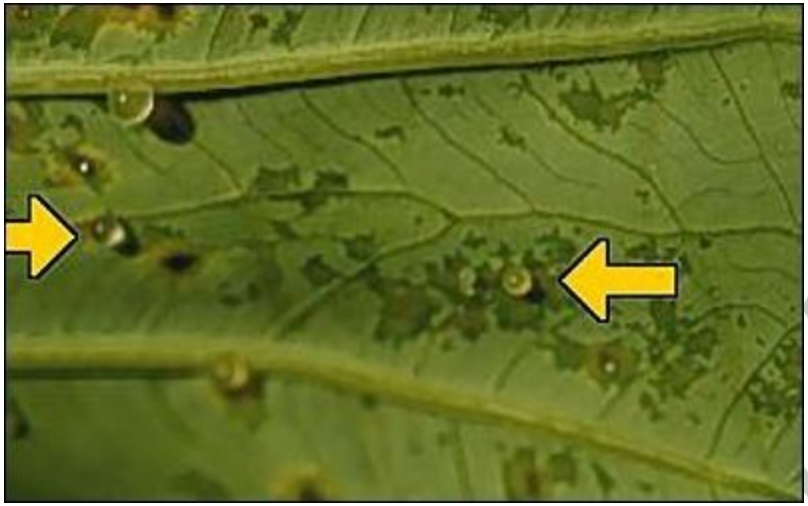
DIAGNOSIS OF BACTERIAL DISEASES

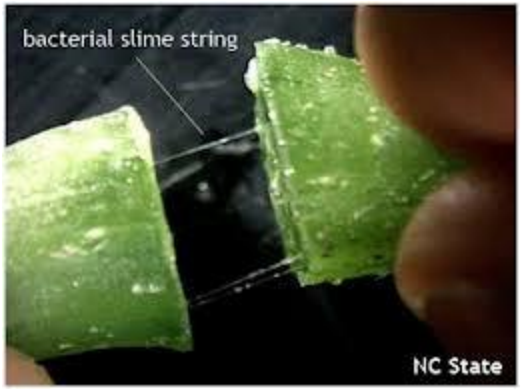
Diagnosis of diseases of plants – characteristic symptoms for bacteria

Water soaking

Diagnosis of diseases of plants – examination of signs (bacterial ooze)

Bacterial ooze



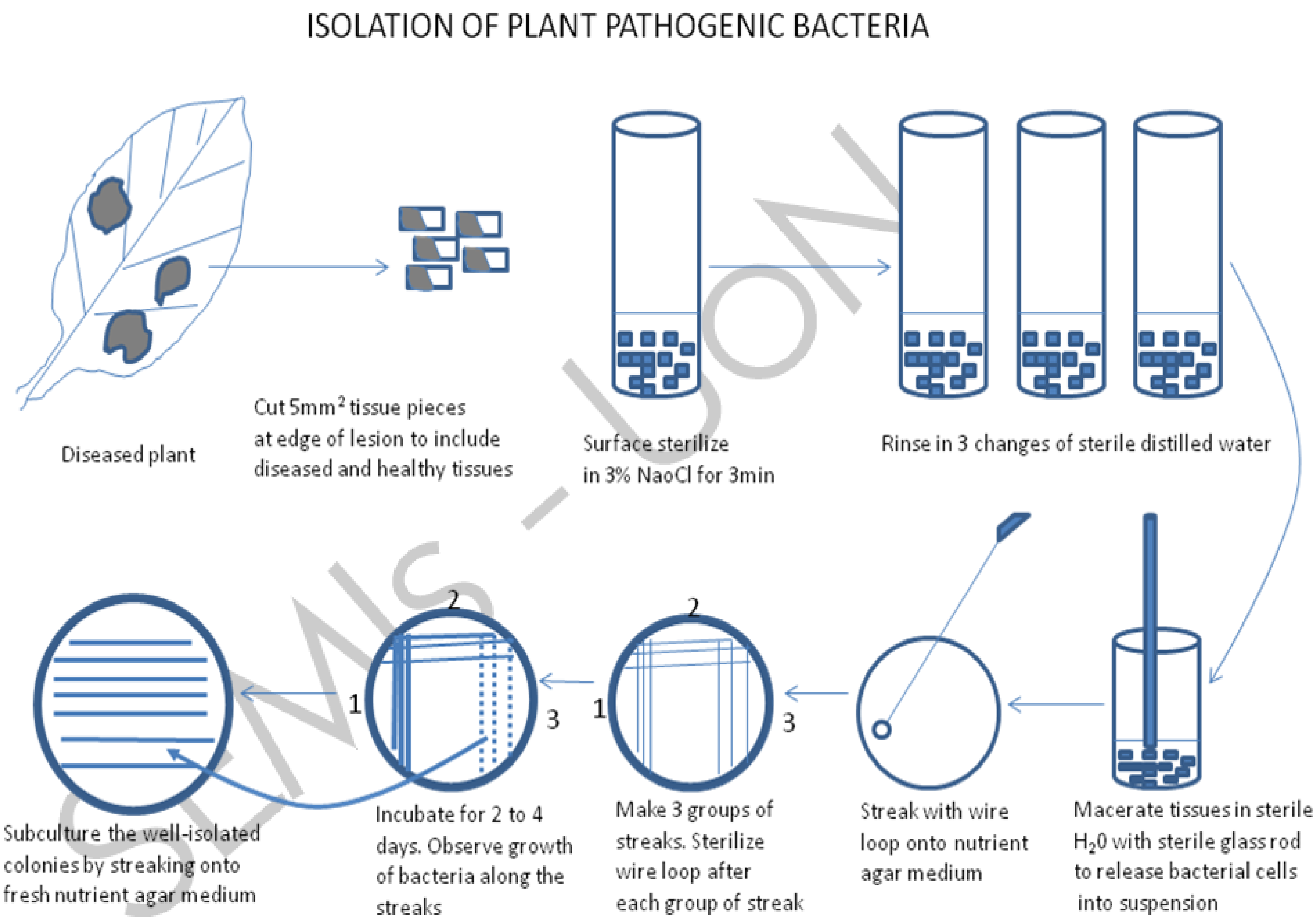


bacterial "ooze" or exudate seen coming out of water soaked lesions (see arrows). The "ooze" forms in the readily seen droplets. These droplets are a sign of the pathogen, being composed mostly of bacterial cells

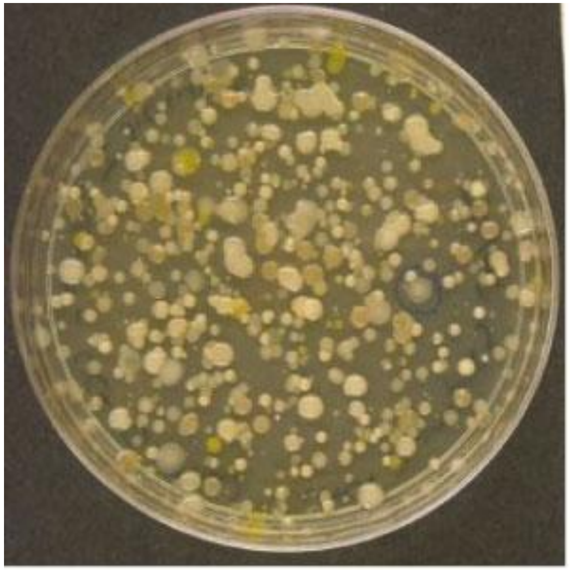
Bacterial streaming test – diagnosis of bacterial wilt

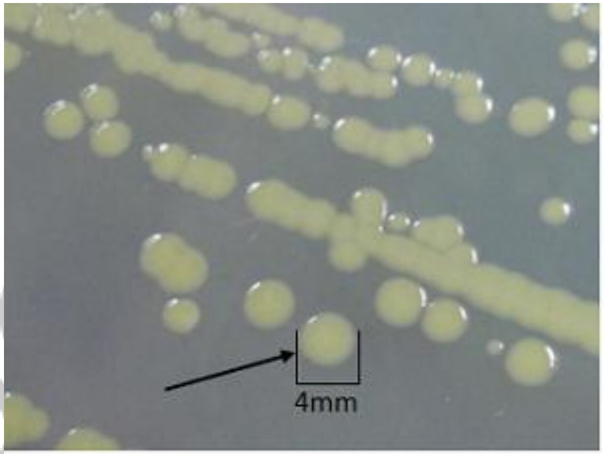
To properly diagnose bacterial wilt, a horizontal cut was made in the lower stem and the cut stem immersed partway in water. Within a few minutes, copious amounts of bacterial exudate emerged from the cut end, forming the white streamers you see in the water. This only occurs with bacterial wilt and not with any other type of pathogen or abiotic cause

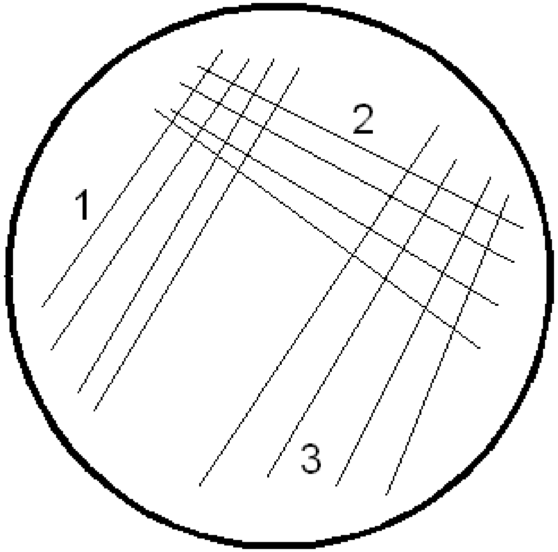
Diagnosis of diseases of plants – isolation of bacteria

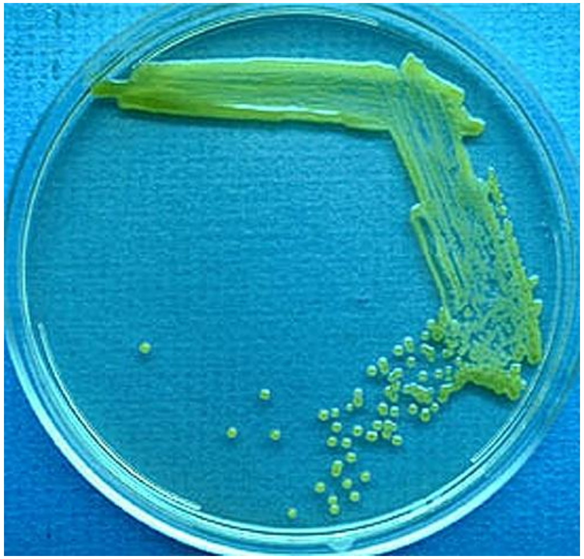


Isolation of bacteria

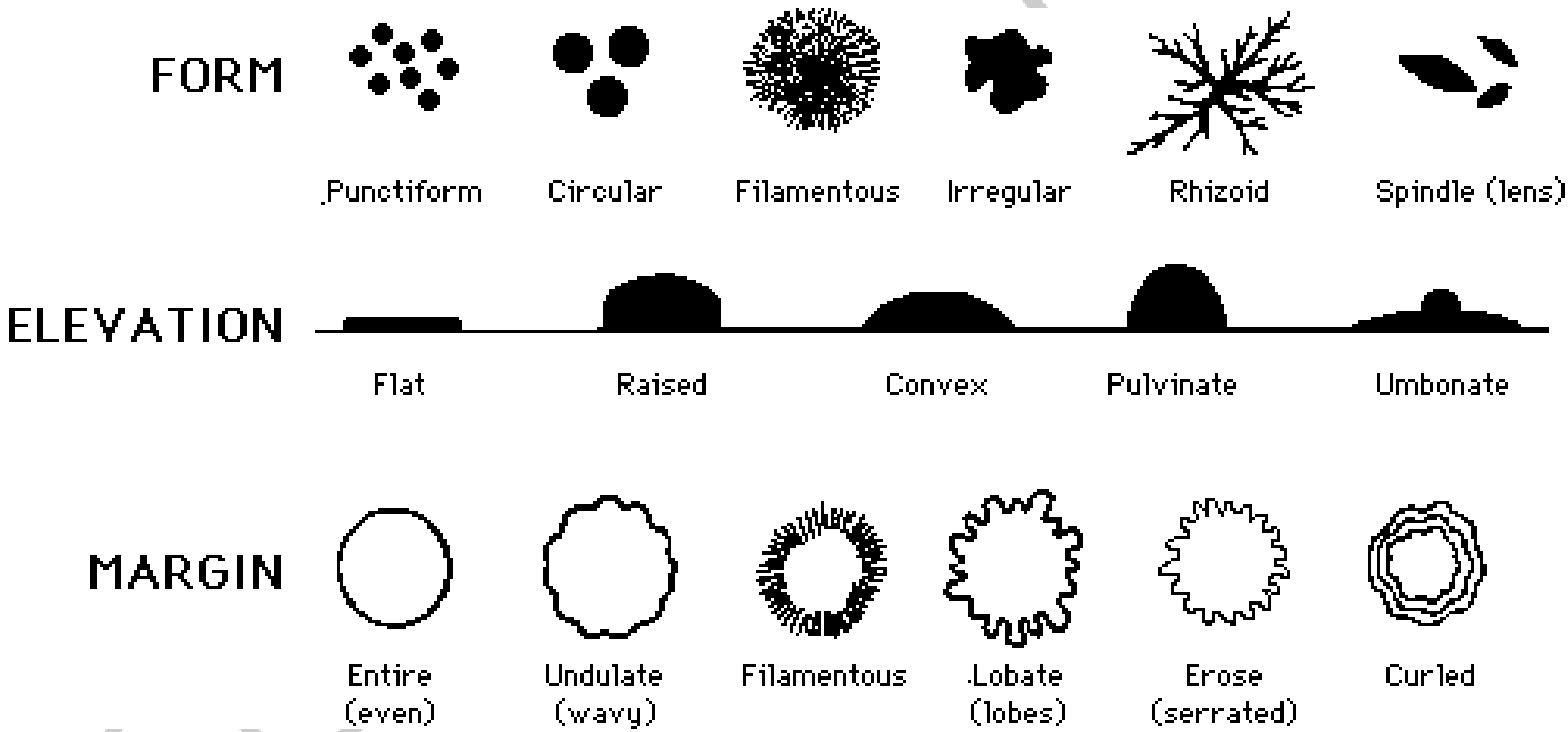




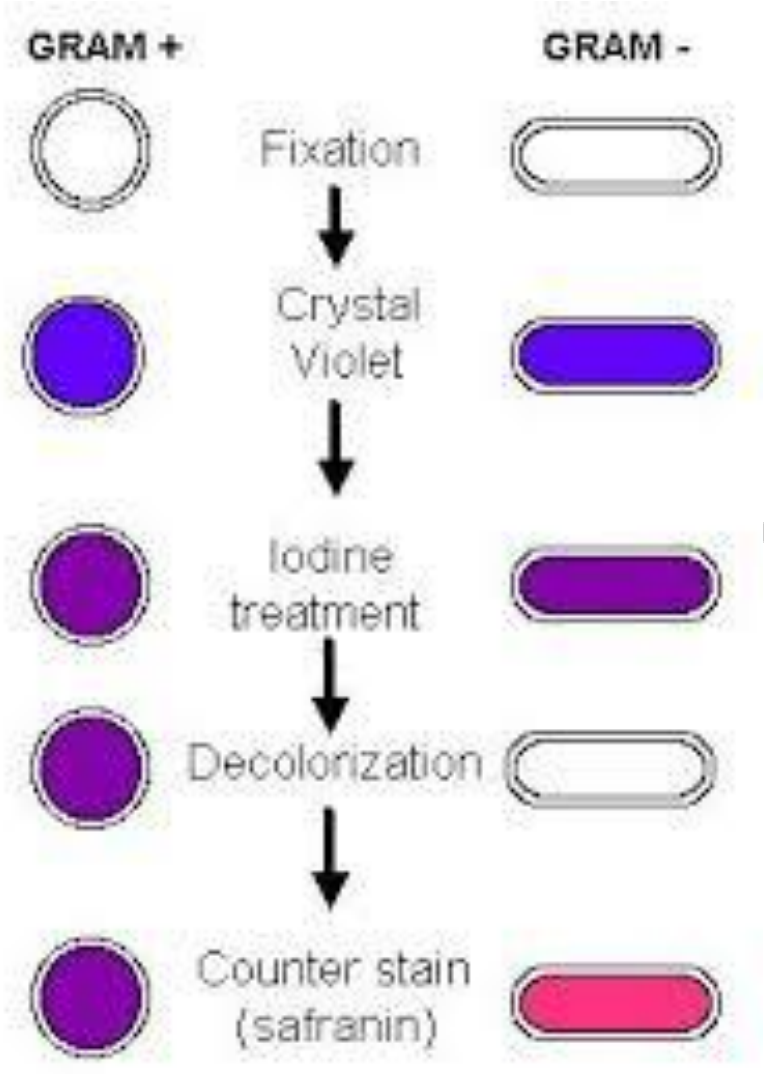


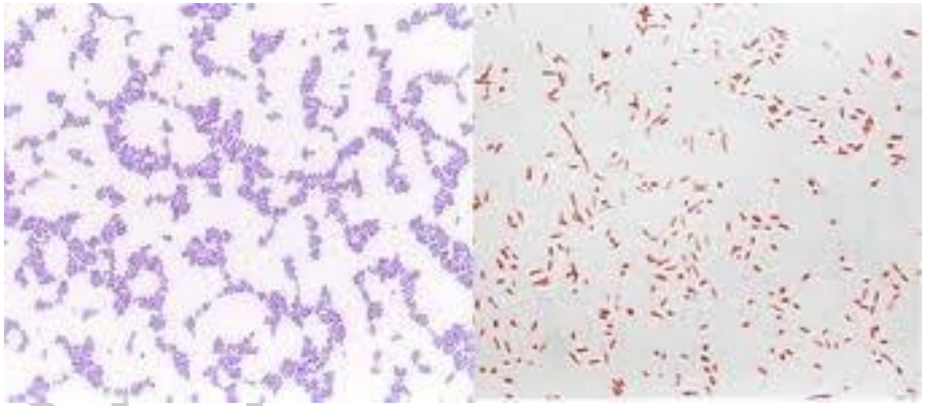


Colony morphology

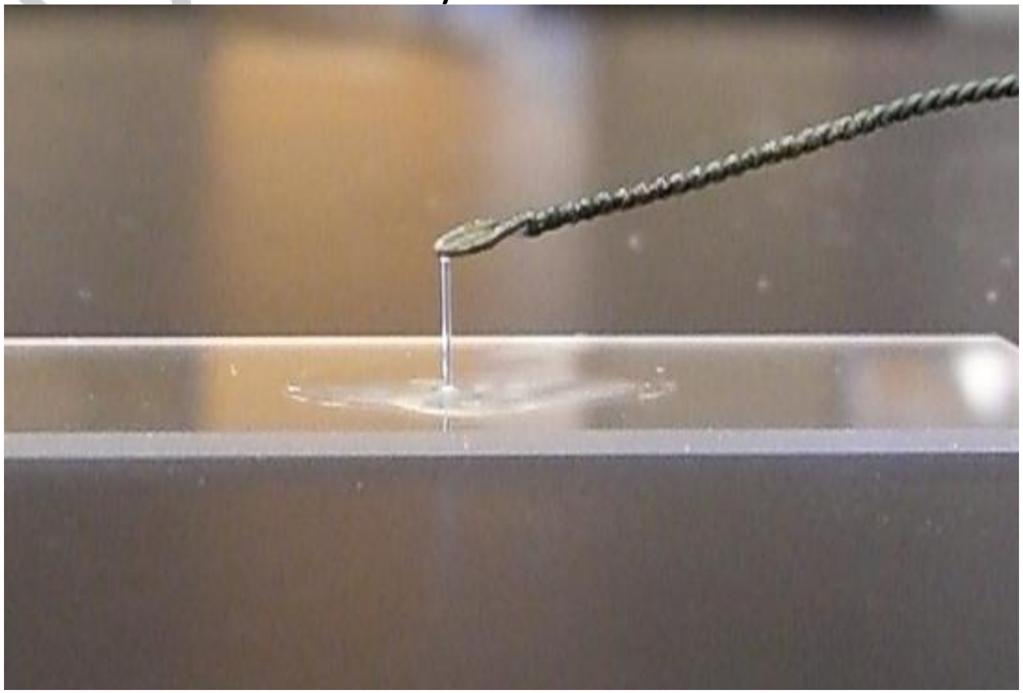


Gram stain test





KOH solubility test for Gram stain



Diagnosis of plant diseases – fatty acid analysis

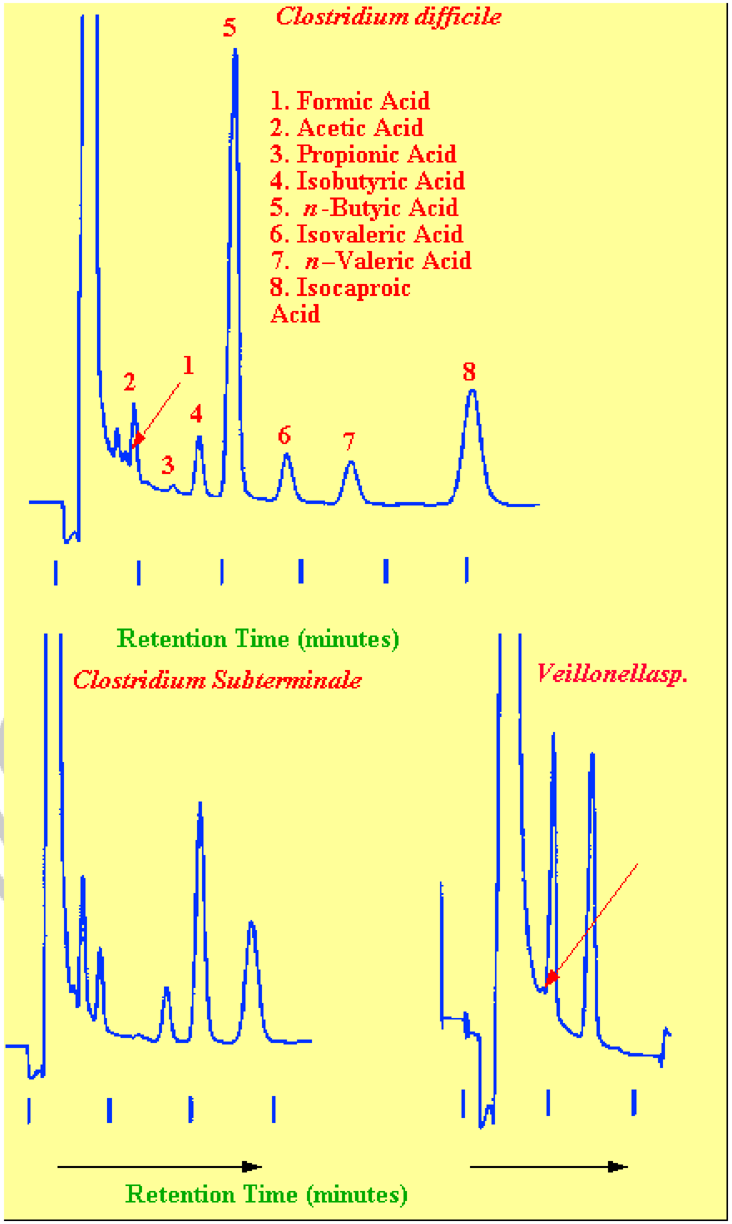
- Serology – ELISA
- Fatty acid analysis
- PCR-based analysis (molecular markers)
- Determination of pathogenicity
    - Inoculation of detached fruits
    - Stem inoculation for canker and gall inducing pathogens
    - Leaf inoculation for leaf spot pathogens
    - Cotyledon inoculation
    - Root inoculation
    - Inoculation of storage organs for soft rot bacteria

Fatty acid analysis

- Bacterial cell membranes contain many different fatty acids
- Types and relative proportions of these are unique to a particular species.
- Fatty acids are extracted & analyzed by gas chromatography and the fatty acid profiles are used to identify the bacteria genus, species, and, in some cases, to strain level

Diagnosis of plant diseases – fatty acid analysis

Gas Chromatogram fatty acid profiles



DNA – based analysis

- Methods are based on gene sequences in the DNA of the bacterial chromosome.
- Gene sequence is unique to a particular species or strain.
- The steps in DNA analysis include:

i. Bacterial DNA is first extracted from the cell

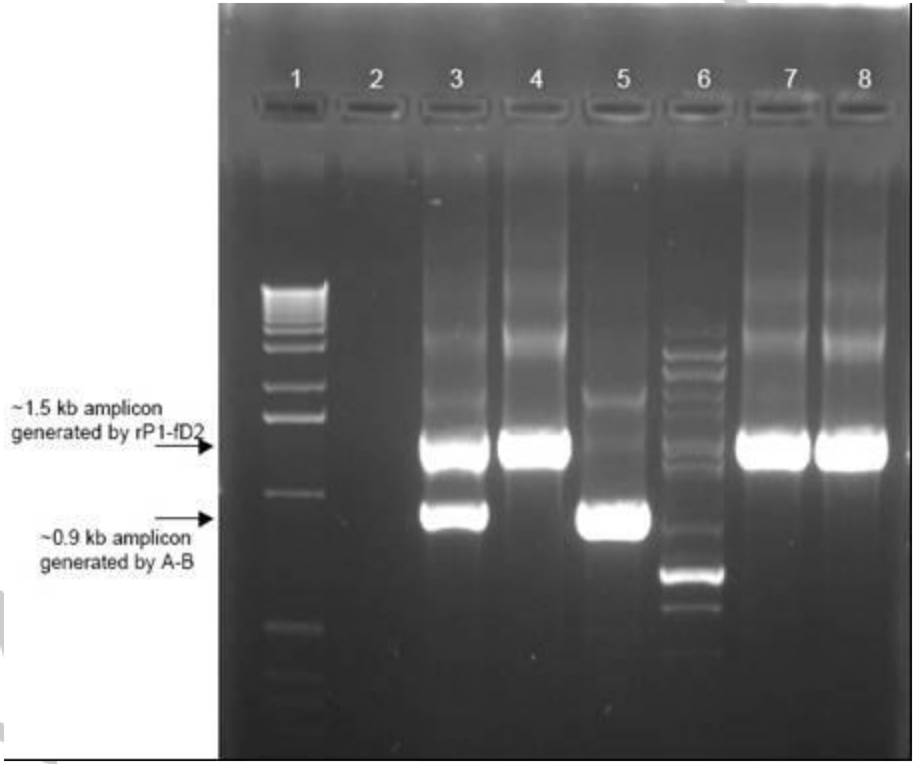
ii. The extracted DNA is amplified by polymerase chain reaction (PCR),

iii. The amplified DNA fragments are separated by electrophoresis on agarose gel to produce finger prints (DNA profiles).

iv. Based on the banding pattern produced on the DNA profiles, the bacteria are identified by comparison to profiles of known DNA

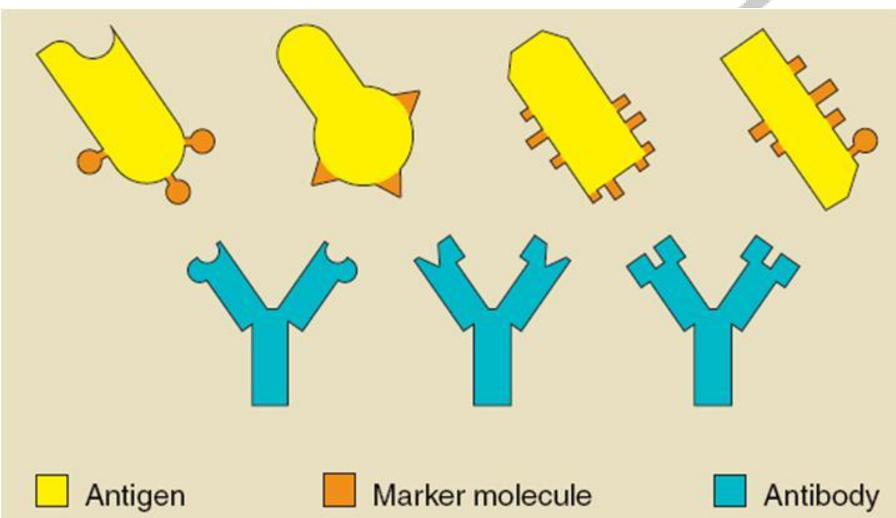
Nucleic acid-based analysis

PCR analysis of bacteria

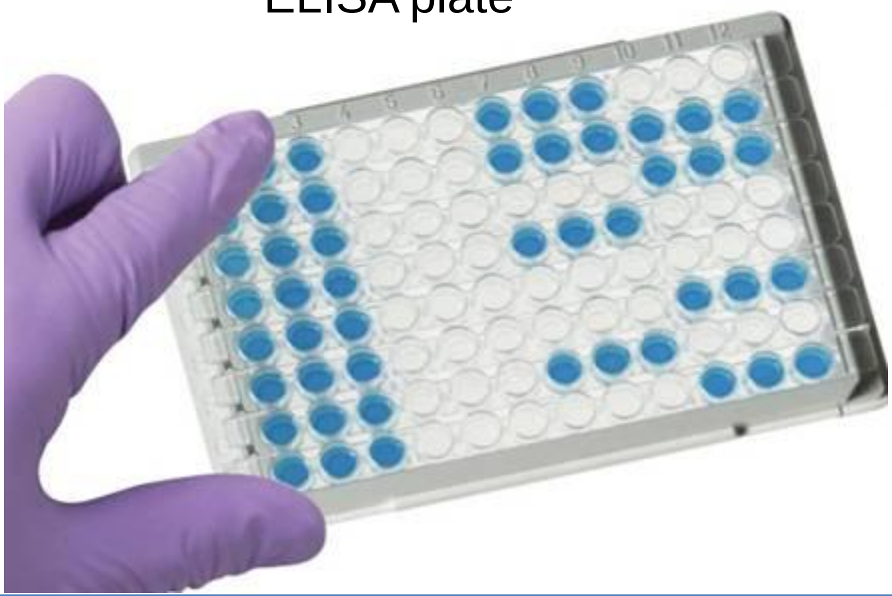


- A specific antibody is conjugated to polystyrene wells and a suspension of the test bacterium is placed in the well and allowed to react with the antibody.
- A positive reaction is indicated by colour change, which can be detected by eye or measured by spectrophotometer (ELISA reader).

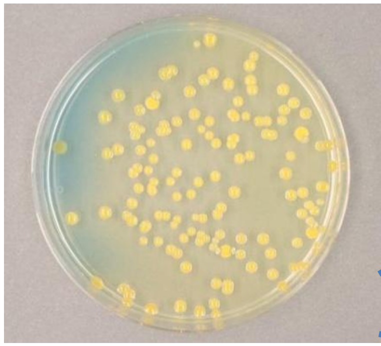
Antigen-antibody reaction



ELISA plate

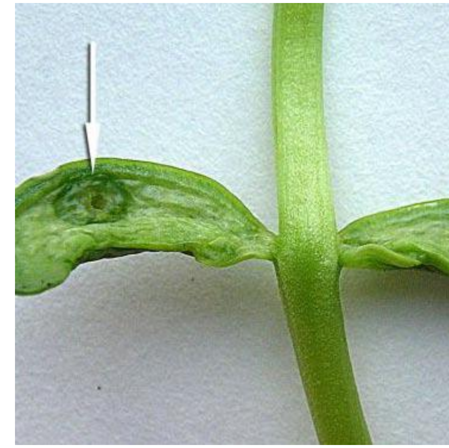


Pathogenicity test

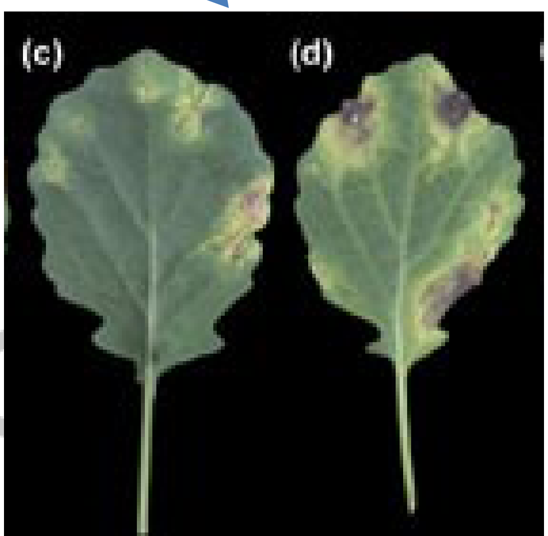


Isolated bacteria

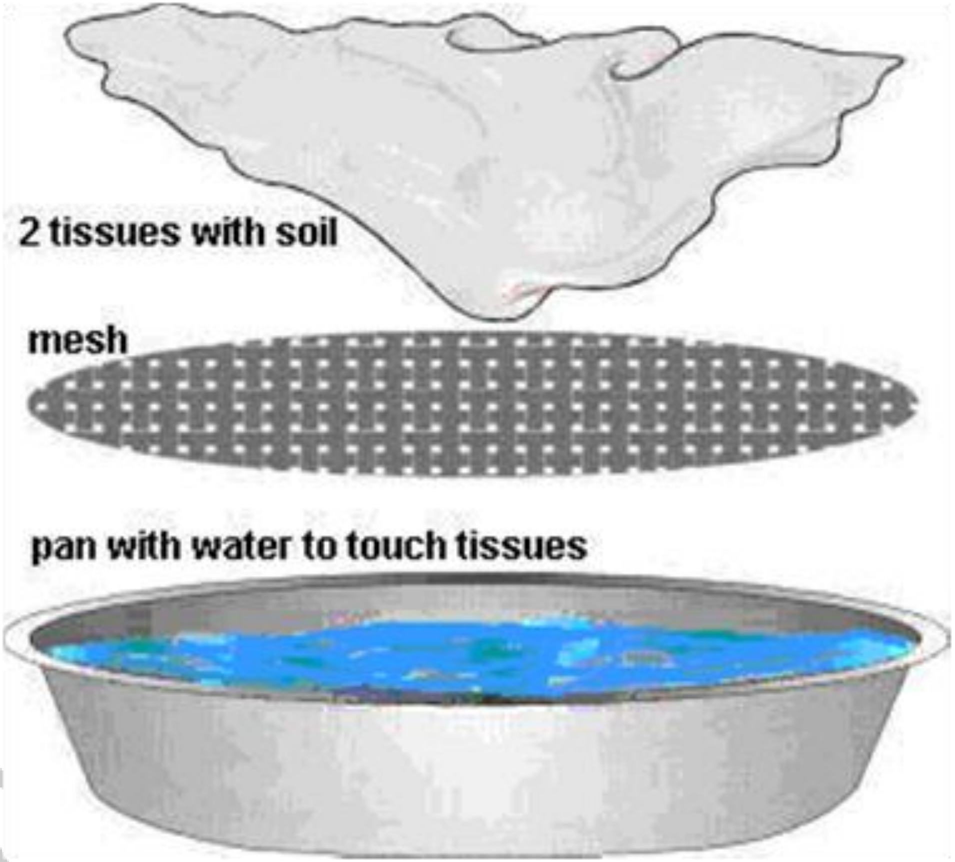
Inoculate on germinated bean cotyledons



Water soaking sympom



Diagnosis of diseases of plants – isolation of nematodes



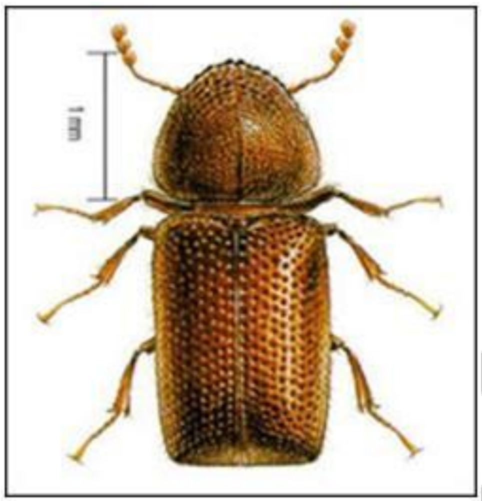
SEED ENTERPRISE MANAGEMENT INSTITUTE (SEMIs)

Seed Production Field Diagnostics

Short Course

22nd – 27th June 2015

Pest Risk Analysis





Prof. James W. Muthomi

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Definition:

Pest Risk Analysis (PRA) is a process of:

- investigation,
- evaluation of information and
- decision making

with respect to a certain pest to avoid or reduce the probability of entrance or establishment of the pest into the country

Why and when is a PRA done?

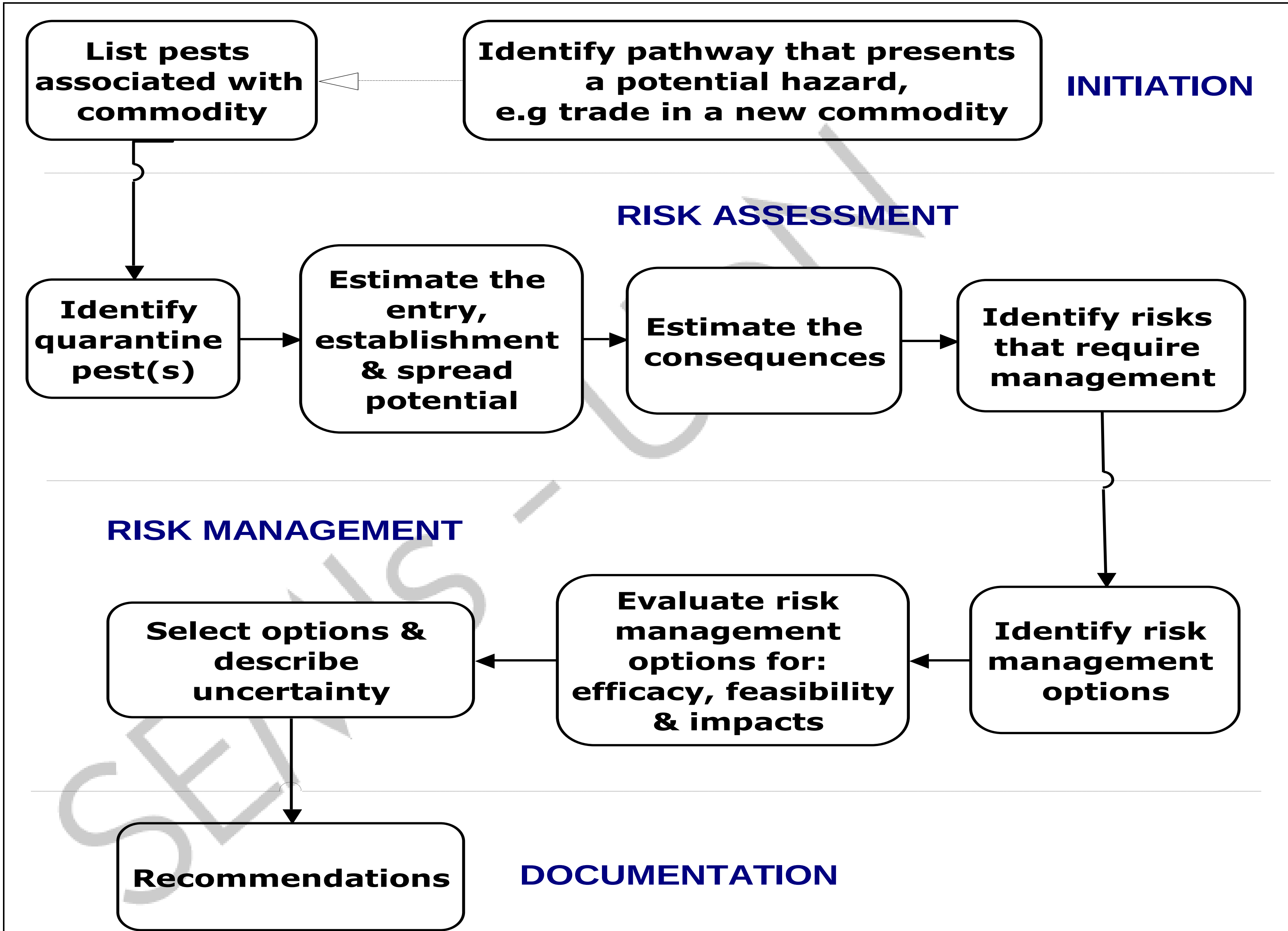
- Pest Risk Analysis (PRA) is done to protect the country's agriculture from damages that can be caused by harmful (quarantine) pests which can be brought in along with imported commodities

- PRA evaluates the likelihood of the entry, establishment, or spread of a pest and the associated potential biological and economic consequences

Stages in Pest Risk Analysis (PRA):

- Stage 1 – PRA initiation => identifying the pest(s) & pathways of quarantine concern.
- Stage 2 - Risk assessment => begins with categorization of individual pests to determine whether the criteria for a quarantine pest are satisfied; followed by evaluation of probability of pest entry, establishment, and spread, and potential economic consequences.
- Stage 3 - Risk management => identifying management options for reducing the risks identified at stage 2. Management options are evaluated for efficacy, feasibility and impact in order to select those that are appropriate.

Pest Risk Analysis



Stage 1: PRA Initiation

Aim of the initiation stage is to identify the pest(s) and pathways which are of quarantine concern

The PRA process may be initiated as a result of:

1. The identification of a pathway that presents a potential pest hazard
2. The identification of a pest that may require phytosanitary measures
3. The review or revision of phytosanitary policies and priorities.

1. PRA initiated by the identification of a pathway

- Trade is initiated in a commodity not previously imported into the country
- New plant species are imported for selection
- A pathway is identified e.g. Natural spread, packing material etc

2. PRA initiated by the identification of a pest

A requirement for a new or revised PRA on a specific pest may arise in the following situations:

- Discovery of an established infestation or outbreak of a new pest
- Interception of a new pest on an imported commodity
- A new pest risk is identified by scientific research
- A pest is introduced into an area

- A pest is reported to be more damaging in an area other than in its area of origin
- A pest is repeatedly intercepted
- A request is made to import an organism
- An organism is identified as a vector for other pests
- An organism is genetically altered in a way which clearly identifies its potential as a plant pest.

3. PRA initiated by the review or revision of a policy

A requirement for a new or revised PRA originating from policy concerns will most frequently arise in the following situations:

- Review phytosanitary regulations, requirements or operations
- A proposal made by another country or by an international organization (RPPO, FAO) is reviewed
- A new treatment or loss of a treatment system, a new process, or new information impacts on an earlier decision
- A dispute arises on phytosanitary measures
- The phytosanitary situation in a country changes, a new country is created, or political boundaries have changed.

Stage 2: Pest Risk Assessment

Pest Risk Analysis

The process for pest risk assessment can be broadly divided into three interrelated steps:

1. Pest categorization
2. Assessment of the probability of introduction and spread
3. Assessment of potential economic consequences (including environmental impacts).

1. Pest Categorization

- Quarantine pest
- Regulated non-quarantine pest

<u>Conclusion of pest categorization</u>

- Pest has the potential to be a quarantine pest, the PRA process should continue.
- Pest does not fulfill all of the criteria for a quarantine pest, the PRA process for that pest may stop.
- Insufficient information, the uncertainties should be identified and the PRA process should continue

2. Assessment of the probability of introduction and spread

This involves assessment of the following:

i. Probability of entry of a pest

ii. Probability of establishment

iii. Probability of spread after establishment

i) Probability of entry of a pest

- Identification of pathways for a PRA initiated by a pest
- Probability of the pest being associated with the pathway at origin
- Probability of survival during transport or storage
- Probability of pest surviving existing pest management procedures
- Probability of transfer to a suitable host

ii) Probability of establishment

- Availability, quantity and distribution of hosts in the PRA area
- Environmental suitability in the PRA area
- Potential for adaptation of the pest
- Reproductive strategy of the pest
- Method of pest survival
- Cultural practices and control measures

iii) Probability of spread after establishment

- Suitability of the natural and/or managed environment for natural spread of the pest
- Presence of natural barriers
- The potential for movement with commodities or conveyances
- Intended use of the commodity
- Potential vectors of the pest in the PRA area
- Potential natural enemies of the pest in the PRA area

3. Assessment of potential economic consequences

Direct pest effects - types, amount & frequency of damage, crop losses (yield and quality), rate of spread, rate of reproduction, control measures (including their efficacy and cost), and effect on existing production practices

Indirect pest effects - effects on domestic and export markets, changes to producer costs or input demands, changes to domestic or foreign consumer demand feasibility and cost of eradication or containment, capacity to act as a vector for other pests, resources needed for additional research and advice, social and other effects.

Conclusions from Pest Risk Assessment

- Used to decide whether risk management is required and the strength of measures to be used.
- Since zero-risk is not a reasonable option, the guiding principle for risk management should be to manage risk to achieve the required degree of safety that can be justified and is feasible within the limits of available options and resources.

Stage 3: Pest Risk Management

- **Pest Risk Management** - process of identifying ways to react to a perceived risk, evaluating the efficacy of these actions, and identifying the most appropriate options.

- Overall risk is determined by the examination of the outputs of the assessments of the probability of introduction and the economic impact.

- If the risk is found to be unacceptable, then the first step in risk management is to identify possible phytosanitary measures that will reduce the risk to, or below an acceptable level.

- Measures are not justified if the risk is already acceptable or must be accepted because it is not manageable (as may be the case with natural spread).

Identification and selection of appropriate risk management options

Appropriate measures should be chosen based on their effectiveness in reducing the probability of introduction of the pest.

The choice should be based on the following considerations:

- Phytosanitary measures shown to be cost-effective and feasible
- Principle of "minimal impact" – not restrict trade
- Reassessment of previous requirements
- Principle of "equivalence" - different phytosanitary measures with the same effect
- Principle of "non-discrimination" - phytosanitary measures should not be more stringent than those applied within the PRA area

Qualitative risk analysis matrix

	Economic/environmental/social consequences				
Likelihood	Negligible	Low	Medium	High	Extreme
Extremely high	H	H	E	E	E
High	M	H	H	E	E
Medium	L	M	H	E	E
Low	L	L	M	H	E
Negligible	L	L	M	H	H

E – Extreme risk; H – High risk; M – Moderate risk; L – Low risk; N – Negligible risk

Pest Risk Analysis

E = Extreme risk - specific action is immediately required to reduce risk

H = High risk - specific action is required, generic risk treatment plans should be adopted as soon as possible in the interim.

M = Moderate risk - adoption of generic risk treatment plans will reduce the risk to suitable levels.

L = Low risk - manage through routine procedures.

N = Negligible risk.

Example:

Estimating the Overall Risk Posed by a Quarantine Pest

Risk Estimation Matrix for Australia

Likelihood of entry, establishment and spread	Negligible	Very low	**Low**	Moderate	High	Extreme
High	Negligible	Very low	Low	Moderate	High	Extreme
Moderate	Negligible	Very low	Low	Moderate	High	Extreme
Low	Negligible	Negligible	Very low	Low	Moderate	High
V. Low	Negligible	Negligible	Negligible	Very low	Low	Moderate
E. Low	Negligible	Negligible	Negligible	Negligible	Very low	Low
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Very low

Consequence of entry, establishment and spread

THANK YOU

- By Prof. R. D. Narla, Dr. D. Kilalo and Prof. F. Olubayo

Contents

- Indentification of insect pests and damage SEMIs Diagnostics course 2014
- Definitions and importance of insect pests
- Plant disease symptoms signs and effects

Identification and recognition of insect pests and their damage

Prof. F. Olubayo and Dr. D. Kilalo
Department of Plant Science and Crop Protection

Outline

- Definitions:
- Why identify or recognize?
- How to identify?
- Illustration of different insects and damages

Introduction

- Identification: ability to give a name to a specimen received /picked using various procedures/protocols. The name given is in line with the **scientific nomenclature**

- Why identify? It is like solving the problem half way through . One has a basis to take specific actions to deal with the problem e. g insect and not fungi OR fungi and not bacteria or nematodes (**management very different**)

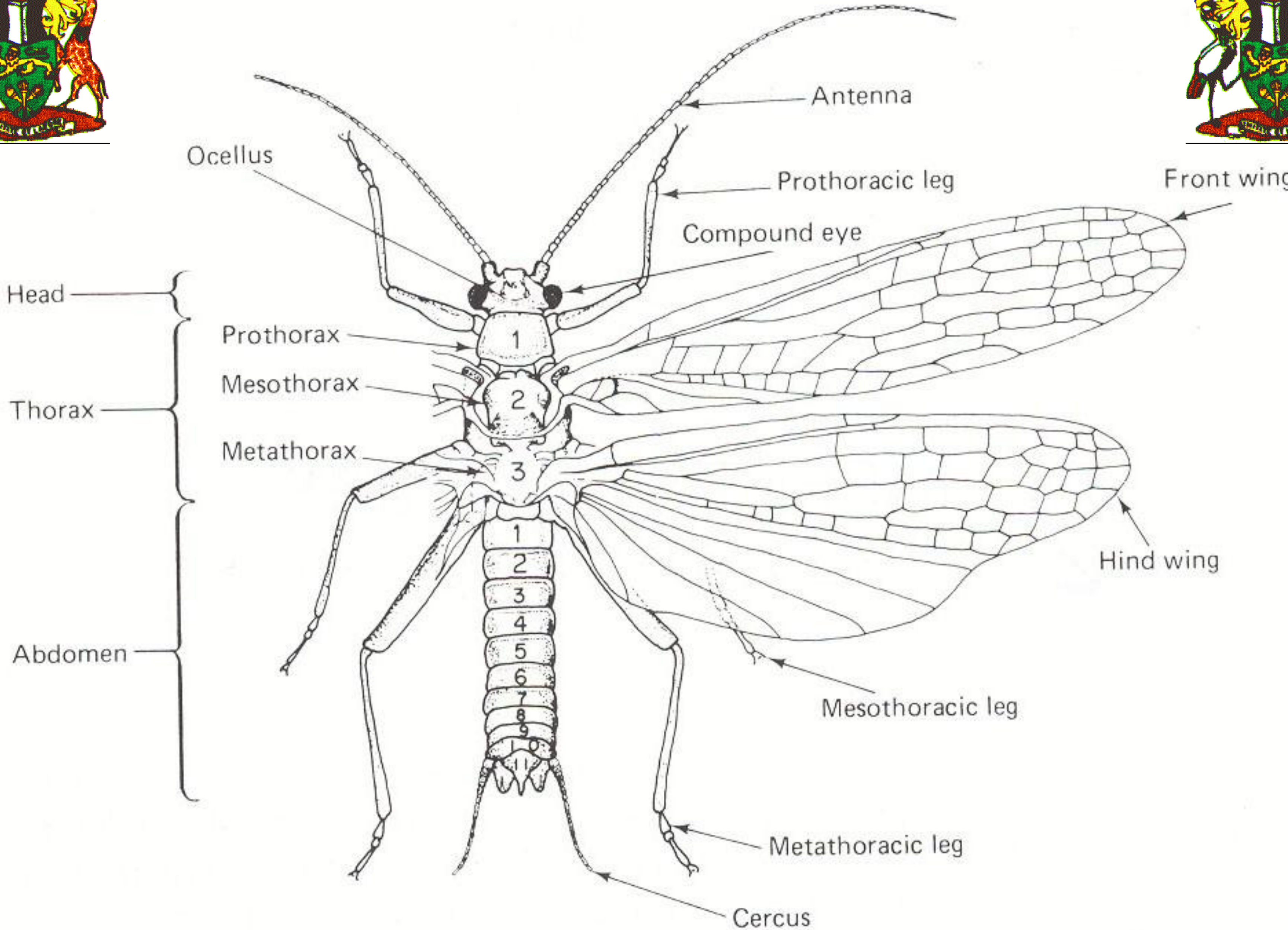
- Recognition: Each pest is associated with **characteristic damage or symptoms** on the plant. Getting to know these makes it easy to deal with certain pest problems in the field. They also help in the process of elimination while getting to know what it is one is dealing with

Recognition

- One has to visually observe various parts of the plant and particularly associated with the pest at certain stages
- Observe whether it is
  – Physical damage: breakage or sunburn or hailstorm
  – Disease symptoms: as caused by various pathogens
  – Arthropod pests : Insects, mites,
  – Molluscs: slugs and snails
  – Vertebrates: Rodents, hare, dik dik, gazelle, elephants

How to identify

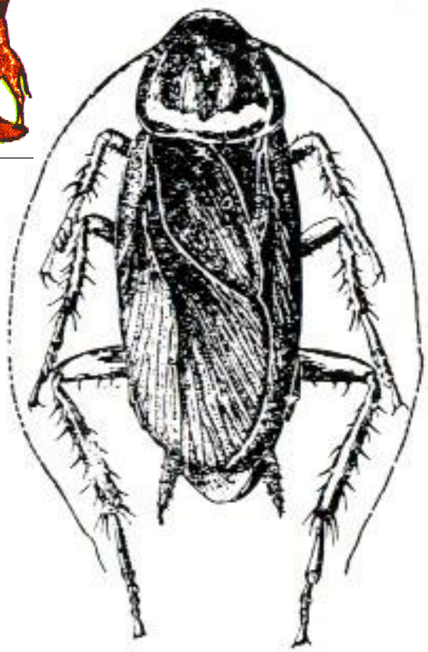
- Use reference materials already collected and identified particularly for insects (insect collection)
- Use experts in the area concerned (individuals and laboratories
- Use morphological descriptions/ characteristics in the form of keys (for insects)
- Use of molecular techniques based on nucleic acid analysis


Antenna
Ocellus
Prothoracic leg
Front wing
Compound eye
Head
Prothorax
Thorax
Mesothorax
Metathorax
Hind wing
Abdomen
Mesothoracic leg
Metathoracic leg
Cercus
1
2
3
1
2
3
4
5
6
7
8
9
10
11

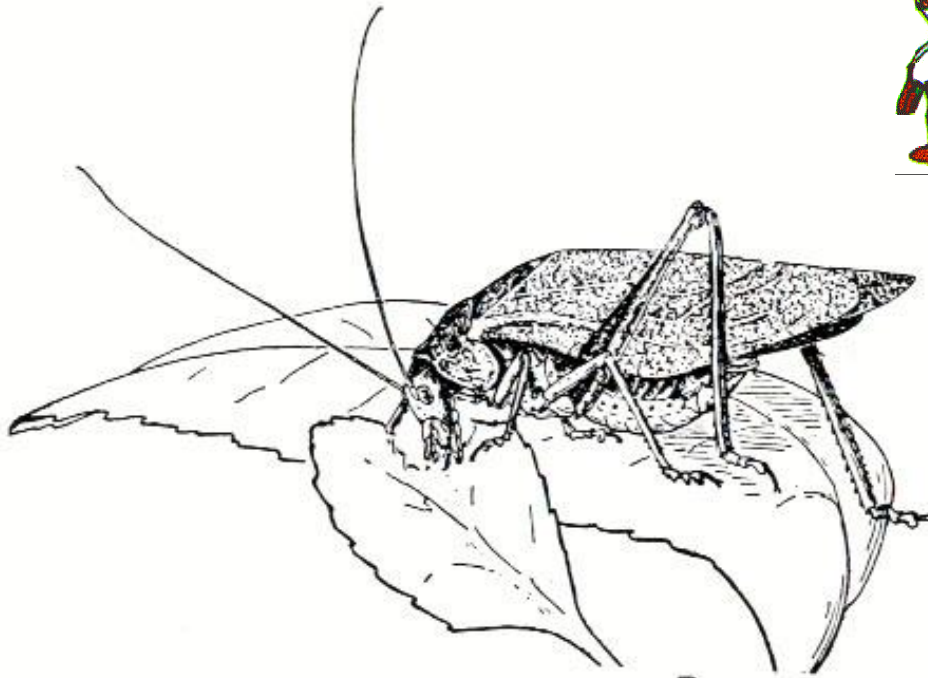
ORDERS OF IMPORTANT AS INSECT PESTS

1. **Orthoptera**

- **Characteristics**
  - Medium to large sized with well developed exoskeleton
  - Two pairs of wings, forewings modified as tegmina and hind wings are membranous
  - Hind legs are usually enlarged for jumping.
  - Mouthparts of generalized biting pattern
  - Females have a well-developed ovipositor
  - Special sound producing and receiving organs often present.
  - Development; Incomplete metamorphosis
  - Antennae long and filamentous (crickets) or short (locusts)
  - Cerci well developed
  - Very destructive to crops



A



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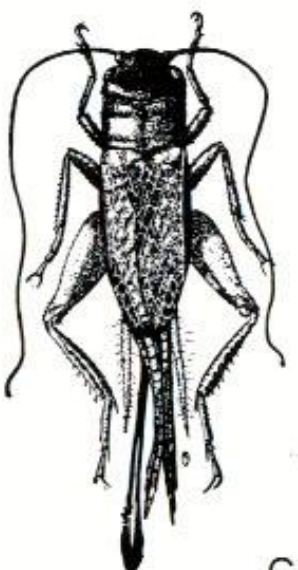

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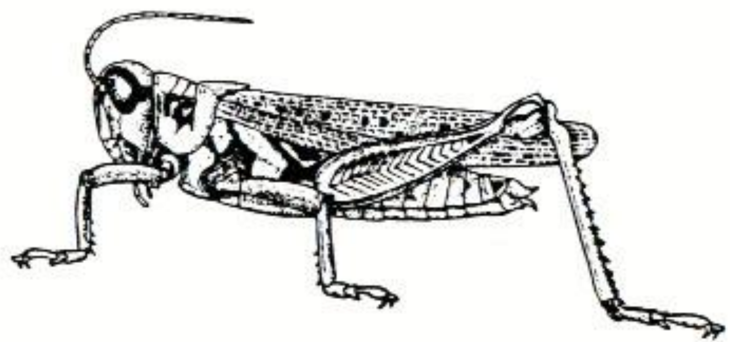
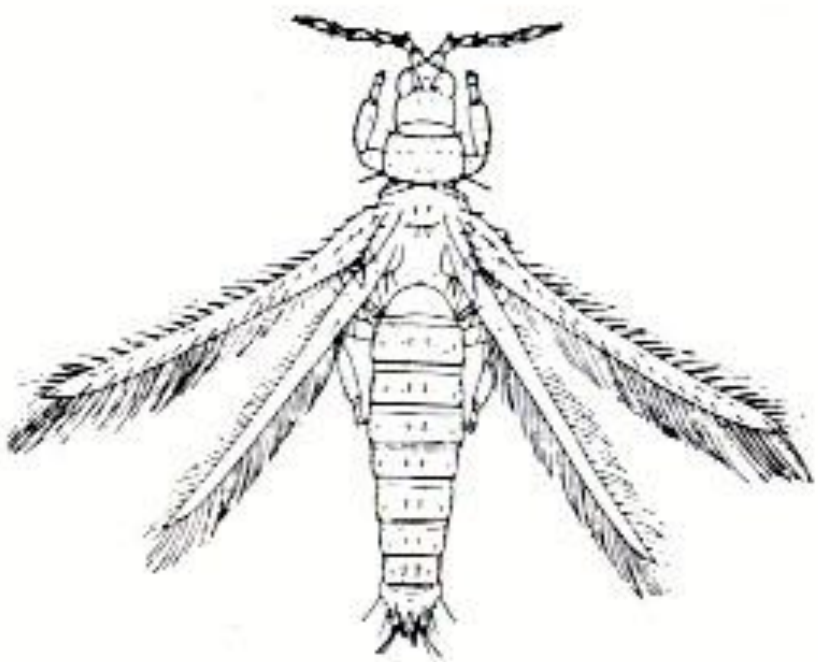


D

Thysanoptera (fringed hairs on the wings)

- **Characteristics**
  - Small, slender bodied, with short 4-9 segmented antennae, and a prominent pro -thorax
  - Asymmetrical mouthparts adapted to rasping and sucking
  - 2 pairs of long narrow wings which have a fringe with long hairs, some spp are wingless
  - Development; Incomplete metamorphosis
  - Mainly feed on leaves and flowers and may spread diseases

Thysanoptera order



D

Hemiptera

Homoptera and Heteroptera

- **Characteristics:**

  - Small to large insects usually with two pairs of wings but apterous (wingless) forms are common

  – Wings when present, have larger forewings and heavier texture than hind wings (uniformity) – (Homoptera) while in sub-order Heteroptera the tip of forewings is more membranous than the base (hemelytra)

  – Piercing – sucking mouthparts (sap feeders)

  – Development; Incomplete metamorphosis .

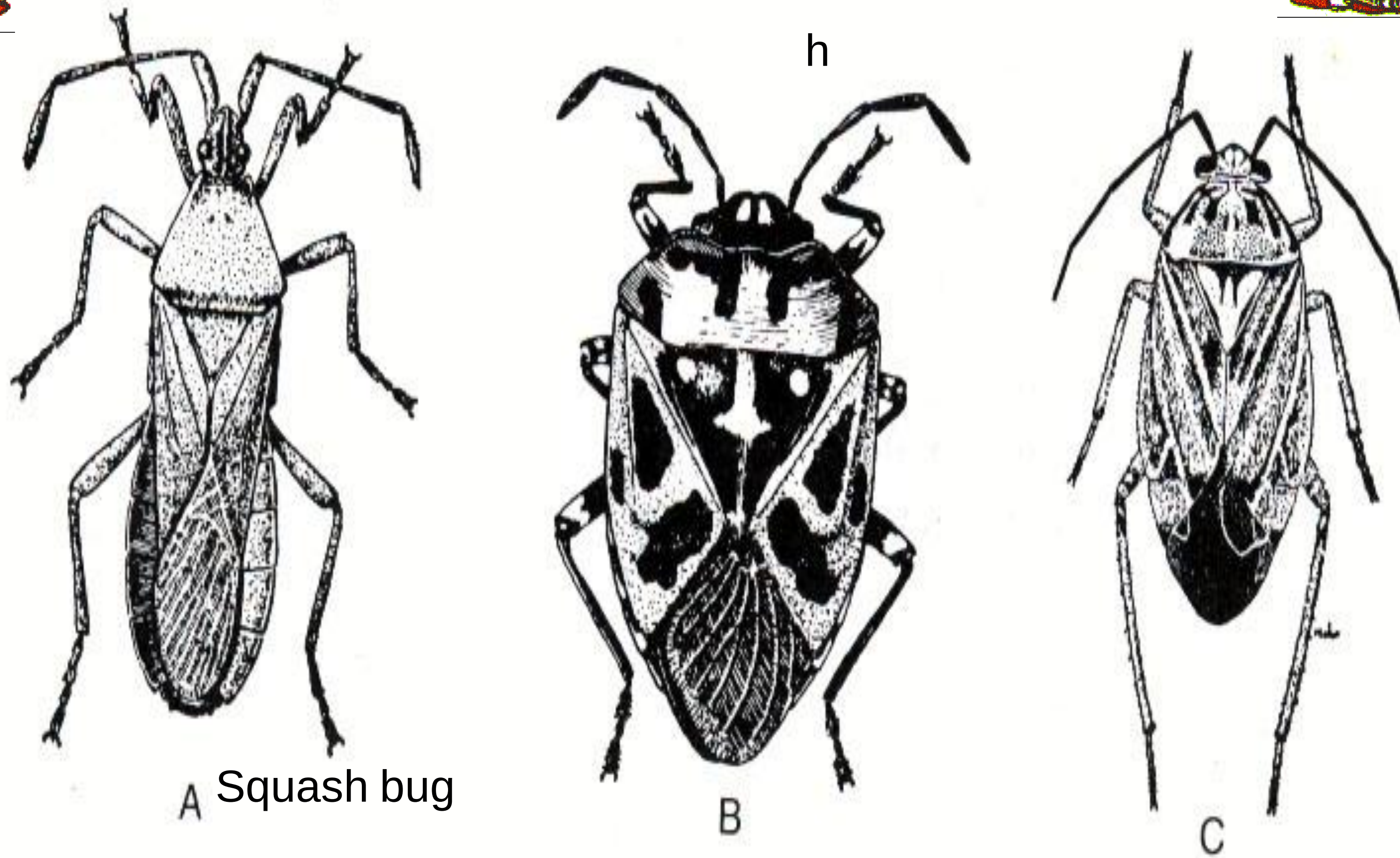
  – Posses toxic saliva

  – Some bugs are aquatic and predaceous, others plant feeders (sap)

  – Are important vectors of diseases particularly viruses

Heteropteran Bugs

h

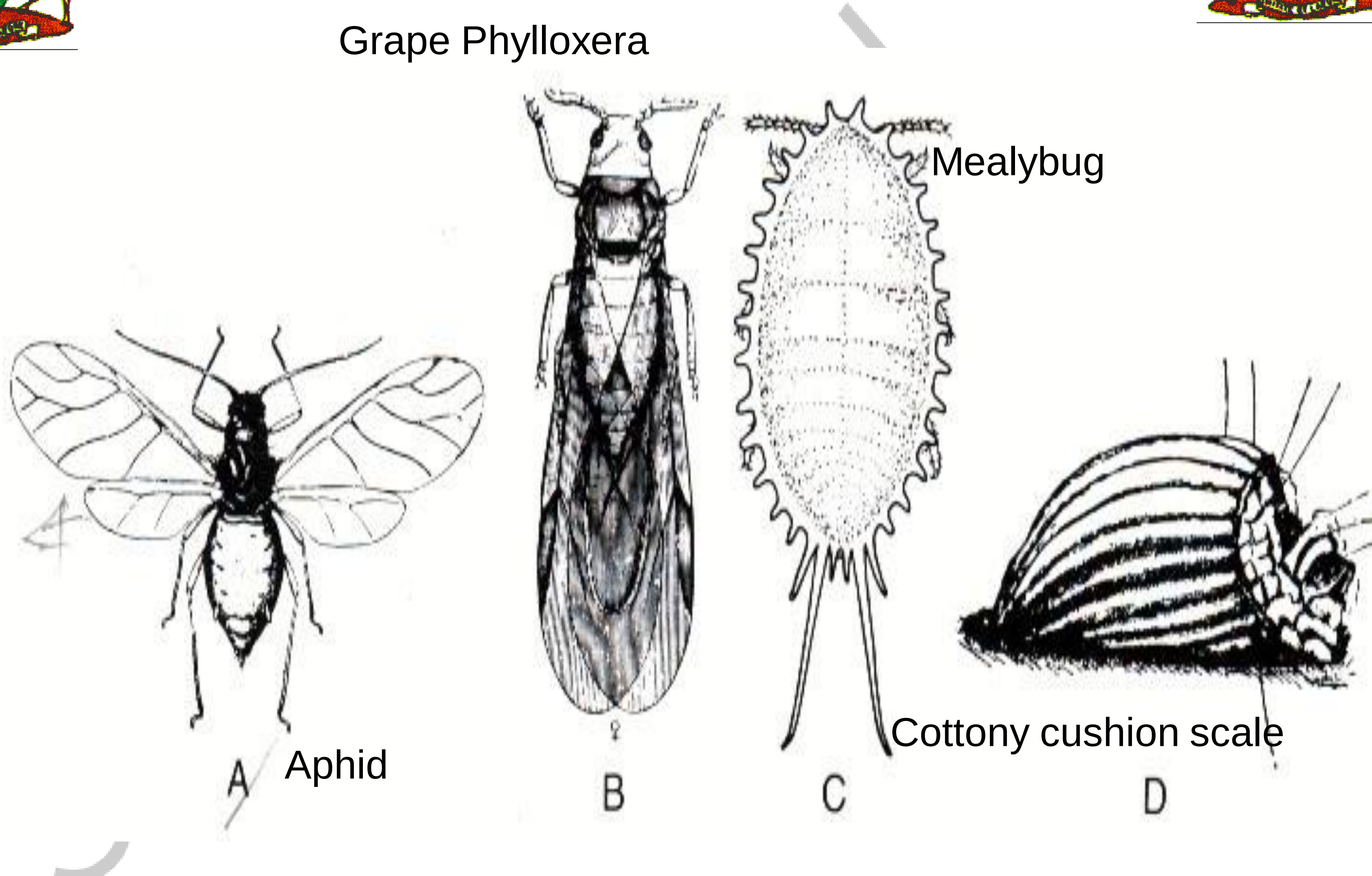


Squash bug

Harlequin bug

Plant bug

Homopterans



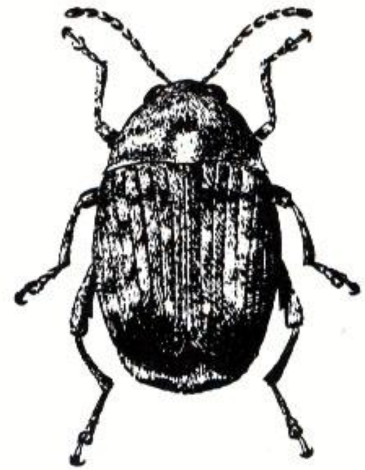
Coleoptera (beetles)

- Largest order of insects
- Characteristics
  - Minute to large insect (gigantic) insects
  - Two pairs of wings, the forewings are not used for flight, but (hardened) modified into hard horny cases (elytra) protecting the membranes hind wings
  - Development; Complete metamorphosis
  - Aquatic and terrestrial in habit
  - Chewing type mouth parts, well developed mandibles
  - Some are destructive (phytophagous) to plants while others are predaceous (beneficial), a few are scavengers, few parasitic and mould and fungal feeders.

Coleopterans

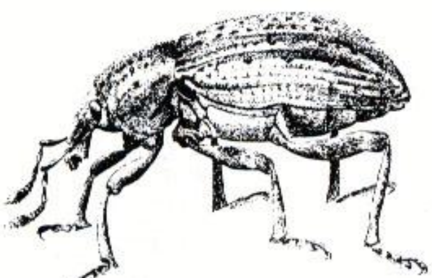
A

Potato beetle

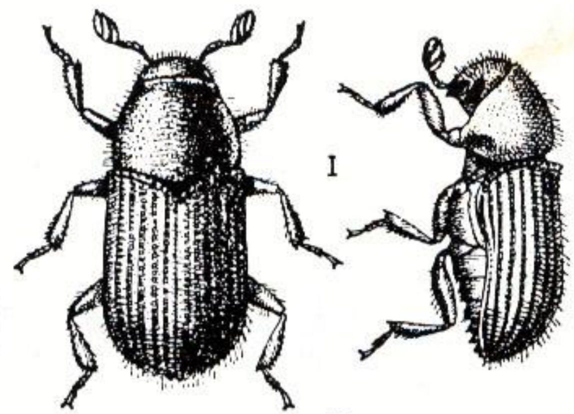


B

Bruchid



Leaf weevil C



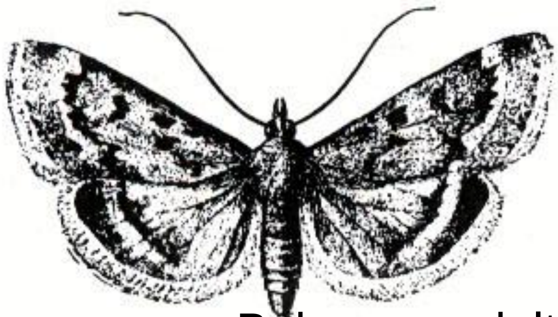
D

Bark beetles

Lepidoptera: (Butterflies and moths)

- (11.000spp)
- **Characteristics**
  - Small to large insects with two pairs of large membranous wings, covered with scales
  - Body and legs are also covered with scales and hairs
  - Adults have siphoning mouthparts while larvae have biting chewing mouthparts
  - Clubbed antenna, tapering or feathery
  - Development; Complete metamorhosis
  - Larvae have abdominal prolegs and are generally called caterpillars
  - Pupae with limbs smoothly enclosed usually in a silken cocoon or earthen cell
  - Terrestrial in habit
  - Larvae are very destructive to plants

Lepidopterans

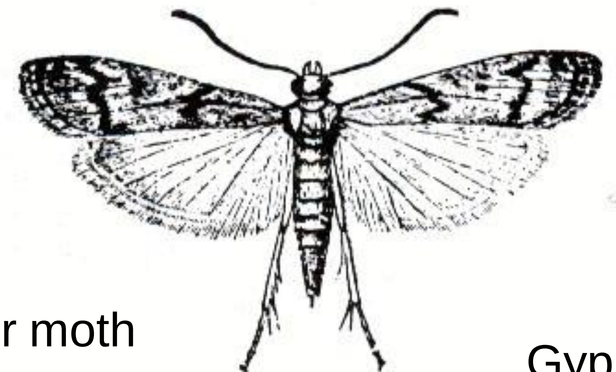


Bebworm adult

A

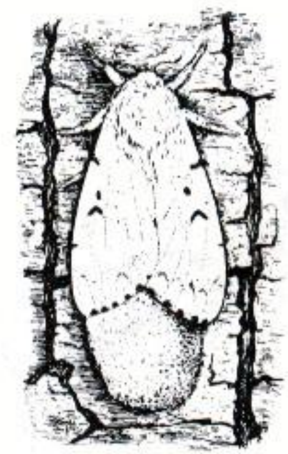
Sugarcane borer

B



Flour moth

C



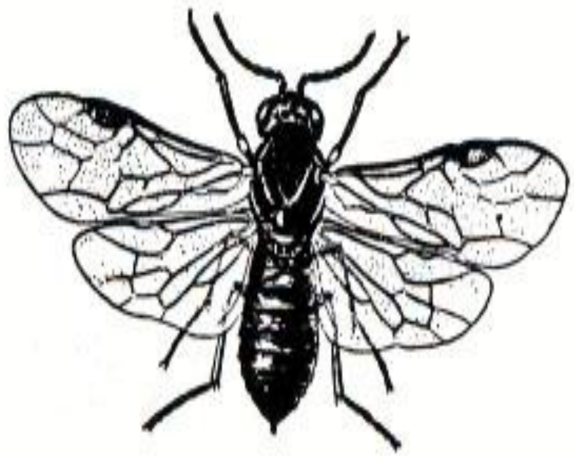
Gypsy moth

D

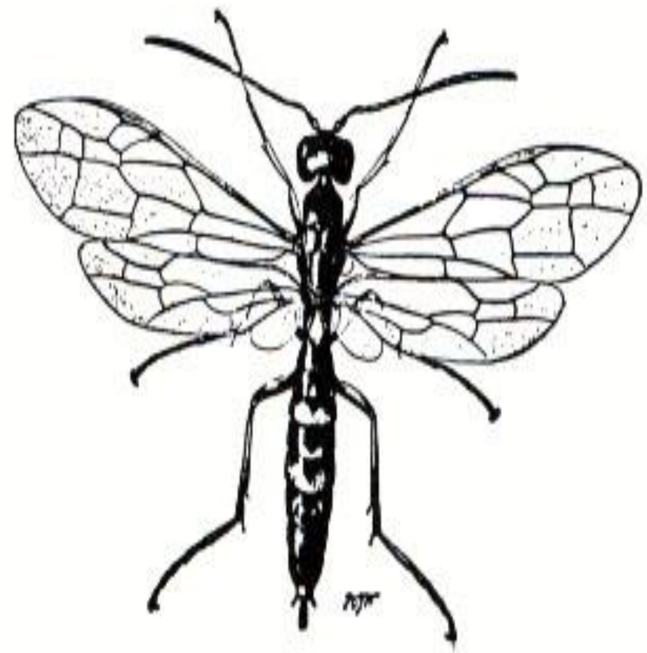
Hymenoptera (sawflies, ants, bees and wasps)

- **Characteristics**
  - Minute to medium – sized with two pairs of membranes wings
  - Biting – chewing mouthparts but may be modified for lapping (chewing-lapping)
  - Development' Complete metamorphosis.
  - Long antennae- contain 10 or more segments
  - Tarsi are usually five-segmented
  - Ovipositor always present and modified for piercing or stinging
  - Larvae bodied and legless, except the sawflies
  - Some spp are social insects (ants and bees)
  - Terrestrial in habit
  - Some are beneficial pollinators, (bees), some are very important biological control agents (wasps) while others are very destructive pests (sawflies)

Hymenopterans



Cherry fruit sawfly



Wheat stem sawfly

Diptera (true flies)

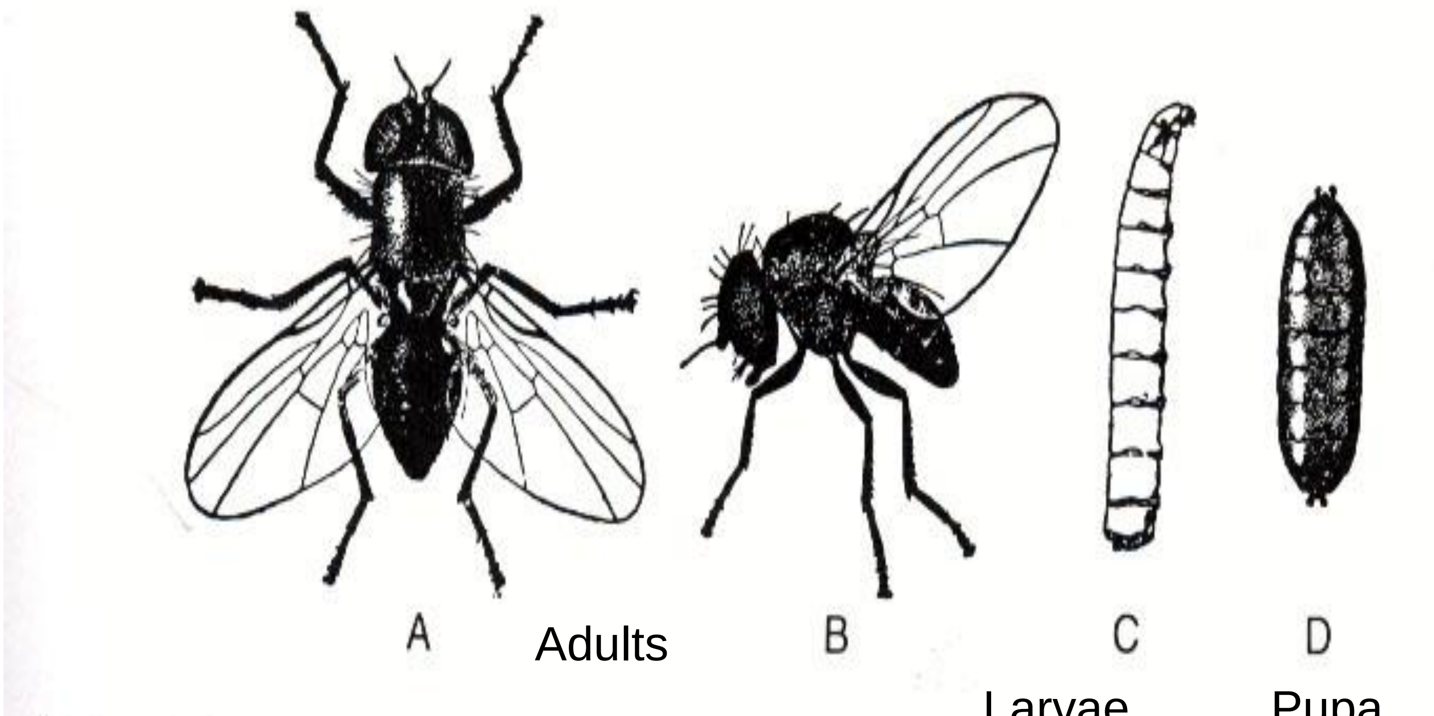
- One of the largest orders
- **Characteristics**

  \- Small to medium-sized, soft-bodied, with a single pair of membranous wings (forewings) the hind wings being modified into specialized balancing organs (halteres)

  – Development; Complete metamorphosis
  – Sponging or piercing- sucking mouthparts
  – Larvae are legless, usually with reduced or retracted head.
  – Many are crop pests but most are pests of medical and veterinary importance
  – Dipterous larvae occur in many kinds of habitats – aquatic, within plant tissues, in water, in soil, under barks or stones

Dipterans

Bean fly



Adults

Larvae

Pupa

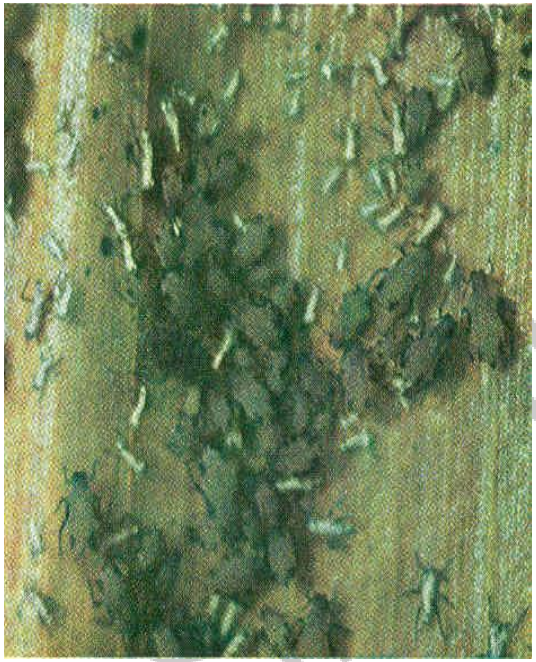
Illustrations of some pests and their damages

Cereal crops

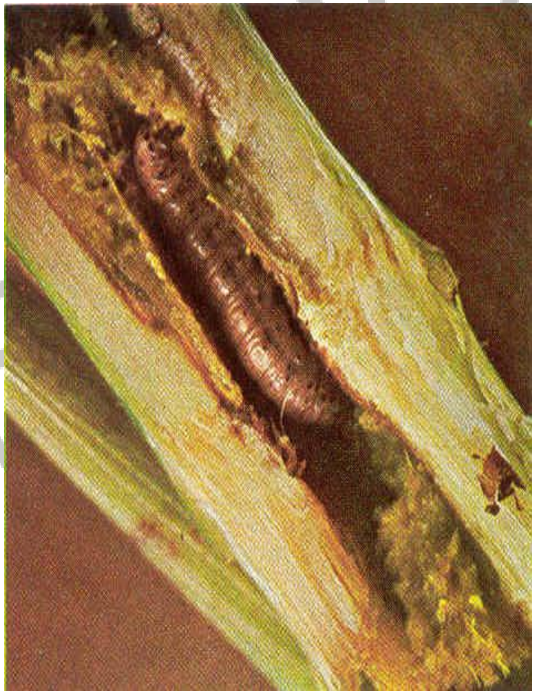
- Maize

Maize aphids

(*Ropalosiphum padi*)



Maize stalk borer (*Buseola fusca*)

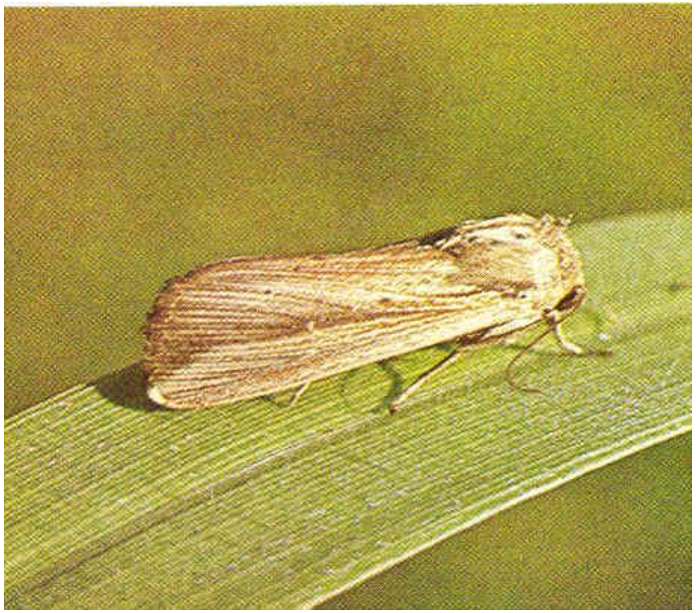


Stalk borer damage

Maize stem borer damage on leaves and stem
Photos by D. Kilalo

Pink stalk borer: caterpillar and adult moth

(S. calamistis)



Tunneling of stems or cobs or harvestable portions

Corn earworm, *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae), in sweet corn.
Photo by G. McIlveen, Jr.

Maize Stem borer (*Chilo spp*) that has pupated in the stem

Chilo spp slightly younger larvae

Armyworms and the skeletonizing damage done on cereals and grasses

- Sorghum

African bollworm caterpillar

Sorghum shoot fly

Damage on sorghum by borers and locusts

Sorghum midge, *Contarinia sorghicola* (Coquillett) (Diptera: Cecidomyiidae). Photo by Drees.

Insect feeds on forming seeds in the milky stage. The head does not fill well and some of the seeds are shriveled lowering sorghum yield.

Sorghum midge damage on seed 30% loss incurred in Kenya1990

Corn aphids on sorghum

Insect PESTS OF PADDY

Borer pests of paddy

Yellow stem borer

Scirpophaga incertulas

Gall midge or Gall fly

Orseolia oryzae

Sucking pests of paddy

Green leaf hoppers (GLH)

1. ***Nephotettix nigropictus***
2. ***N. virescens***

White leaf hopper(WLH)

Cofana spectra

Brown Plant hopper(BPH)

Nilaparvatha lugens

Earhead bug

Leptocorisa oratoria

Thrips

Stenchaetothrips biformis

Mealybugs

Brevennia rehi

Sucking insects : pierce and suck sap from plant

A leafhopper (Homoptera: Cicadellidae)
Photo by C. L. Barr

a

b

c

d

a. Cotton aphid or melon aphid, *Aphis gossypii* Glover
b. Yellow sugarcane aphid, *Sipha flava* (Forbes)
c. Russian wheat aphid, *Diuraphis noxia* (Mordvilko)
d. Corn leaf aphid, *Rhopalosiphum maidis* (Fitch)
(Homoptera: Aphididae).
Photos a, b & d by Drees. and Photo b is by P. Morrison

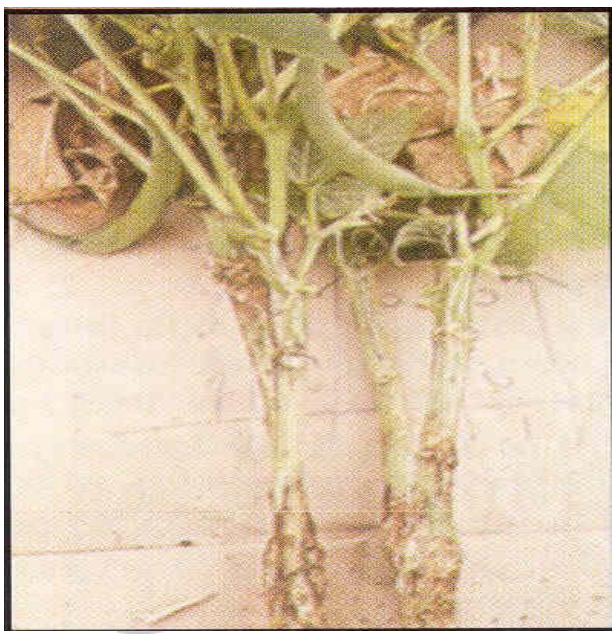
Legume crops

- Beans

Bean stem maggot

(Bean fly damage on stem base)

Seedling dying cause of BSM damage



Bean fly larva tunnelling into the surface of stem (centre, top stem) (Photo: J. Wessels)

Damping off of seedlings

Adult bean fly showing shiny, black body with clear wings (Photo: J. Wessels)

Heavy aphid infestation of growing tips of a dry bean crop

Corn Aphid infestation on maize/ sorghum leaf

Damage done using piercing sucking mouthparts

Two spotted mites

Two spotted mites damage on common bean leaf (yellow colour compared to common bean green leaf)

Photo by Richard Clark, Utah

Destruction of plant tissues by eating away leaves or causing stippling or mines on leaf

Serpentine leafminer, (Diptera: Agromyzidae) maggot damage to chrysanthemum.
Photo by H. A. Turney.

African bollworm on pod

African bollworm on pod and damage

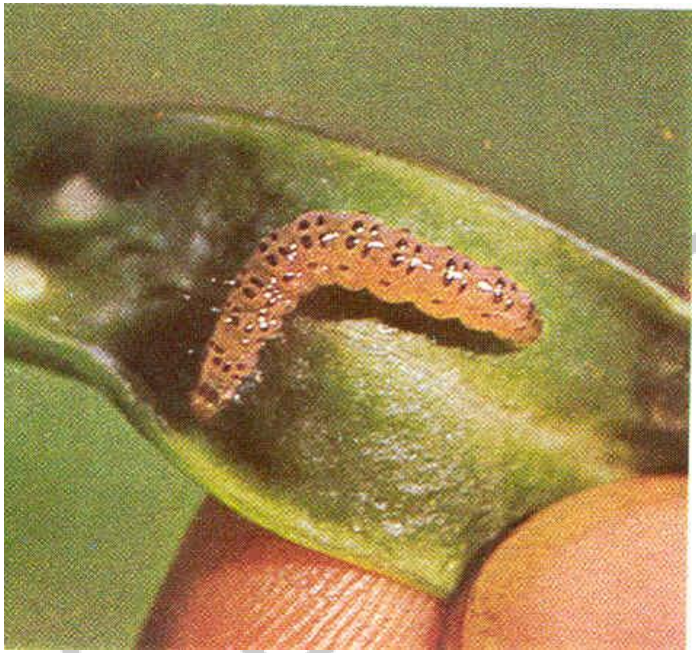
Leaf folder in pod and folded leaves

Blue Butterfly larvae on flowers and young pods

White scales on the stem

Maruca damage on flowers

Maruca spotted borer caterpillar

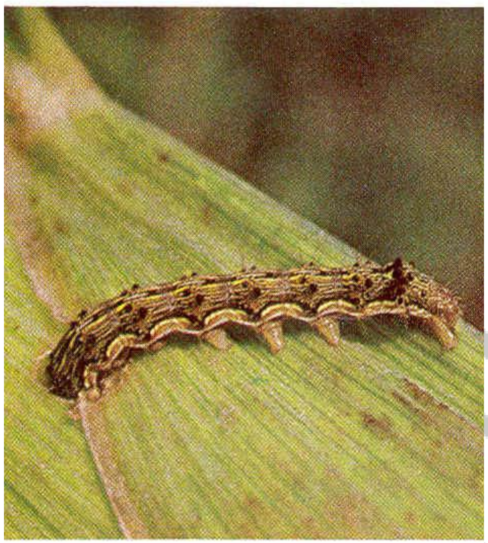


Maruca damage in pod and frass on the pod

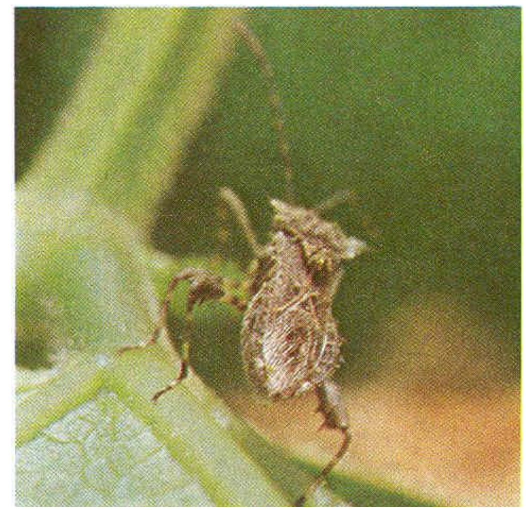
Bean pod borer

Pigeon peas, cowpeas

Pod borers
(African bollworm)



Spiny brown bug (Acanthomia spp)



Blister beetles

Pigeon pea flowering

Cow bugs –a sucking bug

Clavigralla nymphs

Riptortus spp

Pod bugs

Nezara spp

Mealybugs

On leaves

On stems

On flowers

Death due to infestation

Pod fly adult

Aphids

Pod fly maggots

Pod fly pupae

Leaf webber

Maruca damage

Pod borer damage

Healthy grain

Pod bug damage

Pod fly damage

Thrips on florets

Insects eating flowers or seeds that have been stored

Pollen beetle (*Mylabris spp*) feeding on legume flowers

(Photo by D. Botha, Ecoport

Reduces pod setting and hence yield important to control at flowering

Bean bruchid (*Acanthoselides spp*) and its damage on bean seed

Photo by George Geogern Ecoport

Leaf miner and its damage on groundnut leaves

Damage on groundnut leaves by Spodoptera spp

Sucking insects

Adult jassids and their ‘V’ shaped damage on groundnut leaves

Whiteflies (*Bemisia tabaci*) on sweet potato leaves

Silver leaf whitefly (*B. argentifolii)* on tomato leaf

THANK YOU

IMPORTANCE OF INSECT PESTS, DISEASES, WEEDS AND DISORDERS IN SEED PRODUCTION

Introduction

Since the beginning of agriculture almost 10,000 yrs ago, farmers/growers had to compete with harmful organisms. These include organisms such as pests, pathogens and Weeds. The pests include mites, aphids, nematodes, rodents, birds, slugs and snails whereas plant pathogens include fungi, bacteria and viruses. Weeds have also affected agricultural production by competing for nutrients with crops. These organisms are collectively called as pests (biotic stresses) of crops which are meant for human consumption.

Apart from the above pests, humans also suffer crop losses from other abiotic causes like lack or excess water during the crops' growth season, extreme temperatures (high or low) as well as improper nutrient supply.

Biotic stresses have the ability to reduce production substantially in various ways which can either be qualitative and/or quantitative.

Quantitative losses are through reduced productivity leading to a lower yield per unit area, while qualitative losses are reduced contents of valuable seed ingredients, reduced market value due to loss of aesthetic features, reduced germination, production of toxic substances like mycotoxins and finally disease transmission.

Pests and diseases have continued to affect production of crops and have a serious impact on the economic output of a farm. Farmers need to vary their management methods depending on the crops they grow and the pests or diseases they are susceptible to, since they affect crops differently. Farmers also need to ensure that they balance pests and disease prevention and treatment methods against damage to the environment.

Certifying seed is one way to reduce pests and diseases. Crop losses due to these harmful organisms can be substantial and they may be prevented, or reduced when they are understood and proper management measures employed.

Definitions

Pathogen: This is a parasitic organism that causes disease in a plant.

Parasite: This a living organism that attacks and obtains nourishment from cells of another living organism, the host, while contributing nothing to the host's survival.

Note: All pathogens are parasites but not all parasites are pathogenic to plants

Infection: It is the invasion of an organism (plants, animals etc) by a disease causing agent (pathogen), their establishment and multiplication.

Host: It is a living organism or plant that supports the activities of a pathogen or a plant from which a pathogen derives its nourishment or nutrition. A host plant could either be *susceptible* or *resistant* to an invading pathogen.

Biotroph: This is a pathogen or harmful organism which obtains nourishment from the living cells of the host they infect e.g. powdery mildews: cereals powdery mildew – *Erysiphe graminis*

Necrotroph: This is a pathogen which kills the host cells and lives on the dead remains of the host e.g. pathogens causing root rots, e.g. *Fusarium solani, Gaumannomyces graminis*, etc.

Hemibiotroph: They are pathogens which attack a host and obtain nourishment from the living cells in some phases of the disease and upon the death of the host they live on the dead host, e.g. *Colletotrichum lindemuthianum* causing bean anthracnose.

Obligate pathogen: This is a harmful organism which cannot be grown in the absence of a favourable host e.g. cereal powdery mildews.

Facultative pathogen: This refers to any harmful organism (pathogens) which can be grown on artificial media in the absence of the favourable host.

Disease:

-Is the deviation from normal functioning of physiological processes, of sufficient duration to cause disturbance in vital activity of an organism.

-is any abnormal condition that alters the appearance or function of a plant

Diseases can be classified into two categories based on the causal agents:

Pathogenic disease: This is the prolonged change from normal state of an organism due to physiological disturbance of normal functions of plant and is caused by living pathogens (or biotic factors) such as fungi, bacteria and viruses.

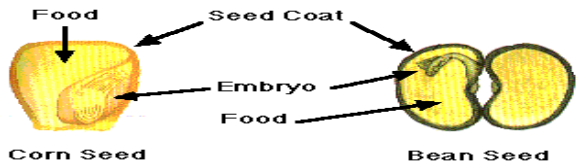
Non-pathogenic disease: This is the prolonged change from normal state of an organism due to physiological disturbance of normal functions of plant caused abiotic factors such as water, chemical injury or damage, nutrient deficiency, etc leading to development of non-infectious or non-transmissible disease.

Pathogenicity: This is the ability of an organism to cause disease on given members of a host species.

Seed, Seed infection and types of seed infection

Seed is the plant material (grain or vegetative parts) for planting or intended for planting and not for consumption or processing. This is different from grains which are a commodity class of seeds intended for processing or consumption and not for planting.

The seed consists of three basic parts: a) embryo, b) storage tissues and c) seed coat.



Basic outer parts of a seed

Internal parts of a seed

Seed infection is the invasion of a plant's propagation material (the seed) by disease-causing agents, their multiplication, and the reaction of host tissues to these organisms. The area of science that studies the relationship between pathogens and seeds is known as Seed Pathology. It not only identifies the pathogens but also includes the role of the seed as source of inoculum, the survival of the pathogen and the actions taken to control the pathogens associated to it. It uses the knowledge of General Pathology, Microbiology and Seed Analysis.

Types of seed infection

The process of seed infection is influenced by the conditions under which the crop grows. These conditions/factors include: the host (and its genotype), the pathogen (and its genotype) and environment.

There are different ways in which the seed gets infected:

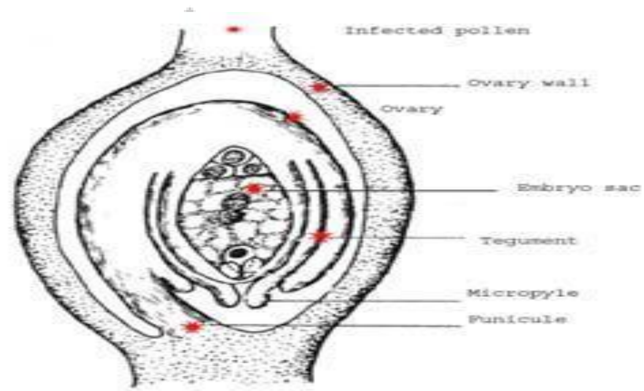
1.)Seed infection refers to when the inoculum is within the seed tissue 2.)Seed infestation refers to where the inoculum is superficial, being confined to the surface of the seed usually as adhering propagules.

1. SEED INFECTION

Seed infection can result through the vascular system or plasmodesmata or directly by natural or artificial wounds. Pathogens can infect the seed using one or more of the mechanisms like below.

a.) Systemic infection through flowers, fruits or funiculus

Most of the systemic seed-borne bacteria and fungi reach and infect the embryo through the flower or from the peduncule of the fruit. Viruses and other systemically infectious pathogens go to the embryo from the systemically infected mother plant and the infected or contaminated pollen. They rarely reach the embryo during the formation of the seed or formation of the embryo itself. Examples of some infections that occur through the vascular system are like *Fusarium oxysporum* in pumpkin and tomato and other crops , *Verticilium dahliae* in spinach; *Xanthomonas campestris* in cabbage and rice, *Xanthomonas axeonpodis* and *Colletotrichum lindemuthianum* in beans.

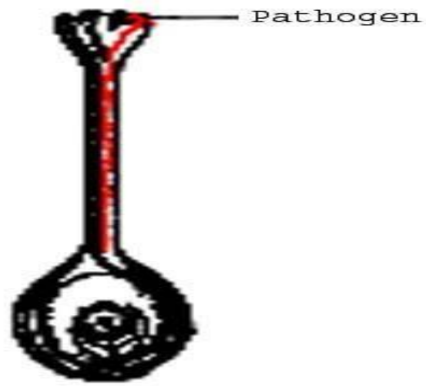


Infected pollen (red spots) entering the flower during fertilization

Penetration through the stigma

In some systemic infections, pathogens follow the same path as the pollen grains do. The spores of some fungi reach the stigma and germinate, producing hyphal strands that reach the ovary through the style, where they can stay as dormant mycelium until seed germination. For example: *Ustilago nuda* and *U. triticci* in wheat, and *Alternaria alternata* in sweet pepper.

Viruses can infect through infected pollen where the male gamete carries the virus and generates an infected embryo on joining the ovule. An infected endosperm may occur if both, the male and female gametes are infected.



Pathogen growing through the stigma infecting the ovary

b.) Penetration through the wall of the ovary or immature seed covers

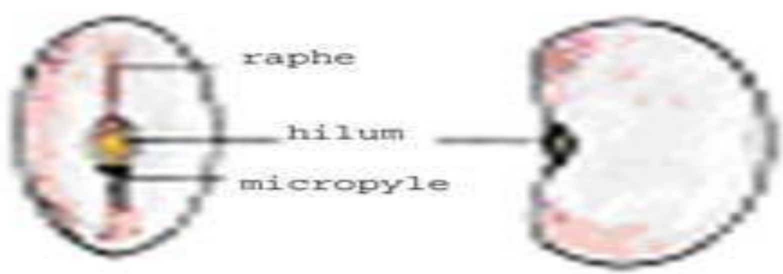
Some fungi, like *Ustilago nuda* and *U. tritici* penetrate through the wall of the ovary as a result of the germination of the Teliospores on the stigma or the wall of the ovary. The pro-mycelium goes through the wall and other tissues until it reaches the embryo. In some other cases, penetration occurs through breakages on the testa, establishing itself in the endopleura or the endosperm. In fleshy fruits, like cucumber, melon, eggplant, tomato, sweet pepper and others, contamination can occur directly through the funiculus or in the tegument, during the process of seed formation.

Examples of this are *Colletotrichum lagenarium* in watermelon and other cucurbits; *Rhizoctonia solani*, when it invades fleshy fruits, like the ones mentioned above, is capable of infecting from the placenta and penetrate to the developing ovule or seeds that are still in its formation process and have not lignified its cover.

c.)Penetration through wounds and natural openings

Natural openings like the hilum and the micropyle or wounds generated during the threshing are spots where pathogens like *Xanthomonas campestris* pv. p*haseolicola* in bean infect the seed.

Seed is penetrated via the vascular system of the pedicel and funiculus. The micropyle also serves as a point of entry into the seed.



Hilum and micropyle: natural openings through which pathogens can infect seed

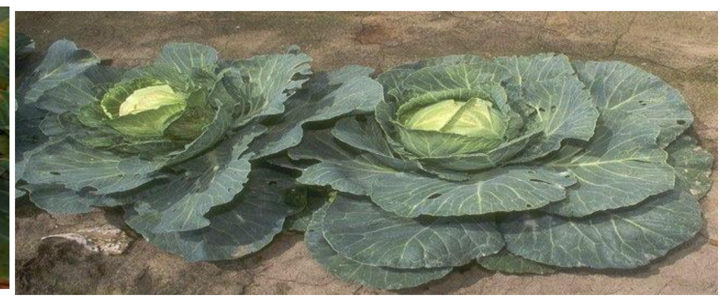
2.) SEED CONTAMINATION/INFESTATION

Seed contamination is the passive relationship of a pathogens and seeds. Seeds can be contaminated with other seeds, pathogens insects and soil particles. The pathogen itself or parts of it like sclerotium, mycelia, spores etc, can stick to surface of the seed or get mixed with the seeds during processes such as seed recollection: harvesting, extraction, threshing, selection and packing. There are two types of contamination:

a.) Pathogens that stick to the surface of the seed

Pathogens stick to seeds during harvest or postharvest by their spores which may include: Clamidospores, Oospores, Teliospores, Uredospores for fungi; bacterial cells and in some cases, virions. Examples of some fungal spores carried on seed coat surfaces are: *Alternaria brassicae* and *A. brassicicola* in crucifers; *A. radicina* in carrot; *Ascochyta pinodella* in pea; *Drechslera oryzae* in rice; Sclerotia *of Rhizoctonia solani* in eggplant, pepper, and tomato and *Urocystis agropyri* in wheat.

Examples of bacteria that contaminate seed surfaces include: *Corynebacterium flaccumfaciens* pv. *flaccumfaciens* in beans, *Pseudomonas syringae* pv. *phaseolicola* in bean, *P. syringae* pv. *tomato* in tomato, *Corynebacterium michiganense* pv. *michiganense* in pepper, *Xanthomonas campestris* pv. *campestris* in cabbage.

Black-rot of cabbage caused by *Xanthomonas campestris pv campestris* (left); healthy and uninfected cabbage on the right

Some viruses such as Tobacco mosaic virus, Tomato mosaic virus, Pepper Mosaic virus may also occur as contaminants.

Tobacco plants infected by Tobacco mosaic virus; some symptoms of the infection include mosaic

Mottling of tobacco leaves infected by Tobacco mosaic virus

b.) Accompanying contamination

This refers to physical mixing of the seed with the pathogen’s propagation organs like the sclerotia, nematode galls, contaminated seed or soil particles containing pathogens.

Roots of maize plant infested by Striga when maize seed is contaminated with striga seed

Anthracnose infected seed

INSECT PESTS

A pest can be described as any organism capable of causing damage to crop plants. Pests are organisms considered harmful or detrimental to humans, his possessions and other human interests. Pests have been defined by FAO as any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products.

Economic importance of insect pests

1. Insect pests destroy crops in the field through their biting, chewing, boring, sucking and defoliation activities.

Tomato fruit damaged by boll worm *Helicoverpa amigera*

Flea beetle damage on bean plants (*Epitrix hirtipennis*)

2. Spots of injuries by insects may predispose crops to disease attack.

Bean fly larva tunnel under the surface of the stem (left). Infestations can cause plant death (right)

3. They increase the cost of production during the course of controlling them as a result of purchasing chemicals and labour incurred it their application.

Aerial pesticide spraying

Boom sprayer

Knapsack sprayer

4. Some are carriers or vectors of diseases e.g. Aphids are vectors of bean common mosaic virus and white flies as vectors of tomato leaf curl virus

Bean Common Mosaic Virus (Potyvirus BCMV) on common bean (*Phaseolus vulgaris*)

Symptoms of tomato yellow leaf curl

Adult and nymph of *Bemisia tabacci* whitefly (right), a vector of TYLCV

5. They reduce the quality of produce in the field as well as in the store e.g. Potato tuber moth (PTM) on Irish Potatoes

Potato tuber moth damage on tubers by PTM larvae

Leaves of potato mined

Larvae and adult of the potato tuber moth

6. They render vegetables and fruits unattractive and unmarketable e.g. damage on crucifer leaves by diamond back moth (*Plutella xylostella*)

Cabbage damaged by Diamondback moth

Kales damaged by Diamondback moth

7. They generally reduce the yield of crops due to their feeding on the leaves and the harvestable parts of the crop.

Mine on tomato leaf caused by the larvae of *Tuta absoluta*

Tomato fruit damage by *Tuta absoluta*

8. They cause reduction in viability of stored produce.

Bean seed infested by bean bruchid (*Callosobruchus Maculatus*)

Maize damaged by maize weevil (*Sitophilus zeamais*)

9. They can also cause total death of crop plants where the whole plant succumbs to the pest damage leading to reduction of profits or total loss. Example banana weevil *Cosmopolites sordidus,* burrowing nematode

Banana crop destroyed by Banana weevil *Cosmopolites sordidus*

Split banana pseudo stem infested with banana weevil (*Cosmopolites sordidus*)

Banana toppling disease caused by burrowing nematodes *Radopholus similis*

Damaged roots due to burrowing nematode infection *Radopholus similis*

PLANT DISEASES

Disease is a change from normal or healthy state due to physiological disturbance of normal functions of plants and is caused by pathogens such as fungi, bacteria, viruses and nematodes. A plant disease is any abnormal condition that alters the appearance or function of a plant. It is a physiological process that affects some or all plant functions. Disease may also reduce yield and quality of harvested product. Disease is a process or a change that occurs over time. It does not occur instantly like injury.

Economic importance of plant diseases

a. Disease Transmission

Seed borne pathogens transmit diseases between fields, regions and countries through seed and other planting material. For example, diseases like Bacterial blight of paddy rice, Sclerotinia diseases of broad beans, common beans and recently cauliflower, are transmitted through movement of improved seed.

Rice field infected by bacterial blight (*Xanthomonas campestris p.v. oryzae*)

A healthy rice field

Cassava plant with early symptoms of Cassava mosaic virus infection

Leaf curling and yellowing of plant tissue

b. Complete loss or reduction in seed germination

Seed borne diseases/pathogens can be spread from the seed and infect the new plant in several ways. Upon sowing, moisture activates pathogens causing pre- and post-emergence damping off, e.g. bean seeds infected with *Macrophomina phaseolina* cause 59% loss of germination. Some of the pathogens like different species of *Fusarium*, *Pythium*, *Rhizoctonia*, *Sclerotinia*, *Alternaria* when present also cause other similar diseases in several crops.

Sorghum ergot caused by *Claviceps africana*

c. Seed abortion

Some of the seed borne pathogens like smut fungi in a number of cereals and viruses like pigeon pea sterility mosaic virus cause heavy seed abortion resulting in 80-100% yield losses.

Head smut of maize caused by *Sphacelotheca reliana*

Loose smut of Maize caused by *Ustilago maydis*

d. Reduction in seed quality

Pathogen infections of seed often substantially reduce seed size resulting in weight reduction. E.g. leaf blight of sunflower, *Alternaria helianthi* and *A. zinnniae* infect the crop resulting in severe leaf blight and yield loss of 80%. *Anguina tritici* in wheat causes seed galls. Seed discolouration is a very important and wide spread symptom produced on seed indicating presence of pathogen e.g. *Fusarium moniliformae* of sorghum and *Aschochyta pisi* of sweet pea all result in reduction in market value. Infected seeds are at risk of being contaminated with mycotoxins and nutritional changes. Biochemical changes in seed products e.g. groundnuts infected with *A. flavus* gives inferior quality of oil through reduction of the refractive index.

Seed-borne mosaic virus on Field pea

Grey mould by *Botrytis* on chickpea seed

Shrivelled wheat seed caused by the nematode *Anguina tritici* compared to healthy wheat seed

Fusarium head blight of wheat - infected seed

Heads of wheat infected by *Fusarium* haed blight

Maize cob infected with *Fusarium* ear rot

e. Reduction in yield

Great yield losses are experienced worldwide through seed borne pathogens

Banana plantation infected by Sigatoka disease caused by *Mycosphaerella musicola*

Infected seedlings, plantations and leaves, which are used often in the developing world as packing materials, are usually responsible for the long- distance spread of the disease.

WEEDS

A weed is a plant that does more harm than good and has a habit of encroaching where it is not wanted. Weeds can be classified in several ways that include life cycle, habitat, nutritional habit and morphological characteristics.

1) Life cycle: Based on the length of time it takes to die, e.g. Annual weeds, perennial weeds,

2)Habitat: Based on the location of the weed, such as terrestrial (upland) weeds, aquatic weeds, weeds of arable crops, weeds of plantations, etc

3)Morphology: such as Narrows leaf weeds - Grasses are usually characterized by narrow leaves, parallel veins and are generally monocotyledons. Broad leaf weeds are generally characterized by net venation, tap root system and are dicotyledons.

Importance of weeds

Weed Problems

1.Crop competition to resources and its effect on crop yield and quality of seed

2.Interference with harvesting operations

3.Allelopathic effect

4.Ability of weeds to reproduce in cropping systems

5.Weeds can harbor diseases and pests

6.Seed contamination from parasitic weeds such as striga in maize.

Striga hamonthica weed on a maize plantation

SIGNS, SYMPTOMS AND EFFECTS OF PLANT DISEASES

PLANT DISEASES

A plant disease is any abnormal condition that alters the appearance or function of a plant.

CAUSES OF PLANT DISEASES

Plant diseases are caused by both infectious (fungi, bacteria, viruses and nematodes) and non infectious agents (mineral deficiency, sun burns etc). Infectious plant diseases are caused by living organisms that attack and obtain their nutrition from the plant they infect. The parasitic organism that causes disease is referred to as a **pathogen** and the plant invaded by the pathogen and serving as its food source is referred to as a **host**. A favourable environment is critically important for disease development – even the most susceptible plants exposed to huge amounts of a pathogen inoculum will not develop disease unless environmental conditions are favourable.

For disease to occur there must be a susceptible host plant, virulent pathogen, favourable environmental conditions for the pathogen to grow, and time for the disease to develop.

The main categories of microbes that cause plant diseases which are fungi, bacteria, viruses and nematodes. Fungi account for around 85 percent of plant diseases

followed by viruses, bacteria and nematodes.

Environmental factors are important in the development of plant diseases and determine whether the diseases become epidemic. These include temperature, relative humidity, soil moisture, soil pH, soil type, and soil fertility during the crop growth.

The plant diseases caused by these factors (environmental factors) due to their deficiencies or excess in nature are classified as “abiotic,” or diseases that are non-infectious.

Upon infection of a plant by a pathogen, the plant may respond to the infection leading to detectable changes in its development and these results in development of symptoms in the infected plant and signs of the pathogen will be visible.

SYMPTOMS AND SIGNS OF PLANT DISEASES

These are visible effects of disease on plants due to the interference in the development and/or function of the plant as it responds to the pathogen i.e. a result of invasion and infection by the pathogen.

Symptoms may be classified as local or systemic, primary or secondary, and microscopic or macroscopic.

Local symptoms are physiological or structural changes within a limited area of host tissue around the infection site, such as leaf spots, galls, and cankers.

Systemic symptoms are those involving the reaction of a greater part or all of the plant, such as wilting, yellowing, and dwarfing.

Primary symptoms are the direct result of pathogen activity on invaded tissues (*e.g.,*swollen “clubs” in clubroot of cabbage and “galls” formed by feeding of the root-knot nematode). On the other hand, secondary symptoms result from the physiological effects of disease on distant tissues and uninvaded organs (*e.g.,* wilting and drooping of bean leaves in hot weather resulting from *Fusarium* root rot or root knot nematodes).

The disease symptoms may be microscopic or macroscopic. In microscopic symptoms, the expressions of disease are in the cell structure or cell arrangements which can be seen under a microscope where as macroscopic symptoms are the expressions of disease on the surface of plant parts that can be seen with the unaided eye in the form of symptoms on the plant.

Macroscopic (morphological) symptoms can be classified as; a.) Necrotic,

b.) Hypoplastic c.) Hyperplastic

Necrosis is localized or the general death/degeneration of plant tissue (protoplast). It includes leaf spots, blight, rots etc.

Some of the necrotic symptoms

Wilting is loss of turgor pressure in a plant leading to temporary or permanent drooping of leaves, shoots, or entire plants from lack of water or infection by different pathogens. This is usually a secondary symptom due to plugging of xylem tissue by an organism eg. *Fusarium* wilt of tomato, Bacterial wilt of Tomatoes, root knot disease of beans

Bacterial wilt of tomatoes caused by *Ralstonia solanacearum*

Spot is a definite, localized, round to regular lesion, often with a border of a different colour, characterized as to location (leaf spot, fruit spot) and colour (brown spot, black spot); if numerous or if spots enlarge and merge, a large irregular blotch or blight may develop such as gray leaf spot of tomato; black spot of rose; Angular leaf spot of beans, Leaf spot with yellow halo, Fruit spot e.t.c.

Angular leaf spot of beans caused by *Phaesariopsis griseola*

Septoria leaf spot of tomato plant caused by *Septoria lycopersici*

Blight is the sudden or total discoloration and killing of large area of a leaf, shoots, or stems or the entire plant; usually young tissues are attacked; the disease name is often coupled with the name of the host and the part attacked—blossom blight, twig blight, tip blight

Common bacterial blight of beans caused by *Xanthomonas axanapodis pv phaseoli*

Bacterial blight of rice caused by *Xanthomonas campestris p.v. oryzae*

A healthy rice crop

Blast is sudden blighting or death of young buds, flowers, or young fruit; failure to produce fruit or seeds such as *Botrytis* blight of roses, onion, strawberry; rice blast *Magnaporthe oryzae (Pyricularia oryzae)*

Rice blast lesions on rice leaves

Panicle blast of rice caused by *Magnaporthe oryzae*

Rice seed infected by blast showing symptoms of brown blotches

Damping off - decay of seed in soil, rapid death of germinating seedlings before emergence, or emerged seedlings suddenly wilting, toppling over, and dying from rot at or near the soil line such as pre-emergence damping-off and post- emergence damping-off; both are common in seedbeds

Damping off in common bean due to *Pythium spp.*

Dieback progressive browning and death of shoots, branches, and roots starting at the tips to down ward e.g. die back of chilli/ citrus

Die back of citrus caused by motile bacteria, Candidatus Liberibacter spp (*Liberobacter asiaticum*, *Liberobacter africanum*)

Rots refer to the decomposition and putrefaction of cells, later of tissues and organs. The rot may be dry, watery or mushy such as bacterial soft rot

Root rot of Beans

Root rot symptoms on common bean plants caused by *Fusarium spp.*

Discoloured vascular system of a root due to *Fusarium oxysporum.*

Red Rot of sugarcane caused by *Colletotrichum falcatum* (*Physalospora tucumanensis)* is a disease that manifest both in the leaf which withers away at the tips along the margins and in the internodes of a stalk by splitting it longitudinally. It includes the reddening of the internal tissues which are usually elongated at right angles to the long axis of the stalk. The diseased cane also emits acidic-sour smell. As the disease advances, the stalk becomes hollow and covered with white mycelial growth.

Red rot of sugar cane symptoms on leaves
External symptoms of Red rot on sugar cane stalks

Red rot of sugar cane caused by *Colletotrichum falcatum* (*Physalospora tucumanensis)* on stems both external

Soft rot diseases are caused by pathogens that secrete enzymes capable of decomposing cell wall structures, thereby destroying the texture of plant tissue—i.e., the plant tissue becomes macerated (soft and watery). Soft rots commonly occur on fleshy vegetables such as potato, carrot, capscicum, squash, and tomato.

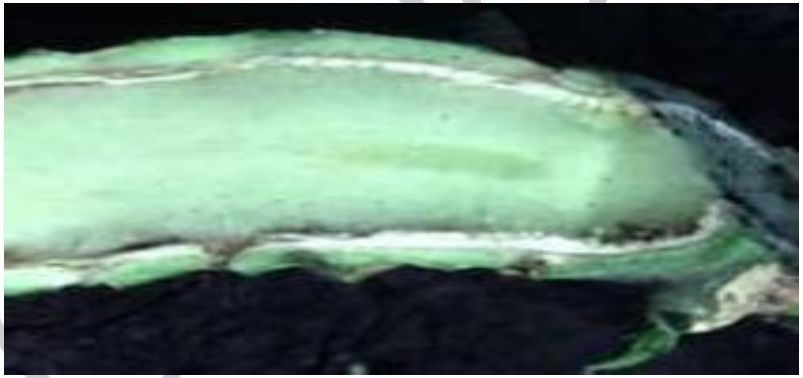
Soft rot symptoms on Capsicum caused by *Erwinia carotovora* subsp. *Atroseptica*

Soft rot symptoms on Avocado caused by *Erwinia herbicola*

Soft rot symptoms on carrot caused by *Erwinia carotovora*

Black rot of crucifers caused by *Xanthomonas campestris p.v. campestris* is also a bacterial disease where the vascular system is infected and leads to necrosis of the leaves.

Symptoms of black rot on cabbage transplants
V-shaped lesions on mature cabbage



Discoloured vascular tissue in cabbage stem due to black rot caused by *Xanthomonas campestris p.v campestris*

Streak narrow, elongated, somewhat superficial necrotic lesions, with irregular margins, on stems or leaf veins such as virus streak

Stripe narrow, elongated, parallel, necrotic lesions especially in leaf diseases of cereals and grasses *Helminthosporium* stripe of barley, Red stripe of sugarcane caused by *Pseudomonas rubrilineans*

Maize streak disease on maize leaf caused by the Maize streak virus

Red stripe of sugarcane on leaves - *Pseudomonas rubrilineans*

Water-soaking (Hydrosis) is a translucent condition of tissues caused by water moving from host cells due to rupturing of cell membranes into intercellular spaces e.g. late blight lesions on potato and tomato leaves; bacterial soft rot of fleshy vegetables

Hydrosis on Irish potato leaf due to late blight caused by *Phytophthora infestans*

Symptoms of Late blight caused by *Phytophthora infestans* on tomato stems

Symptoms of Late blight caused by *Phytophthora infestans* tomato fruits

Canker a definite, dead, often sunken or swollen and cracked area on a stem, limb, trunk, tuber, or root surrounded by living tissues:

Bacterial canker of tomatoes Clavibater michiganensis p.v. michiganensis

HYPOPLASTIC

Hypoplasia is the failure of plants or organs to develop fully i.e to obtain normal size.

Abnormal size and pale colouration is the most common hypoplastic symptom. Other symptoms include:

Dwarfing is the underdevelopment of the plant or some of its organs eg MSV or mosaic; curly top of beans;

Maize stunt due to Maize streak virus disease

Rosetting is the shortening of internodes of shoots and branches, producing a bunchy growth habit example are the ground nut rosette.

Ground nut rosette caused by groundnut rosette umbravirus

Albication is the complete repression of colour caused by viruses, bacteria, fungi, and iron deficiency leading to albinism or whitening of leaf tissue.

Broad Bean Stain Virus (BBSV) symptoms on pea plants include whitening of interveinal tissue and necrosis.

Chlorosis this is the yellowing or whitening of normal green tissue due to partial or complete failure of chlorophyll to develop this symptom can developed due to different diseases such as *Fusarium* yellows of beans

Chlorosis on bean leaves due to *Fusarium oxysporum*

Mosaic is the abnormal coloration yellowing, reddening, bronzing, or purpling in localized areas of leaves where chlorophyll has been destroyed; Symptoms such as a clearing along the leaf veins (vein clearing)

Turnip Mosiac virus on cabbage leaves

cauliflower mosaic virus on Kale (below)

Veinal necrosis on common bean leaf due to Bean Common Mosaic Virus

Dark green, light green pattern/ chlorotic areas on leaves due to virus infection

HYPERPLASTIC

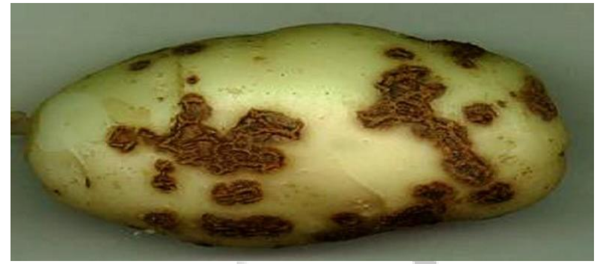
Hyperplasia is the overdevelopment (in size and colour) of the plant parts. Hypertrophy on the other hand is the exclusive development of a plants organ due to over hyperplasia and they include;

Leaf curls -overgrowth of tissue on one side of a leaf or petal resulting to leaves rolling.

Curled tomato leaves caused by tomato leaf curl virus

Scabs roughened to crust like, more or less circular, slightly raised or sunken lesions on the surface of leaves, stems, fruit, or tubers e.g. common scab of potato, apple scab and wheat scab.

Fruit scab on Avocado due to *Sphaceloma perseae*



Potato scab caused by *Streptomyces scabies*

Tumours are symptoms that are caused by pathogens that stimulate uncontrolled multiplication of plant cells, resulting in the formation of abnormally large structures

Crown galls

Crown gall symptoms on roses caused by *Agrobacteriu tumafaciens*

Club root symptom is where the roots appear swollen, club-shaped roots

Clubroot symptom on cabbage caused by *Plasmodiophora brassicae*

Root knots are the formation of galls on the roots which is as a result of nematode infection.

Root knots (galling) on common bean roots due to nematode (*Meloigogyne spp.*) infection

SIGNS OF PLANT DISEASES

This is the physical evidence of the pathogen causing disease. Examples of signs of a pathogen include; fungal fruiting bodies, mycelia, bacterial ooze, or nematode cysts. Signs also can help with plant disease identification.

1.) **Mycelium** or **Mold Growth**: under some conditions, mycelia or fungal growth is readily visible to the naked eye.

Mycelium of *Phytophthora infestans* on tomato fruits

Sunken lesions with purple coloured mycelium on bean pods – sing of anthracnose caused by (*Colleototricum lindemuthianum)*

2.) **Conks** and **Mushrooms**: These are the familiar structures of some fungi that are formed by some pathogenic fungi such as *Armilaria mellea.*

Armillaria mellea mushrooms from base of infected tree

Fruiting Bodies: They are reproductive structures of some fungi that are embedded in diseased tissue, often requiring a hand lens to see e.g. sclerotia, stroma

a.) Sclerotia these are hard resistant structures of some fungi

Hard black sclerotia inside the stem a definitive sign of the pathogen causing this wilt, *Sclerotinia sclerotinium* commonly called white mold.

Visible fungal mycelia and sclerotia on tomato, the sclerotia (seed-like structures in the middle of the fungus mat) identify southern blight fungus *Sclerotium rolfsii*.

b.) Cleistothecium a speck-sized, black fruiting body completely enclosing sexual spores of many powdery mildew fungi

Powdery mildew of cucumber caused by *Sphacerotheca fuligenea*. Chletothecia visible under high magnification

c.) Acervulus a shallow, saucer-shaped fungal structure that bears asexual spores (conidia); it is usually formed below the cuticle or epidermis of leaves, stems, and fruits, later rupturing the surface and exposing its spore- bearing surface anthracnose of beans, avocado, tomato e.t.c.

Anthracnose on common bean caused by *Colletotrichum lindemuthianum.* Note the purplish colouration in the sunken lesions.

d.) Sorus (pustule) a compact mass of spores, or a cluster of sporangia (spore-bearing structures), produced in or

on the host by fungi causing such diseases as white rust, smut, and true rust; before rupturing, the sorus is normally

Maize leaf with symptoms of maize leaf rust caused by *Puccinia sorghi*

3.) Mold growth on the host plant

a.) Powdery mildew white, powdery to mealy, superficial growths of mycelia and conidiophores on surfaces of leaves, stems, flowers, and fruit powdery mildew diseases of capsicum, beans, mango etc

Powdery mildew caused by *Leveillula taurica* on capsicum plants. Note the powdery mycelium growing on the leaf.

b.) **White mold** on several crops caused by *Sclerotinia sclerotiorum*

Floral infection of sunflower caused by *Sclerotinia sclerotiorum*

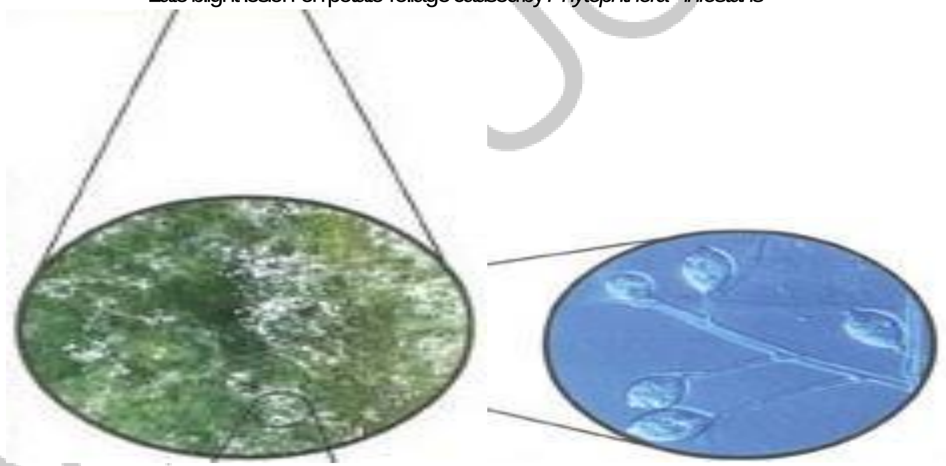
Symptoms and signs of white mold on snap bean pod caused by *Sclerotinia sclerotiorum*.

Advanced signs of white mold of snap bean. Mature sclerotia formed on the diseased tissues.

Sclerotium and apothecia of *Sclerotinia sclerotiorum*

c.) Mold of *Phytophthora infestans* on infected Potato plant

Late blight lesion on potato foliage caused by *Phytophthora infestans*



Lesion of late blight as seen through the hand lens

Micrograph of sporangia on sporangiophores

d.) **Ooze and Specific Odors**: associated with tissue macerations

Grey-brown discoloration of vascular tissues (vascular ring) and bacterial ooze in potato tuber infected by *Ralstonia solanacearum*

Bacterial streaming in water from a cut stem

This occurs when cut stem sections from infected plants are placed in water and threads of a viscous white slime can be observed streaming from the cut end of the stem within 15 min. These threads are bacterial ooze exuding from the infected

.

Bacterial streaming in water from a cut tomato stem infected by *Ralstonia. solanacearum*