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

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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;

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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	Isocathion	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

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