KHEA
Knowledge Hub for Organic Agriculture in Eastern Africa

KCOA
Knowledge Centre for Organic Agriculture in Africa

INTEGRATED PEST MANAGEMENT

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EFFECTIVE IPM ASSOCIATION

Introduction

- Food security and increased income are the primary goals of most poor farmers throughout sub-Saharan Africa where the majority of agriculture is carried out on smallholdings, often of less than ONE hectare. Farm size limits what farmers can produce, and this can be a great burden when most families' livelihoods depend on the amount of food they can produce.
- It has been estimated that for every 10% increase in farm yields, poverty was reduced by 7% in Africa (Irz *et al.*, 2001). According to the International Fund for Agricultural Development (IFAD) an increase of just 1% in agricultural per-capita Gross Domestic Product (GDP) would reduce the poverty gap five times more than a similar increase in GDP in any other sector, and would particularly target the poorest people. So helping smallholders to produce more food can alleviate poverty.

Introduction cont

- Among the many factors that affect food production in Africa are pests and diseases that can lead to total crop failure. Accessibility of synthetic pesticides for pest and disease control is limited for many farmers due to their cost and restricted distribution networks. Products are frequently adulterated by unscrupulous traders, and inappropriate application can exacerbate pests and lead to pesticide resistance. Pesticidal plants are widely available at minimal or no cost to farmers, and have been used for centuries, so are culturally relevant.

- *Pests are organisms that damage or interfere with desirable plants in our fields and orchards, landscapes, or wildlands, or damage homes or other structures. Pests also include organisms that impact human or animal health. Pests may transmit disease or may be just a nuisance. A pest can be a plant (weed), vertebrate (bird, rodent, or other mammal), invertebrate (insect, tick, mite, or snail), nematode, pathogen (bacteria, virus, or fungus) that causes disease, or other unwanted organism that may harm water quality, animal life, or other parts of the ecosystem*

AFRICA BOLLWORM

APHID

STINK BUG

CABBAGE LOOPER

WEBWORM

CUT WORM

DIAMOND BACKMOTH

FRUIT FLY

MEELY BUGS

STRIGA WEED

Parasite attachment to the host roots

Sorghum field devasted by heavy infestation of Striga hermonthica

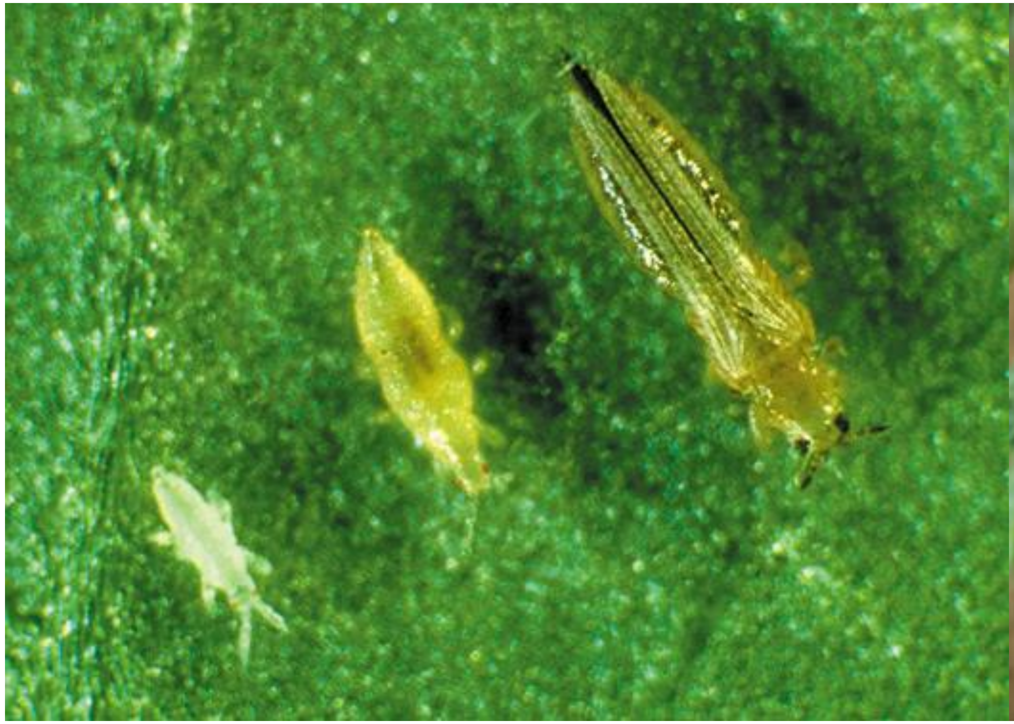
ROOT KNOT

GIANT EAST AFRICA SNAIL

LEAF MINERS

SPIDER MITE

THRIPS



WHITE FLIES

FALL ARMYWORM

ANTHRACNOSE

BACTARIAL WILT

BLACK ROT

EARLY BLIGHT

FUSARIUM WILT

LATE BLIGHT

POWDERY MILDEW

IPM DEFINITION

- Integrated Pest Management (EPM) is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides.

ESSENTIALS OF AN IPM PROGRAM

- **Monitoring.** This includes regular site inspections and trapping to determine the types and infestation levels of pests at each site.
- **Record-Keeping.** A record-keeping system is essential to establish trends and patterns in pest outbreaks. Information recorded at every inspection or treatment should include pest identification, population size, distribution, recommendations for future prevention, and complete information on the treatment action.
- **Action Levels.** Pests are virtually never eradicated. An action level is the population size which requires remedial action for human health, economic, or aesthetic reasons.
- **Prevention.** Preventive measures must be incorporated into the existing structures and designs for new structures. Prevention is and should be the primary means of pest control in an IPM program..
- **Evaluation.** A regular evaluation program is essential to determine the success of the pest management strategies.

IPM METHODS
1. Cultural method

Revolves around the use of different agronomic practices in the field which are not meant for pest management but end up helping in reducing their population.

They include:

- Timely planting
- Soil cultivation
- Weeding
- Watering

Cultural methods cont

- Fertility management
- Crop rotation
- Clean planting meterials

2. Behavioral method

- Involves the deliberate change of behavior of pests by introducing favorable or unfavorable conditions

1. Use of attractants e.g. if you planting sunflower in a maize field all weaver birds will be attracted to the sunflower and leave your maize
2. Use of repellants e.g. onions, garlic, dania, Mexican marigold if intercropped with vegetables will repel a number of soft bodied insects.

4. Biological methods

- Revolves around the use of living organisms to manage pests (natural enemies
- They include :

1. Preditors: These are organisms that prey and feed on other organisms. They often feed on various stages of the host (pest): eggs, larvae, pupae and adult.

- 2. Parasitoids: Organisms that during the larval stages feed on pests (external parasitoids) or *in* the pest (internal parasitoids). They complete their development on a single host, killing it. In their adult stages they are mostly free-living and feed on pollen and nectar or other sugary substances such as honeydew.

- The most common parasitoids are parasitic wasps and flies

Parasitoids cont

- some parasitoids lay eggs in or on other species of insect (called hosts) and the larval stage kills the host as it feeds on it and develops

Pathogens:

- Organisms that can cause diseases of pests. They include fungi, bacteria, viruses and nematodes. They can be important in controlling pest populations in agricultural systems. However, naturally occurring pathogens often are too rare to serve as important control agents or occur when the damage has already been done.
- Some pathogens such as the bacterium *Bacillus thuringiensis* (Bt) and the fungus *Trichoderma viride* are commercially available in many countries, including Kenya
- Other fungi such as *Zoophthora, Verticillium* and *Entomophthora* can be readily found in the field at particular times of the year, infecting aphids, beetles, caterpillars, grasshoppers and whiteflies.

Cont

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3. Pathogens: These are fatal or debilitating diseases to arthropod pests and include fungi nematodes, bacteria, viruses, and other microbes. Fungi, particularly *Deuteromycetes*, can infect pests externally under favourable conditions, but other pathogens must be ingested to be effective as control agents. Pathogens are very specific to their hosts

Examples of predators – lady bird

Hoverfly

Assassin bug

Chameleon

Praying mantis

Rove beetle

Predatory wasp

Predatory thrip

Predatory mite

PARASITOIDS
parasitic wasp

Braconid wasp

Tricnid fly

Conservation of natural enemies

- Reduced use of chemicals that are non selective and will kill both the pestd and their natural enemies
- Growing flowering plants which provide nectar and pollen to farmers' friends such as adult parasitoid wasps, hover-flies and ladybird beetles adults by having living fences (hedges) around the crop to provide shelter and refuge for farmers' friends should be encouraged. These are called refugia, and examples include beetle banks (grassy areas near crops) flowering plants and unsprayed field edges
- Mulching and having life fences to provide habitat for ground for natural enemies

BOTANICAL PESTICIDES

- Plants that are sources of botanical pesticides are easily available in the environment and most of them have multiple uses such as medicines, spices, ornamentals, food and or as feed Their availability makes them inexpensive and hence they are easily incorporated into agricultural production systems
- Commercialized pesticides from plants such as pyrethrum, neem and sabadilla are some of the least toxic especially to non-targets organisms such as pollinators and fish. This attribute makes botanical pesticides effective, reliable and acceptable in sustainable crop protection

- In addition, they do not leave residues on crop produce and the environment thus contributing to environmental conservation and ensuring safety to consumers
- The interaction between botanical pesticides and the pests is naturally biochemical therefore pests are unlikely to develop resistance
- The plant-based chemical compounds in extracts and essential oils are target specific which ensures safety on non-target organisms especially the beneficial organisms including pollinator bees and predators

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- Depending on the source plant and the concentrations used, the botanical pesticides have zero or little allelopathic effect on crops

MODES OF ACTION

- Botanical pesticides exhibit varied modes of action on the target pests such as repellence, toxicity, growth regulation and structural modification making them suitable alternatives in crop pest management

- They interfere with insect behaviour, physiological activities, biochemical processes, morphology and metabolic pathways

- The increasing interest in natural plant products in medicine, agriculture and food industry has spurred research in the composition of compounds in various plant families

- The common bioactive compounds in botanical pesticides are majorly secondary metabolites such as steroids, alkaloids, tannins, terpenes, phenols, flavonoids and resins that possess antifungal, antibacterial, antioxidant or insecticidal properties

- The specific compounds found in given species of plants make them effective against a given category of pests

Source Plant	Mode of action
Neem (Azadirachta indica)	Binding to acetylcholine receptors thereby disrupting the nervous system
	Repellence
	Feeding deterrence
	Inhibition of oviposition, egg hatching and moulting
Garlic (Allium sativum)	Delay and inhibit spore germination
	Inhibits protein and DNA synthesis
	Inhibits production of mycotoxins
	Disrupts cellular components and their activities
	Hyphal and mycelial modifications
Aloe	Inhibits cellular activities
	Impairs permeability of plasma membrane
	Denatures proteins
	Inhibits ATP production and glucose uptake
Tagetes Minuta	Inhibits egg hatching
	Larval toxicity
	Structural modification
	Mortality

MECHANISMS OF ACTION OF BOTANICAL PESTICIDES

- The bioactive compounds in botanical pesticides have varied modes of action against different pests including insects, fungi, bacteria, nematodes and plant host cells infected by viral pathogens

- The modes of action include repellence, inhibition, denaturation of proteins and other effects depending on type of botanical compound and pest. For instance, pesticides from pyrethrum target the nerve cells of insects leading to paralysis and later death while neem-based pesticides have anti-feedant and repellence properties, induce moulting abnormalities, hinder oviposition and disrupt the endocrine system

- The synthetic pesticides are more specific on their targets and are mostly neurotoxicants with similar end results as the botanical pesticides

ROTENONE

- **Structure.** $C_{23}H_{228}O_6$
- **Source.** Rotenone is insecticidal compound that occurs in the roots and leaves of Tephrosia Vogeli species, Derris species and several other related tropical legumes.
- Rotenone is extracted from cube roots in acetone or ether. Extraction produces a 2-40% rotenone resin which contains several related but less insecticidal compounds known as rotenoids. The resin is used to make liquid concentrates or to impregnate inert dusts or other carriers. Most rotenone products are made from the complex resin rather than from purified rotenone itself. Alternatively, cube roots may be dried, powdered and mixed directly with an inert carrier to form an insecticidal dust.
- **Mode of action.** Rotenone is a powerful inhibitor of cellular respiration, the process that converts nutrient compounds into energy at the cellular level. In insects rotenone exerts its toxic effects primarily on nerve and muscle cells, causing rapid cessation of feeding. Death occurs several hours to a few days after exposure. Rotenone is extremely toxic to fish, and is often used as a fish poison (piscicide) in water management programs. It is effectively synergized by PBO or MGK 264.

NICOTENE

- **Source.** Nicotine is a simple alkaloid derived from tobacco, *Nictiana tabacum*, and other Nicotiana species. Nicotine conStitutes 2-8% of dried tobacco leaves. Insecticidal formulations generally contain nicotine in the form of 40% nicotine sulfate and are currently imported in small quantities from India.

- **Mode of action.** In both insects and mammals, nicotine is an extremely fast-acting nerve toxin. It competes with acetylcholine, the major neurotransmitter, by bonding to acetylcholine receptors at nerve synapses and causing uncontrolled nerve firing. This disruption of normal nerve impulse activity results in rapid failure of those body systems that depend on nervous input for proper functioning. In insects, the action of nicotine is fairly selective, and only certain types of insects are affected.

NEEM

- **Source.** Neem products are derived from the neem tree, *Azadirachta indica*, that grows in arid tropical and subtropical regions on several continents. The principle active compound in neem is azadirachtin, a bitter, complex chemical that is both a feeding deterrent and a growth regulator. Meliantriol, salannin, and many other minor components of neem ar also active in various ways. Neem products include teas and dusts made from leaves and bark, extracts from whole fruits, seeds, or seed kernels, and an oil expressed from the seed kernel.

- The product known as "neem oil" is more like a vegetable or horticultural oil and acts to suffocate insects.

- **Mode of action.** Neem is a complex mixture of biologically active materials, and it is difficult to pinpoint the exact modes of action of various extracts or preparations. In insects, neem is most active as a feeding deterrent, but in various forms it also serves as a repellent, growth regulator, oviposition (egg deposition) suppressant, sterilant, or toxin.

Trade names of products	Active substances of products	Target pest/disease	Agent / distributor
Amblytech	Amblyseius californicus (predatory mite)	Natural enemy for control of red spider mites (Tetranchus urticae) on vegetables and roses	Flamingo Horticulture (K) Ltd, Naivasha
Amblytech C	Amblyseius cucumeris (predatory mite)	Bioagent for control of thrips and spider mites on flowers in greenhouses	Flamingo Horticulture (K) Ltd, Naivasha
Aphitech	Aphididius transcapicus (parasitic wasp)	Natural enemy for control of aphids (Aphis spp. and Acrosiphum spp. on vegetables	Flamingo Horticulture (K) Ltd, Naivasha
Vectonil 50 WP	Bacillus thuringiensis	Larvicide to control mosquito larvae in breeding sites	Osho Chemicals Industries Ltd
BioDewcon 2% WP	Ampelomyces quisqualis (fungus)	Fungicide for control of powdery and downy mildew on courgettes and snowpeas	Osho Chemical Industries Ltd
BioCatch 1.15 WP	Verticillium lecanii (fungus)	Insecticide for control of aphids and whiteflies on roses, French beans and tomatoes	Osho Chemical Industries Ltd
Biokil WP	Bacillus thuringiensis var. kurstaki (bacterium)	Insecticide for control of thrips and African bollworms on French beans	Agrifarm Biologicals Ltd
Bio-Nematon 1.15 WP	Paecilomyces lilacinus (fungus)	Nematicide for control of Root-knot nematodes in French beans, roses and tomatoes	Osho Chemical Industries Ltd
Bio-Power 1.15 WP	Beauveria bassiana Strain GHA (fungus)	Insecticide for control of aphids and diamondback moth on cabbages	Osho Chemical Industries Ltd
Botanigard ES	Beauveria bassiana Strain GHA (fungus)	Biopesticide for control of sucking insects (aphids, thrips and whiteflies) on French beans and Snow peas	Amiran (K) Ltd
Delfin 6.4 WG	Bacillus thuringiensis var. kurstaki Strain SA-11 (bacterium)	Selective biological larvicide for control of Diamondback moth on brassicas and giant looper on coffee	Sineria (K) Ltd

Diglytech	**Diglyphus isaea (parasitic wasp)**	**Natural enemy for control of leafminers (Liriomyza spp.) on flowers and vegetables**	**Flamingo Horticulture (K) Ltd, Naivasha**
Dipel 2X	Bacillus thuringiensis var. kurstaki Strain ABTS-351 (bacterium)	Lepidopteran larvae (caterpillars) in coffee and horticultural crops	Safina (EA). Ltd
Dipel DF	Bacillus thuringiensis var. kurstaki Strain ABTS-351 (bacterium)	Selective biological larvicide for control of Lepidopteran larvae (caterpillars) (Helicoverpa armigera; Spodoptera exigua) plus leaf-rollers on carnation and roses	Safina (EA). Ltd
Ditera DC	Myrothecium verrucaria (fungus)	Nematodes in ornamentals	Safina (EA). Ltd
Eco-T WP	Trichoderma harzianum Strain k.d. (fungus)	Fungicide for control of soil-borne diseases (Fusarium, Pythium and Rhizoctonia)	Madumbi East Africa Ltd

LIME SULPHUR BREW

- Lime-Sulphur brew
- Use: The sulphur acts against pests and working together with microbiology forms sulphur oxide
- which helps break down organic matter.
- Ingredients:
- 100L of water

Spidex	**Phytoseiulus persimilis (predatory mite)**	**Biological control agent for control of red spider mites on roses**	**Koppert Biological Systems (K) Ltd**
Swirski-Mite	Amblyseius swirskii (predatory mite)	Macrobial pesticide for control of whiteflies on roses	Koppert Biological Systems (K) Ltd
Thripex	Amblyseius cucumeris (predatory mite)	Biological control agent for control of flower thrips and spider mites on carnation grown in greenhouses	Koppert Biological Systems (K) Ltd
Thuricide HP	Bacillus thuringiensis var. kurstaki (bacterium)	Lepidopteran larvae (caterpillars) on vegetables and giant looper on coffee	Farmchem (K) Ltd
Trianum-P 11.5 WP	Trichoderma harzianum Rifai Strain KRL-AG2 (T22) (fungus)	Biopesticide for control of soil-borne fungal diseases caused by Pythium, Rhizoctonia and Fusarium spp. in French beans and carnations	Koppert Biological Systems (K) Ltd
Trichotech	Trichoderma asperullum (fungus)	Biopesticide for control of soil-borne fungal diseases caused by Pythium, Rhizoctonia and Fusarium spp. in French beans, or the control of fusarium wilt in carnations	Flamingo Horticulture (K) Ltd, Naivasha
Xentari	Bacillus thuringiensis var. aizawai (bacterium)	Insecticide for control of giant looper on coffee and for the control of caterpillars on Roses and Carnations	Safina (EA) Ltd

- 20kg of sulphur
- 10kg of lime (Calcium oxide/quick lime is the best. NO agricultural lime)
- Notes:
- The mix of lime and sulphur is to make sulphur soluble.
- There are different concentrations of sulphur on the market (80-100%). The purer the better.

Process

- Boil the water
- - Mix the lime and the sulphur (break the lumps of sulphur) in dry conditions and add to the water.
- - Once the sulphur has become soluble mix for 20-30min on the surface of the mix to form a
- vortex then take off the fire. The mixture should be dark brick red when taken off the fire.
- - Let cool down, take of the upper layer that has formed and it is ready.

- Keep some cool water near the brews, when it gets too hot the water will rise and with a little
- cool water it will reduce in size again.
- This brew can last up to 12 months. To preserve put in a coloured (no light exposition) glass
- bottle and add a little oil at the top to prevent oxygen from reaching.
- The paste left at the bottom can be used to cover trees scars!! Very effective!!
- Application:
- - Dilute 3-5L in 100L of water (3-5%) and use as folia-spray