

PESTICIDES AND INSECTICIDES IN SOUTHERN AFRICA

By

David C. Munthali

Botswana College of Agriculture, P/Bag 0027,
Gaborone, Botswana

*A paper presented at the Regional Training
Seminar on Diseases of Honey Bees*

14 - 17 June 2011

OUTLINE OF PRESENTATION

- ▶ Pesticides and the development of Agriculture in Southern Africa
- ▶ Periods when honey bees face the greatest risk of pesticide poisoning
- ▶ Potential hazards to humans and honey bees from pesticide use in crop production
- ▶ Potential hazards to humans from use of pesticides in apiculture
- ▶ *Future direction on pesticides & insecticides in southern*

PESTICIDES & DEVELOPMENT OF AGRICULTURE IN SOUTHERN AFRICA



PESTICIDES IN A CHANGING AGRICULTURAL LANDSCAPE IN SOUTHERN AFRICA

- ▶ Increased urbanisation in all SADC countries
Causing high demand for food & fibre
- ▶ Resulting in a general shift from Subsistence to Commercial farming
Causing change in farmers' attitudes towards Pest Control
Also causing a general shift from "low value" to "high" value crops
- ▶ The term "Agribusiness" is becoming part of the language of agriculture in the region

HOW THE SHIFT IS CHANGING FARMERS' PERCEPTIONS OF CROP PESTS & DISEASES

- ▶ Yield losses that were tolerated in subsistence cropping systems are no longer tolerable
- ▶ Any losses caused by pests are now perceived as threatening the agribusiness
- ▶ Presence of any pests on crop plants are seen as threatening "profits"
- ▶ To remove this risk: "Effective Pest Control" is becoming the main objective of farmers
- ▶ *Farmers see Chemical control as offering the most reliable & demonstrable levels of pest control relative to cost of application*

CURRENT PERCEPTIONS OF PESTICIDES BY FARMERS IN SOUTHERN AFRICA

- ▶ Most commercial farmers perceive pesticides as crucial in their production systems
- ▶ Most believe that it is impossible to grow certain crops without applying pesticides
- ▶ Most either use calendar sprays or apply pesticides whenever they find any insect in their crop field
- ▶ Frequencies of 2 to 3 application per week are not unusual in high value crops
- ▶ *There is a growing over-reliance on pesticides by most commercial farmers in Southern Africa*

PROBLEMS ASSOCIATED WITH OVER-RELIANCE ON PESTICIDES

- ▶ Pesticide resistance in pest species that were previously controlled by them
- ▶ Outbreaks of new pests
- ▶ Adverse effects on non-target organisms including beneficial (natural enemies & pollinators like honey bees)
- ▶ Mammalian toxicity (including toxicity to humans)
- ▶ Pollution of the environment (the soil, water bodies & the air)

PESTICIDE POISONING OF HONEY BEES

- ▶ Occurs when:
- ▶ Worker bees are foraging for nectar, pollen & propolis from crop plants in a farm
- ▶ Workers forage for nectar, pollen & propolis from wild flowering plants in vegetation near the farm/garden
- ▶ Workers are foraging for water from polluted pools in farms and surrounding areas
- ▶ Workers collect nectar & pollen contaminated with pesticides
- ▶ *The greatest risk of honey bee poisoning is when major forage plants are in bloom*

PERIODS WHEN HONEY BEES FACE THE GREATEST RISK OF PESTICIDE POISONING

- ▶ When wild bee forage plants are in bloom
 - ▶ When cultivated forage plants are in bloom
 - ▶ During the build-up period and the honey flow periods
- 

FLOWERING PERIODS OF COMMON FORAGE PLANTS IN GABORONE (I: ACACIA SPECIES)

Forage species	Forage items	Period in bloom & Greatest risk of Bee poisoning
<i>A. erioloba</i>	Nectar & pollen	July - September
<i>A. mellifera</i>	Nectar & pollen	August - March
<i>A. robusta</i>	Nectar & pollen	August - October
<i>A. erubescens</i>	Nectar & pollen	August - October
<i>A. nigrescens</i>	Nectar & pollen	August - November
<i>A. caffra</i>	Nectar & pollen	September - November
<i>A. polycantha</i>	Nectar & pollen	September - December
<i>A. nilotica</i>	Nectar & pollen	September - April
<i>A. tortilis</i>	Nectar & pollen	November - January
<i>A. flekii</i>	Nectar & pollen	November - March

ACACIA SPECIES IN BLOOM



FLOWERING PERIODS OF COMMON FORAGE PLANTS IN GABORONE (WILD TREE SPECIES)

Forage species	Forage items	Period in bloom & Greatest risk of Bee poisoning
<i>Bolusanthus speciosus</i>	Nectar & pollen	August - September
<i>Schinus molle</i>	Nectar & pollen	August - October
<i>Terminalia sericea</i>	Nectar & pollen	September - December
<i>Berchemia discolor</i>	Nectar & pollen	October - January
<i>Tipuana tipuana</i>	Nectar & pollen	November - December
<i>Zizipus macrunata</i>	Nectar & pollen	November - February
<i>Bauhammia</i> spp.	Nectar & pollen	May - June
<i>Rhus lancea</i>	Nectar & pollen	June
<i>Dombeya rotandifoliia</i>	Nectar & pollen	August - October
<i>Combretum</i> spp.	Nectar & pollen	July - October

DOMBEYA ROTANDIFOLIA IN BLOOM



FLOWERING PERIODS OF COMMON FORAGE PLANTS IN GABORONE (CULTIVATED FORESTRY TREE SPECIES)

Forage species	Forage items	Period in bloom & Greatest risk of Bee poisoning
<i>Eucalyptus cammaldulensis</i>	Nectar, pollen & propolis	August - December
<i>E. tricortonis</i>	Nectar, pollen & propolis	August - December
<i>Grewia bicolor</i>	Nectar, pollen & propolis	October - January
<i>Grevillea robusta</i>	Nectar, pollen & propolis	November - January

FLOWERING PERIODS OF COMMON FORAGE PLANTS IN GABORONE (CULTIVATED FRUITS & VINES)

Forage species	Forage items	Period in bloom & Greatest risk of Pesticide Bee poisoning
Peach	Nectar & Pollen	June
Avocado	Nectar & Pollen	November - January
Citrus	Nectar & Pollen	August - September
Grape	Nectar & Pollen	July - August
Cucurbits	Nectar & Pollen	Any time (depending on weather)
Sunflower	Nectar & Pollen	Any time (depending on weather)

***FORAGING WORKER BEE CARRYING AWAY HER
LOAD OF POLLEN***



PESTICIDE HAZARDS TO HUMANS

- ▶ In SADC countries, pesticide hazards occur through:
- ▶ Direct contact with the skin; eyes during application (**Dermal toxicity**)
- ▶ Inhalation of air polluted with pesticide (drifting from farms or in fumigated enclosures)
- ▶ Consumption of contaminated food including honey & pollen (**Oral toxicity**)
- ▶ Drinking polluted water or using pesticide polluted water for bathing (**Oral toxicity**)

PESTICIDES COMMONLY USED IN CROP PRODUCTION IN BOTSWANA (SOURCE: OBOPILE *ET AL.*, 2008) & PUBLIC HEALTH

Type of Pesticide	Pesticide	Target Pests
Pyrethroids	Cypermethrin; Alpha-methrin; Beta-cypermethrin	DBM; White flies; American bollworm; Bagrada bug; Aphids; Locusts; Armyworms
Organo phosphates	Malathion; Dimethoate; Chlorpyrifos; Fenthion; Fenitrothion; Diazinon; Trichlorfon; Dichlorvos; Dimeton-s-methyl; Cyanophos	Fruit flies; DBM; Aphids; American; Leaf miners; Quelea
Carbamates	Methomyl; Carbaryl; Carbofuran	American bollworm; Bagrada bug; Cutworms; DBM; Aphids
Organochlorines	Endosulfan; Dicofol DDT	American bollworm; Red spider mites Mosquito control

**MAMMALIAN TOXICITY AND TOXICITY TO BEES:
SELECTED PESTICIDES USED IN HORTICULTURE IN
BOTSWANA (I: PYRETHROIDS)**

Pesticide	Mammalian toxicity (WHO Class)	Typical symptoms of bee poisoning
Cypermethrin	II	Regurgitation; Erratic movements; Paralysis; Death within short time
Alpha-cypermethrin	II	Regurgitation; Erratic movements; Paralysis; Death within short time
Deltamethrin	II	Regurgitation; Erratic movements; Paralysis; Death within short time
Beta-cyhalorin	II	Regurgitation; Erratic movements; Paralysis;

MAMMALIAN TOXICITY AND TOXICITY TO BEES: SELECTED PESTICIDES USED IN HORTICULTURE IN BOTSWANA (II: ORGANOPHOSPHATES)

Pesticide	Mammalian toxicity (WHO Class)	Typical symptoms of bee poisoning
Dichlorvos	Ib	Regurgitation; Disorientation; Paralysis; Distended abdomen; Wings held together & away from the body
Dimethoate	II	Regurgitation; Disorientation; Paralysis; Distended abdomen; Wings held together & away from the body
Chlorpyrifos	II	Regurgitation; Disorientation; Paralysis; Distended abdomen; Wings held together & away from the body
Malathion	III	Regurgitation; Disorientation; Paralysis; Distended abdomen; Wings held together & away from the body

MAMMALIAN TOXICITY AND TOXICITY TO BEES: SELECTED PESTICIDES USED IN HORTICULTURE IN BOTSWANA (III: CARBAMATES)

Pesticide	Mammalian toxicity (WHO Class)	Typical symptoms of bee poisoning
Carbaryl	II	Increased aggressiveness; Erratic movements; Inability to fly; Paralysis
Carbofuran	Ib	Increased aggressiveness; Erratic movements; Inability to fly; Paralysis
Methomyl (Lanate)	Ib	Increased aggressiveness; Erratic movements; Inability to fly; Paralysis

MAMMALIAN TOXICITY AND TOXICITY TO BEES: *SELECTED PESTICIDES USED IN HORTICULTURE IN BOTSWANA (IV: AVEMECTINS, SPINOSYNS & MICROOBIAL & INORGANICS)*

Pesticide	Mammalian toxicity (WHO Class)	Typical symptoms of bee poisoning
Abamectin	Ib	Relatively low
Spinosad	IV	Relatively low
<i>Bacillus thuringiensis</i>	IV	Minimum injury (Can be used around bees)
Mencozeb	IV	Relatively safe
Copperoxychloride	III	Relatively safe

RELATIVELY NEW & ENVIRONMENTALLY FRIENDLY PESTICIDES REGISTERED IN BOTSWANA (*SELECTED FROM MOA LIST*)

Type of Pesticide	Pesticide	Target Pests
Products of Actinomycetes (Avermectins)	Abamactin (Fermented product of <i>Streptomyces avermectilis</i>)	Mites, ticks (ectoparasites); Leaf miners; Mosquito larvae
Products of Actinomycetes (Spinosyns)	Spinosad (Fermented product of <i>Sacharopolyspora spinosa</i>)	Caterpillars (including DBM); Dry wood termites; Fruit flies
Microbial (Bacteria)	<i>Bacillus thuringiensis</i>	Caterpillars (including DBM)

EXAMPLE PESTICIDES CLASSIFIED BASED ON TOXICITY TO BEES (*SELECTED FROM MOA LIST OF REGISTERED PESTICIDES IN BOTSWANA*)

Highly toxic	Moderately hazardous	Can be used around bees	Relatively non-hazardous to bees
Carbaryl	Demeton	Allerine	Diquat
Cardofuran	Disulfoton	Bt	Captan
Chlorpyrifos	Endosulfan	Diflubenzuron (Dimilin)	Mencozeb
Diazinon	Metasystox	Dicofol	Maneb
Dichlorvos	Phorate	Natural pyrethrum	Copperoxychloride
Dimethoate		Tetradifon	Sulfur
Fenitrothion		Trichlorfon	
Malathion			

POTENTIAL HAZARDS FROM PESTICIDES & DRUGS USED IN APICULTURE



NEED FOR TESTING PESTICIDE RESIDUES IN HONEY

- ▶ *Pesticides and drugs used to treat colonies for the control of pests & diseases can leave pesticide residues in honey & bees wax*
- ▶ The ratio of residues in honey: Bees wax is estimated at about 1 : 9
- ▶ *Potential risk of poisoning is through consumption of :*
 - ▶ Honey In liquid form
 - ▶ Honey used as a sweetener
 - ▶ Honey used as a glazing agent in confectionary products

**ALLOWABLE DAILY INTAKE (ADI) OF PESTICIDES USED IN
APICULTURE & IN CROP PRODUCTION (FROM BOTSWANA GOV.
MOA LIST OF REGISTERED PESTICIDES)**

Pesticide	ADI (mg/kg bw/day)	Animal health	Crops
Amitraz (Acaricide)	0.01	Against ticks	Against mites
Commaphos (Acaricide)	-	Against ticks	-
Flumethrin (Acaricide)	0.004	Against ticks	Against mites
Malathion (Insecticide)	0.3	Against wide range of insects	Against wide range of insects
Permethrin (Insecticide)	0.05	Against wide range of insects	Against wide range of insects
Spinosad (Insecticide)	0.02	-	Against wide range of insects

**ALLOWABLE DAILY INTAKE (ADI) OF DRUGS USED IN
APICULTURE & IN ANIMAL HEALTH (*FROM LIST OF
DRUGS USED AT BCA ANIMAL CLINIC*)**

Drug	ADI (mg/kg bw/day)	Use in Animal health
Erythromycin	0.0007	Antibiotic against respiratory infections
Lincomycin hydrochloride	0.03	Antibiotic
Menensin	0.01	Antibiotic used in feeds and drinking water
Oxytetracycline	0.003	Broad spectrum antibiotic
Rifampicin	-	anti-tuberculosis drug
Streptomycin	-	Antibiotic against gram-negative bacteria
Sulfathiazol	No ADI allowed	Antibiotic
Tyrosin tarrate	0.03	Against respiratory diseases (Cattle Lung Disease)

FUTURE DIRECTION ON PESTICIDES & INSECTICIDES IN SOUTHERN AFRICA

- ▶ Research to identify efficient, safe and environmentally friendly use of pesticides
- ▶ Research and monitoring the impact of pesticides on bee colonies kept by farmers
- ▶ Analysis of bee products for pesticide and drug residues
- ▶ Training farmers and beekeepers on efficient use of pesticides and hazards caused by pesticides
- ▶ Training farmers on pollution of the environment caused by pesticides
- ▶ Advocacy among decision makers on importance of protection of the environment from pesticide pollution

THANK YOU FOR YOUR ATTENTION

