Pesticides and Other Chemicals in the Forest Protection

(The Use of Chemicals in the Forest Protection)

Chemical stuffs used in the Forest Protection

In the Forest Protection there are used many different chemical stuffs for various purposes with various effects

- **Pesticides**
- **Repellents**
- **Antifeedants**
- **Pheromones**
- **Biopreparations**

- Semiochemicals (chemical stuffs affecting animal behavior) – the subgroup are PHEROMONES
- Chemical analogues of Insect hormones
- Dessicants
- Antitranspirants
- Growth regulators
- Auxiliary agents (adjuvants) for final adjustment of preparations and liquids (surfactants = wetting agents, solvents, adherents, carrying agents, etc.)

Pesticides

- **Division of pesticides according to purpose of the use - type of target organism:**
- **ZOOCIDES :**

  - acaricides

  - nematocides

  - insecticides

  - moluscocides

  - rodenticides

- **PHYTOCIDES :**
  - **algicides**
  - **herbicides**
  - **arboricides**
- **FUNGICIDES**
- **BACTERICIDES**

Division of pesticides according to mode of action:

- Total = non-selective (active to all organisms- for example in insecticides, to all insects)
- Selective (active to a group of organisms – for example aphicides = active esspecially to aphids)
- Systemic (the active ingredient is absorbed by plant and distributed to all parts of the plant)
- Contact (only contact of the pesticide with pest organism is sufficient to provide activity of the pesticide)
- Digestive (the pesticide has to be swallowed and digested, to reach its activity)
- Fumigant (the insect is inoxicated by breathing, because the pesticide is active by its vapours)

- **Given preparation always integrates several of this features. For example:**
- **Organophosporous insecticides posses systemic, digestive and fumigating activity**
- **While insecticides from the group of synthetic pyrethroids posses quick contact activity (so-called „knockdown effect“) and in lower doses digestive and repelent activity**

(ofcourse, no preparation could be total and selective at the same time)

Active ingredient (a. i.)

- **Each preperation has to have an active ingredient (a. i.). Active ingredient is the potent portion of a compound, and actual agent with pesticidal activity, used as basis to estimate the chemical effect.**

The formulation of the preparation

- on the other hand, each preparation contains aditional substances, for example solvents, emulsifiators, tenzids, adhesives, pigments, filling agents etc. - and with the help of this so-called „adjuvants“ is the preparation ready to practical use (by spraying, dusting, painting, granules spreading, etc.) with its specific shape (form) (emulsifiable concentrate, liquid, dust, granules, paste)

= it is formulated

The formulation of the preparation

- Pesticide products very rarely consist of pure technical material. The a. i. is usually formulated with other materials and this is the product as sold, but it may be further diluted in use. Formulation improves the properties of a chemical for handling, storage, application and may substantially influence effectiveness and safety

- **The type of formulation is usually a part of the name of the preparation, and is here as an abbrevitation, for example:**

EC – emulsifiable concentrate
L – liquid
D – dust
G – granules
WP – wettable powder
DP – dipping powder
WG – wettable granules
DG – dipping granules (=wettable granules)
ODC – oil dispegable concentrate
RB – ready bait (ready to use in this shape)
ULV – Ultra Low Volume, aplication with ULV techniques

etc. (the abbrevitations of formulations are many)

The toxicity of a preparation is indicated with the help of LD_{50} – dosis lethalis media

- LD_{50} is the amount of a material, given all at once, which causes the death of 50% (one half) of a group of test animals. The LD_{50} is one way to measure the short-term poisoning potential (acute toxicity) of a preparation.

- The lower the LD_{50} is, the more toxic is the preparation.

- **Toxicologists can use many kinds of animals but most often testing is done with rats and mice. It is usually expressed as the amount of chemical administered (e.g., milligrams) per 100 grams (for smaller animals) or per kilogram (for bigger test subjects) of the body weight of the test animal. The LD50 can be found for any route of entry or administration but dermal (applied to the skin) and oral (given by mouth) administration methods are the most common.**

- The LD_{50} is sometimes noted in the label of the preparation.
- The LD_{50} is also tested with target organisms (and this is not noted in the labels).
- Most important thing is, that the praparatiom should be much more toxic to target organism, than to man, so the safety of the aplication would be ensured easily.

(LD_{50} to rat should be higher than LD_{50} to target organism)

Insecticides

- An insecticide is a pesticide used against insects in all developmental forms.

- Sub-groups of the insecticides exist as to group of insects intended, for example:
  - aphicides (active to aphids)
  - muscicides (active to flies)
  - acaricides (active to mites)
  - non-slelective insecticides (largest group with universal activity)

Insecticides – subgroups according to chemical composition

- **Much more significant sorting is according to chemical composition of the active ingredient**

- **When we know the group according to chemical composition, so we generaly know the mode of activity, and suitability to specific pest and situation in which we can use it, and even the safety of application and the danger for the environment.**

Insecticides -categories according to chemical composition

- Natural stuffs
- Anorganic compounds
- Dinitrophenols
- Organochlorine compounds
- Organophosphoric insecticides
- Carbamates
- Synthetic pyrethrins (pyrethroids)
- Others

(in some cases, also biopreparations with insecticidal activity is subgroup of insecticides)

Insecticides
- categories according to chemical composition

- **Natural stuffs:**

  - nicotine (*Nicotiana* spp.)

  - rotenoids (derris – *Derris eliptica*)

  - natural pyrethrins (*Pyrethrum* spp.)

  - nereistoxins

  (=NTX - *Lumbriconereis heteropoda*)

Insecticides
- categories according to chemical composition

- **Anorganic compounds:**

  - arsenic compounds (calcium arsenate, led arsenate

(not used today, in the past they were used as a dust – in mixture with talc)

Insecticides
- categories according to chemical composition

- **Dinitrophenols:**

  - DNOK (dinitro-o-cresol)

- not used today, because compound is toxic both to animals and plants. Dangerous to animals living in water (and drinking water)

Insecticides
- categories according to chemical composition

- **Organochlorine compounds:**

- **DDT, HCH (=BHC), Lindane, and others**

Well known insecticides, during WW II in military use, after the WW II also in civil use. Moderately toxic to humans and animals (in fact, no acute toxicity). Very stable (very slow or no decompositionin the environment). Strong affinity to lipids (easily dissolved with fats). Acumulating in fat reserves in the bodies of animals. Cumulative toxicity and other lateral effects.

Insecticides
- categories according to chemical composition

- **Organophosphoric compounds:**

- lateral result of military development of casualty poison agents (that is why they are active also to mamals and humans (acute toxicity)

- used principally as insecticides, some acaricides. Act by contact, inhalation or ingestion

Insecticides
- categories according to chemical composition

- **Carbamates (with insecticidal action):**

- chemical analogues of a natural alcaloid physostigmin (from the plant *Physostigma venenosum)*

- posses systemic and digestive action, some a.i. are esspecially active to aphids, some of them highly toxic to animals and humans

Furadan (a.i. carbofuran)

Pirimor (a.i. pririmifos-methyl)

Marshall (a.i. carbosulfan)

Insecticides
- categories according to chemical composition

- **Synthetic pyrethrins (= synthetic pyrethroids)**

- **synthetic pyrethrins are chemical analogues of natural pyrethrins (natural pyrethrins were isolated from the plant *Pyrethrum cinerariaefolium* – kind of marquerite).**

- **they are highly active to insects even in very low doses (strong „knockdown effect“). They posses a repelent activity also.**

- **are decomposed (rather quickly) by light. Are very harmfull to fishes and cold-blooded animals. To mammals irritant when the eyes or air passages are affected.**

(generally safe when applied, only irritant effect is frequent – when protection tools and clothes are not properly used.)

Insecticides
- categories according to chemical composition

- Vaztak (Fastac) – a.i. alpha- cypermethrine
- Karate - a.i. lambda-cyhalothrine
- Decis – a.i. deltamethrine
- Cymbush – a.i. cypermethrine
- Ambush – a.i. permethrine

Insecticides
- categories according to chemical composition

- **Nereistoxins – chemical analogues of natural stuff found in the seaworm *Lumbriconereis heteropoda***
- **(Nereistoxin - NTX;**
  4-N,N-dimethylamino-1,2-dithiolan)

- **Evisekt**
- **Cartap**

Fungicides

- Stuffs and preparations used to reduce the growth of the undesirable species of fungi
- Most fungicides act only on surface of the plant, they prevent germinating of fungal spores and the mycelium growth
- Systemic and curative (healing) action have only a few of fungicides

Fungicides
- categories according to chemical composition

- Anorganic fungicides
- Organic metallic compounds
- Dithiocarbamates and similar compounds
- Phenols
- Captan and similar compounds
- Chinones
- Systemic fungicides

Fungicides
- categories according to chemical composition

- **Anorganic fungicides (anorganic compounds)**

- sulphur (dusted or prepared as colloidal solution)

- sulphur-lime broth

- sulphur-copper broth (bordeaux broth) (a mixture of a $CuSO_4$ solution with „lime milk“ = milky lime suspension)

Fungicides
- categories according to chemical composition

- Metal organic compounds
- Mercury compounds (now forbidden, in the last century were used as seed disinfectants - treating seed before sowing)
- Tin compounds = organotin compounds

fungicides, - and moluscocides and miticides too (now in limited use)

- triphenyltin chloride
- triphenytltin acetate
- triphenyltin hydroxide

Fungicides
- categories according to chemical composition

- **Dithiocarbamates and similar compounds:**

  - Dithane (a.i. mancozeb)

- **Captan and similar compounds:**

  - Captan (a. i. captan)
  - Merpan (a. i. captan)

Fungicides
- categories according to chemical composition

- **Systemic fungicides (fungicides with systemic action):**

- preparations uptaked by plant by leaves or roots (sometimes injected ditectly to conductive tissues) and translocated into all parts of the plant. Systemic fungicides have curative effect (are capable to heal plants allready infected by fungi). Some of them have also negative side effect – growth inhibition.

Fungicides
- categories according to chemical composition

- **Systemic fungicides:**

- **dicarboximides, carboximides and carbamates**

- **thiocarbamates, organophosphoric fungicides and pyrimidins,**

- **inhibitors of sterol synthesis**

Herbicides

- **Stuffs, used to kill weeds.**

The definition of a weed: Weed is a plant, which grows on the improper place (from man point of wiew).

- **Most dynamic and qiuckly developing group of pesticides. Greatest incom for the producents and sellers.**

- **Herbicides can make the work in the field, forest or nursery easier, but frequently the environment is ballasted by undecomposed rests – so-called residues**

- **In some states (Austria, for example) is the application of hermicides in the freeland prohibited**

Herbicides
- categories according to chemical composition

- Anorganic compounds
- Carboxylic acids (phenoxyacids) and similar compounds
- Chlorinated alifatic carboxylic acids
- Aromatic carbamates and uric compounds
- Heterocyclic compounds
- Growth regulators
- Other stuffs and compounds

Herbicides
- categories according to chemical composition

- **Anorganic compounds:**

  - chlorides
  - copper salts
  - arsenic compounds
  - kalium chloride
  - DNOK (dinitro-o-kresol)

(no one of above mentioned is in use today)

Herbicides

- categories according to chemical composition

- **Carboxylic acids:**

- **derivates of phenoxy acetic acid (2,4 – dichlorphenoxyacetic acid = 2,4 D) (for example preparation Dicopur)**

- **2,4,5 – trichlorphenoxyacetic acid = 2,4,5 T (this a.i. was used in the preparation „Agent Orange“ used in Vietnam to defoliate the jungle – the environment is till today ballasted by 2,4,5T, but great problems the inhabitants have today are caused by**
- **dioxins = technical impurities of the 2,4,5 T)**

- **a.i. dichlobenil in the preparation Casoron (still in use)**

Herbicides

- categories according to chemical composition

- **Chlorinated alifatic carboxylic acids:**

- natrium salt of 2,2 – dichlorpropionic acid (the preparation Dalapon, today not in use)

- Trcichloracetic acid (TCA) – the a.i. triclopyr, preparation Garlon

Herbicides

- categories according to chemical composition

- **Aromatic carbamates and uric compounds:**

- preparation Maloran, a.i. chlorbromuron

Herbicides

- categories according to chemical composition

- **Heterocyclic compounds (triazins, bipyridylic compounds):**

- Gesatop (a.i. simazine)
- Geasagard (a.i. prometryn)
- Velpar (a.i. hexazinon)
- Gramoxone (a.i. paraquat)
- Reglone (a.i. diquat)

Herbicides

- categories according to chemical composition

- **Derivates of phosphoric acid:**

- Roundup (a.i. glyphosate)

- Basta (a.i. gluphosinate)

Herbicides

- categories according to chemical composition

- **Pyridins:**

- Fusilade (a.i. fluazifop-butyl)

The Register of Pestitices

- In the Czech Republic, each pesticide has to be tested and registered before use in agriculture or forestry.
- Even each machinery used in plant protection has to be tested and registered before use.
- The Register of Approved Pesticides is edited each year by State Phytosanitary Administration

The Application of Pesticides

(as important as knowledge of pesticides itself)

- **The goal of the pesticide application is to reach sufficient result of the treatment and eliminate or minimize side effects**

- the lowest essential amount of pesticide should be applied to the target without any drift

(that means to get the pesticide to the place it has to be, and dont vaste it on the places where it is useless or undesirable)

The Application of Pesticides

- To reach this reqirements we can use:

- suitable conditions in the time of application (weather, time when sensitive stage of pest is exposed, etc.)

- suitable method of application (spraying, dusting, injecting, painting, baiting, etc.)

- modifying of application mixture

- proper use of suitable application equipment

The Application of Pesticides

- The use and influencing of weather conditions:

- the air mowement should be slower then 3 m/s, in all cases not highest than 5 m/s
- dry weather is ideal, the spray should dry out untill first rain
- no direct sunlight, sunlight can damage the plants just after spraying (droplets act as a magnifying glass

(=ideal time to applicate pesticides by spraying is early morning or evening)

The Application of Pesticides

- **Modifying of the properties of the application mixture:**

- the choice of the carrying agent (water, oil, oil/water mixture, or other solvents)

- the modifying (lowering) of the surface tension of water dilution using surfactants

- the use of other helping agents, for example adherents, penetrants, etc.

The Application of Pesticides

- **Selection of application equipment suitable to intended purpose:**

- **for application of herbicides are used nozzles producing larger drops (heavy drops are falling down without drift)**
- **on the other hand, insecticide and fungicide application requires very small droplets, because all surface of the plant has to be covered = this helps to incease spray coverage**

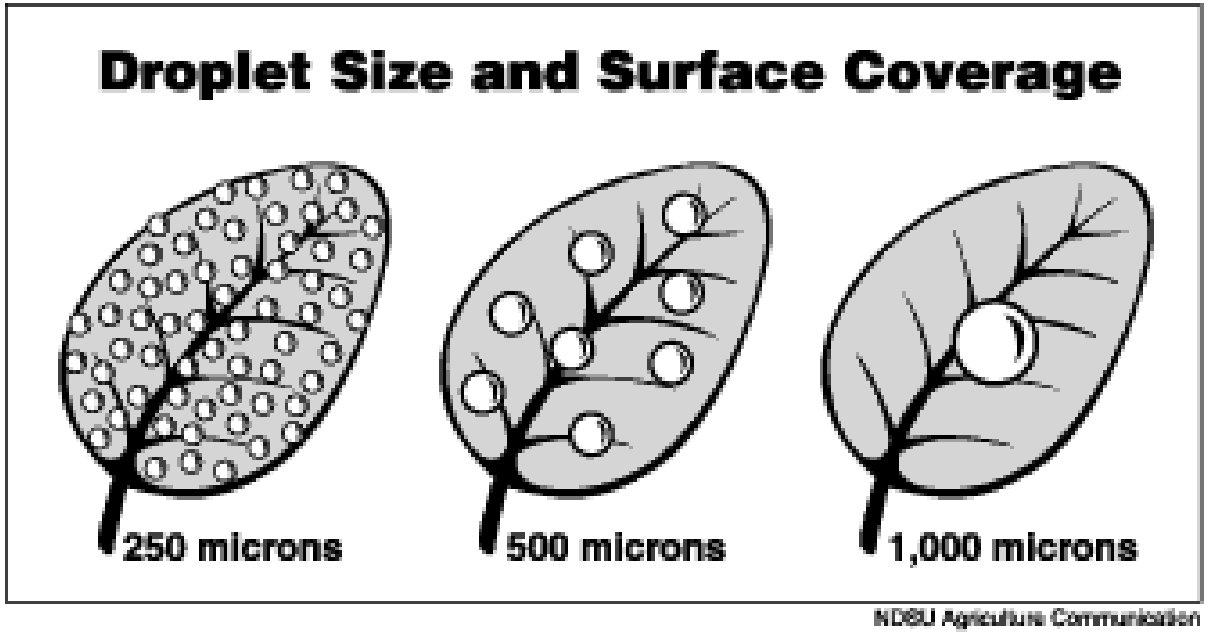
The Application of Pesticides

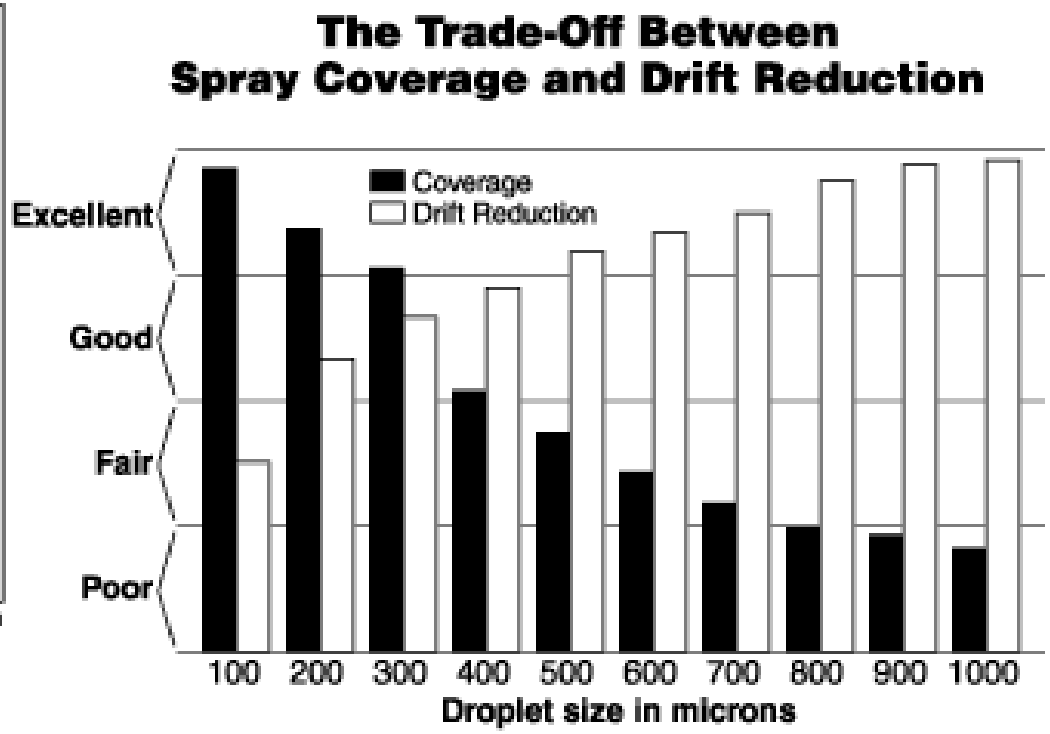
- **Spray coverage:**

- **Both:**

- % of the surface covered by droplets

- number of droplets per square centimeter


Droplet Size and Surface Coverage
250 microns
500 microns
1,000 microns
NDSU Agriculture Communication


The Trade-Off Between
Spray Coverage and Drift Reduction
Coverage
Drift Reduction
Excellent
Good
Fair
Poor
100 200 300 400 500 600 700 800 900 1000
Droplet size in microns

The Application of Pesticides

- **According to purpose of application:**

- **a suitable equipmet has to be chosen**

- **suitable nozzle should be chosen, cappable to produce desirable size of droplets (small/large droplets)**

The Application of Pesticides

- **Spray categories:**

- **600 microns + ……. coarse spray**
- **400 – 600 microns ……. medium/coarse spray**
- **300 – 400 microns …… medium spray**
- **200 – 300 microns ……fine/medium spray**
- **100 – 200 microns …….fine spray**
- **30- 50 microns …….. cold aerosol, ULV applications**
- **20-25 microns ……. ED (electrodynamic aplication)**
- **5 micronos …… warm aerosol**

Dusters

- **Used to applicate preparations formulated as a dust**

Duster for household and small scale use, the

JT Eaton 530 Hand Duster

- **The main disadvantage of dusting is a great drift of the dust – therefore is used only in special cases (not in the forestry)**

Compression sprayers

Small only for household use, larger can be used in forestry also (removable nozzle – various types nozzles available, better health safety)

Knapsack sprayer

The membrane pump is powered by lever (not visible in this picture), it is suitable for use in the forestry for pesticide application (herbicides, insecticides and fungicides)

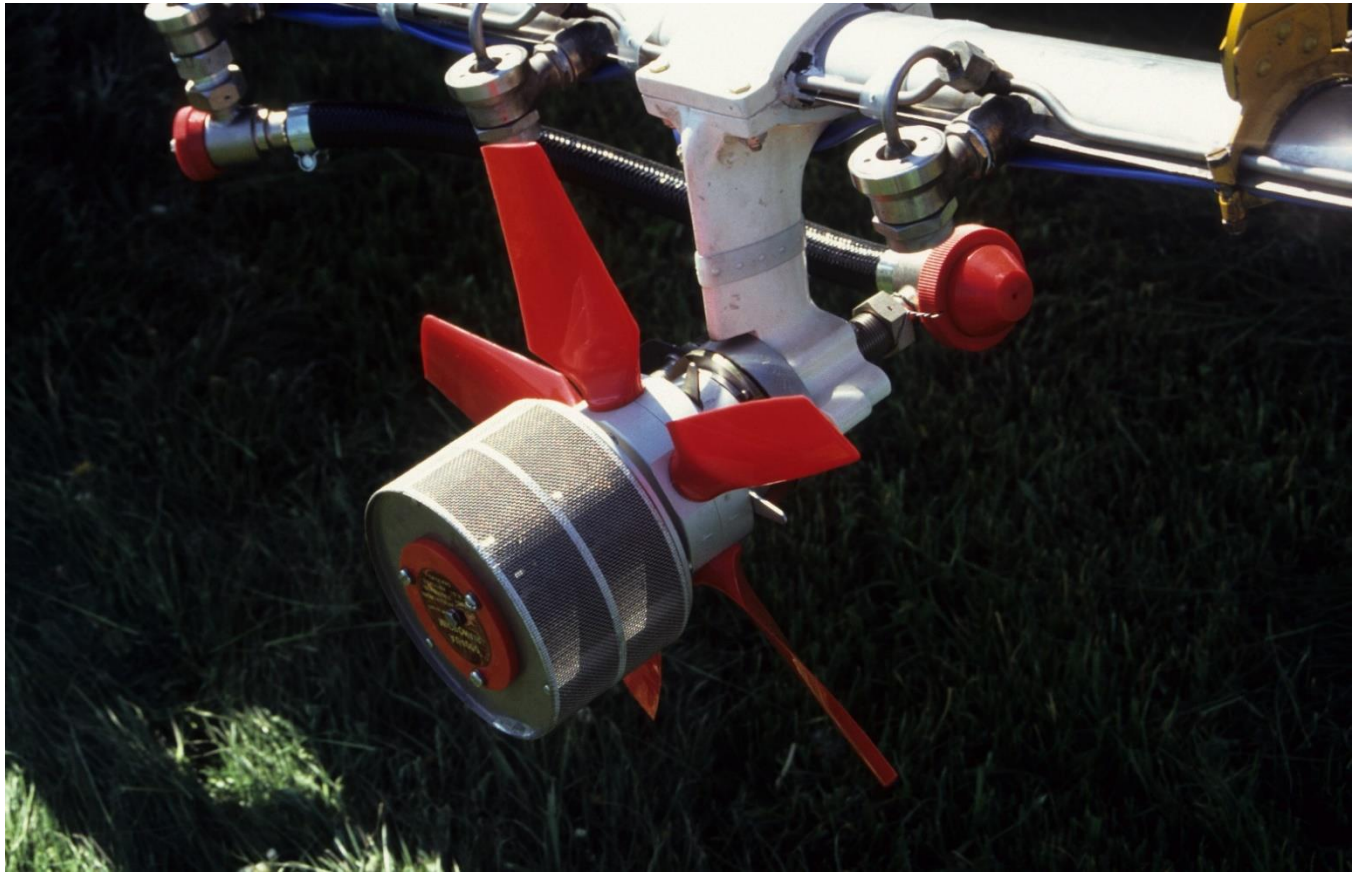
Engine sprayers

The „core“ of this spraers is a ventilator, powered by engine.

Rotary atomizers

- **Used in aerial application, mounted on airplanes.**

The rotary atomizer Micronaire AU 3000



Hot Aerosol Generators

- **Hot aerosol generator Igeba TF 35**

- used in greenhouses, stored products, in the forestry sometimes against greenflies of the family Adelgidae (in young stands)

Health safety

- **Storing of pesticides:**

- **special stores for pesticides (many special requirements must be provided)**

- **pesticides has to be stored separately from foodstuffs and rodenticid baits**

Health safety

- **Protective clothes and other protective tools:**

- the kind of protective clothes depends also on kind and toxicity of a preparation applied

- when preparation with fumigative activity is applied, or small droplets are produced, a face mask has to be worn

Health safety

- **A proper practice in application:**

- before application, read the label

- movement from sprayed areas to unsprayed
(= movement with back in upwind direction)

Health safety

- the liquidation of empty coverings and containers: the proper method of liquidation is usually noted on the label of preparation

- there is necessery a knowledge, how to act at accidents

- and how to give first aid

Legislative (laws)

- The Law no. 326/2004 statutes, on the Phytosanitary care
- The Regulation no. 329/2004 statutes, on Preparations and other stuffs used in plant protection
- The Regulation no. 333/2004 statutes, on the QualificationIn plant protection
- The Regulation no.334/2004 statutes, on the Machinery in the plant protection
- The Regulation no. 327/2004 statutes, on the Protection of bees, wild game, water life and other non-target organisms to preparations used in plant protection
- The Law no. 289/1995 statutes on the Forests (Forest Law)


CP15
CP3