A Basic Understanding of the Impacts of Pesticides and Fertilisers

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T E A M

Tesi Environmental Awareness Movement

The Tesi Environmental Awareness Movement (TEAM) is a newly established non-profit, non-governmental organization set up with a mission to revive the ecological consciousness of the Tibetan people by rekindling their traditional ecological values and by introducing them to modern, pro-nature ways of living.

TEAM aims to connect the ecological aspect of Tibetan spirituality with modern concepts of reform ecology and return as many Tibetans into stewards of Mother Nature.

TEAM aims to achieve these goals by: teaching school age Tibetans the foundations of ecological awareness; reminding adults their ecological-ethnic roots and exposing them to alternative, modern, eco-friendly lifestyles; guiding the monks and nuns on how to be engaged spiritual practitioners; and to become an organic seed source, a consultant body and a support system for the Tibetan organic farmers.

PREFACE

August 2003, I had my first opportunity to visit the Tibetan Settlements in South India. Being born and raised in Ladakh, the abundance of flat lands and greeneries impressed me at the first glance. As I stayed longer and learned more from the local agriculture extension officers about the history of this land, true picture started appearing and no longer I felt that I was on the lap of a healthy earth. On closer looks, I started seeing huge monoculture farms of maize and patches of cotton on droughty-soil, cracked, pale and malnourished.

As I probed more into the facts file of the land, I was told of a gross story of how a beautiful jungle, home of Indian Elephants and precious sandalwoods, was brought to this existing situation. Of course, land tillage and the settlement on the land could not be avoided, as those were the lands given to the Tibetan farmers. But how we have cultivated and managed the land, to me, seems quite disappointing. For the passed three and half decades, our farmers out of ignorance blindly followed India's model of so called "Green Revolution" pursued heavy conventional farming using hybrid seeds, fertilizers and pesticides, without crop rotation, water harvesting and composting. All these methods proved fatal to the land, as she is now sick and malnourished.

Fortunately, with the presence of our great leadership, some hopes still remain. Since 2000, the Tibetan Government-in-Exile has been planting the idea of organic faming in our farmers and even issued directives on zero tolerance towards use of pesticides and fertilizers. Still, osmosis is slow and not all farmers have transformed.

In this road to transformation, here is our contribution, as a start, to the agriculture extension officers (AEOs), a list

all the major man-made chemical additives used in our farms and their harmful effects.

The information are gathered from various sources and the used sources are listed below every chapter. The backgrounds of the sources are in the chapters 'Information on Resources'.

The materials have been mapped according to a standard format that includes general information, uses, effect and health and environmental effects. Although, we have no detailed information on the natural alternative to chemical pesticides, we have provided some information whenever available.

We hope this helps our AEOs and our farmers a little in realising how we are poisoning our future and ourselves.

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FERTILIZERS

NPK (nitrogen, phosphate, potassium):
N based:
Nitrate
Urea (46% nitrogen)

P based:
DAP (Diammonium phosphate)
SSP (Single Super Phosphate)
PSM (Phosphate Solubilizing Microorganisms)

K based:
Potash (potassium)
MoP (Muriate of Potash)

IFFCO (Indian Farmers Fertilizers Co-operative Limited):
A co-operative society engaged in the production and distribution of fertilizers. It caters to the specific requirements of farmers and aims to bridge the demand supply gap in the country. IFFCO's main thrust has been the production and distribution of mineral fertilizers.

PESTICIDES

The four main classes of insecticides are organophosphates, carbamates, chlorinated hydrocarbons, and insecticides derived from plants (botanical). Organophosphate and carbamate insecticides act by inhibiting acetylcholinesterase, the enzyme that degrades acetylcholine (the messenger of the parasympathetic nervous system). As a result, acetylcholine levels remain high, exaggerating the normal functions of the parasympathetic system. Effects such as salivation, lacrimation, urination, defecation, twitching of the skeletal muscles, and in severe poisoning, death from respiratory depression occur.

Chlorinated hydrocarbons used as insecticides, such as chlorophenothane (DDT), are larger molecules than the chlorinated hydrocarbons used as organic solvents, such as chloroform. The former stimulates the central nervous system; the latter depress it. The major toxic effect produced by these insecticides is convulsions.

In general, insecticides derived from plants are low in toxicity. Pyrethrins are widely used insecticides in the home. They have a rapid "knockdown" for insects and have a low potential for producing toxicity in humans. The major toxicity of pyrethrins is allergy.

Herbicides are chemicals used to kill plants. Their potential to produce toxicity in humans is rather low.

Sources

Encyclopedia Britannica

Pesticides - Chlorinated Hydrocarbones

DDT
Endosulfan

DDT Insecticide

General information

DDT (dichlorodiphenyltrichloroethane) is an organochlorine insecticide. It is also called 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane. DDT is available in several different forms: aerosol, dustable powder, emulsifiable concentrate, granules, and wettable powder.

Pure DDT is a colourless, crystalline solid. The commercial product, which is usually 65 to 80 percent active compounds, along with related substances, is an amorphous powder. DDT is applied as a dust or by spraying its aqueous suspension.

Trade or other names include Anofex, Cesarex, Chlorophenothane, Dedelop, pÕ-DDT, Dichlorodiphenyl-trichloroethane, Dinocide, Didimac, Digmar, ENT 1506, Genitox, Guesapon, Guesarol, Gexarex, Gyron, Hildit, Ixodex, Kopsol, Neocid, OMS 16, Micro DDT 75, Pentachlorin, Rukseam, R50 and Zerdane (79,73).

Uses

DDT's insecticidal properties were discovered in the 1930s. During the Second World War DDT was used for crop protection as well as protection of troops from malaria and typhus. Regardless of some proved negative effects, DDT's efficacy and low-production costs made it the most widely used agricultural insecticide in the world from 1946 to 1972.

DDT was found to be effective against lice, fleas, and mosquitoes (the carriers of typhus, of plague, and of malaria and yellow fever, respectively) as well as the Colorado potato beetle, the gypsy moth, and other insects that attack valuable crops.

DDT prevented many human deaths due to malaria. Some mosquitoes became "resistant" to DDT. There is evidence that anti-malarial operations did not produce the mosquito resistance. Farmers, especially cotton growers, can lay that to the intemperate and inappropriate use of DDT. They used the insecticide at levels that would accelerate, if not actually induce, the selection of a resistant population of mosquitoes.

Currently, DDT's only official use, as specified by the World Health Organisation (WHO), is for the control of disease vectors in indoor house spraying although other (illegal) uses are suspected.

Effect

DDT is highly toxic toward a wide variety of insects as a contact poison that apparently exerts its effect by disorganising the nervous system.

Health Effects

DDT enters the body through food such as fruits, vegetables, meat, fish, and poultry, especially imported foods that are contaminated by it. DDT is found in soil, and can be transferred to crops grown on this soil. Root and leafy vegetables contain the highest amounts. DDT accumulates in fatty tissues. Infants may be exposed through breast milk

DDT is a probable human carcinogen, it damages the liver, it temporarily damages the nervous system, it reduces reproductive success and can cause liver cancer and birth defects. The immune system is affected by it. Ingestion or exposure may cause excitability, tremors, seizures, rashes, confusion, convulsions and parethesia (paralysis) of the tongue and lips. Women whose breast milk contains higher levels of DDE - a breakdown product of DDT - lactate for shorter periods of time.

Environmental Effects

DDT is very highly persistent in the environment and is immobile in most soils. Breakdown products in the soil environment are DDE and DDD, which are also highly

persistent and have similar chemical and physical properties. DDT does not appear to be taken up or stored by plants to a great extent.

DDT may be slightly toxic to practically non-toxic to birds. In birds, exposure to DDT occurs mainly through the food web through predation on aquatic and/or terrestrial species having body burdens of DDT, such as fish, earthworms and other birds. There has been much concern over chronic exposure of bird species to DDT and effects on reproduction, especially eggshell thinning and embryo deaths. DDT is very highly toxic to many aquatic invertebrate species. In addition to acute toxic effects, DDT may bio-accumulate significantly in fish and other aquatic species, leading to long-term exposure. This occurs mainly through uptake from sediment and water into aquatic flora and fauna, and also fishes. Earthworms are not susceptible to acute effects of DDT and its metabolites at levels higher than those likely to be found in the environment, but they may serve as an exposure source to species that feed on them. DDT is non-toxic to bees.

Problems related to extensive use of DDT began to appear in the late 1940s. Many species of insects developed resistance to DDT. The high stability of the compound leads to its accumulation in insects that constitute the diet of other animals.

The chemical stability of DDT and its fat solubility compound the problem. Animals do not metabolise DDT very rapidly; instead, it is deposited and stored in the fatty tissues. The biological half-life of DDT is about eight years; that is, it takes about eight years for an animal to metabolise half of the amount it assimilates. If ingestion continues at a steady rate, DDT builds up within the animal over time.

Findings about the toxicity of DDT led to restrictions and bans in the U.S., Canada, and most European countries in the early 1970s. Other parts of the world continue to use DDT in agricultural practices and in disease-control

programs.

In December 2000, over 120 countries finalised a treaty to phase out persistent organic pollutants (POPs), a dangerous class of chemicals that includes DDT. The treaty still allowed for its continued limited use for malaria control.

Alternatives

A report released by WWF, "Disease Vector Management for Public Health and Conservation" demonstrates that a variety of innovative mechanisms can control malaria and other diseases just as effectively as DDT. These alternatives are less harmful to the environment and human health. They include pesticide-impregnated bednets (which reduce the need for indoor spraying); odour-baited cloth targets to attract and destroy disease-carrying insects; lower-risk pesticides used in rotation to avoid the development of resistance; and widespread elimination of mosquito breeding grounds and introduction of natural predators.

According to WWF, pesticides widely being introduced to replace DDT, particularly various synthetic pyrethroids, also have been associated with disruption of the endocrine system and adverse reproductive, developmental, immunological, neurological and behavioural outcomes. The dilemma is that both malaria and the chemicals used to control it pose a threat to human health.

Sources

http://ace.ace.orst.edu/info/extoxnet/pips/ddt.htm
http://www.worldwildlife.org/toxics/progareas/pop/ddt.htm
http://www.ems.org/pops/ddt.html
Encyclopedia Brittannica

Endosulfan Pesticide

General Information

Endosulfan is a chlorinated hydrocarbon insecticide and acaricide of the cyclodiene subgroup. Formulations of endosulfan include emsulsifiable concentrate, wettable

powder, ultra-low volume (ULV) liquid, and smoke tablets. It is compatible with many other pesticides and may be found in formulations with dimethoate, malathion, methomyl, monocrotophos, pirimicarb, triazophos, fenoprop, parathion, petroleum oils, and oxine-copper. **The chemical name is** 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzadioxathiepin 3-oxide.

Trade or other names for the product include Afidan, Beosit, Cyclodan, Devisulfan, Endocel, Endocide, Endosol, FMC 5462, Hexasulfan, Hildan, Hoe 2671, Insectophene, Malix, Phaser, Thiodan, Thimul, Thifor, and Thionex.

Uses

Endosulfan is used to control insects on food and non-food crops. It acts as a poison to a wide variety of insects and mites on contact. Although it may also be used as a wood preservative, it is used primarily on a wide variety of food crops including tea, coffee, fruits, and vegetables, as well as on rice, cereals, maize, sorghum, or other grains.

Effect

Stimulation of the central nervous system is the major characteristic of endosulfan poisoning.

Health Effects

Endosulfan is highly toxic via the oral route. It is also highly toxic via the dermal route. Endosulfan may be only slightly toxic via inhalation. Stimulation of the central nervous system is the major characteristic of endosulfan poisoning. Symptoms noted in acutely exposed humans include those commons to the other cyclodienes, e.g., incoordination, imbalance, difficulty breathing, gagging, vomiting, diarrhoea, agitation, convulsions, and loss of consciousness.

Endosulfan affects the central nervous system and prevents it from working properly. Hyperactivity, nausea, dizziness, headache, or convulsions have been observed in adults exposed to high doses. Severe poisoning may result in death.

Studies of the effects of endosulfan on animals suggest that long-term exposure to endosulfan can also damage the kidneys, testes, and liver and may possibly affect the body's ability to fight infection. However, it is not known if these effects also occur in humans.

It is unlikely that endosulfan will cause reproductive and teratogenic effects in humans at expected exposure levels. Evidence suggests that exposure to endosulfan may cause mutagenic effects in humans if exposure is great enough.

Environmental Effects

Endosulfan enters the air, water, and soil during its manufacture and use. Endosulfan on crops usually breaks down in a few weeks, but endosulfan sticks to soil particles and may take years to completely break down. Endosulfan does not dissolve easily in water. Endosulfan in surface water is attached to soil particles floating in water or attached to soil at the bottom. Endosulfan can build up in the bodies of animals that live in endosulfan-contaminated water.

Endosulfan is highly to moderately toxic to bird species. It is very highly toxic to fish and aquatic invertebrates studied. It is moderately toxic to bees and is relatively non-toxic to beneficial insects such as parasitic wasps, ladybird beetles, and some mites.

Exposure to endosulfan has resulted in both reproductive and development effects in non-target animals, particularly birds, fish and mammals.

Sources

http://ace.ace.orst.edu/info/extoxnet/pips/endosulf.htm
http://www.atsdr.cdc.gov/tfacts41.html
http://www.epa.gov/oppsrrd1/reregistration/endosulfan/
Encyclopaedia Britannica

PESTICIDES - CARBAMATES

Carbendazim
Mancozeb

CARBENDAZIM FUNGICIDE

General Information

Carbendazim is a systemic benzimidazole fungicide (methyl 2-benzimidazole carbamate) that is used in plant disease control. The chemical name is methyl benzimidazol-2-ylcarbamate ($C_9H_9N_3O_2$).

Uses

Carbendazim is used to control a broad range of diseases on arable crops (cereals, oilseed rape), fruits, vegetables and ornamentals. It is also used in post-harvest food storage, and as a seed pre-planting treatment. It is frequently sold in combination with other fungicides, such as triazoles, dithiocarbamates and dicarboximides.

Carbendazim has extensive applications worldwide. Over the years, there has been a gradual reduction in carbendazim use. This is because modern conazole and strobilurin fungicides are more efficacious.

Effect

Carbendazim works by inhibiting the development of fungi probably by interfering with spindle formation at mitosis (cell division). Thus, it interferes with cellular respiration.

Health Effects

Carbendazim is a suspected endocrine disruptor that is believed to affect hormone function. Some studies found evidence that carbendazim disrupts reproduction (damage to the development of mammals in the womb and the development of sperm and testicular development). Some scientists concluded that there were only minor signs of reproductive toxicity at high doses and no effects on http:/

development in the absence of maternal and/or paternal toxicity. Carbendazim affects the number of chromosomes even at low exposures and it is obvious that carbendazim is a potent aneugen.

For agricultural workers, occupational exposure during manufacture or use is considered to be within acceptable levels. Carbendazim is of low toxicity to rodent and non-rodent species via the oral, dermal, inhalation and intraperitoneal routes.

Environmental Effects

Carbendazim is a fungicide of major concern due to its suspected hormone disrupting effects. Carbendazim is said to be harmful to fish or other aquatic life. However, it is probable that this high toxicity is unlikely to be seen in the field, because carbendazim is strongly adsorbed to sediment. Sediment-living organisms would probably receive high exposure, it is unsurprising that it may diminish earthworm populations. Carbendazim has a low acute toxicity for birds.

Carbendazim has a half-life (time taken for half the sample to decay) of 6-12 months on bare soil and 3-6 months on turf and is mainly decomposed by microorganisms. One study demonstrated that whilst carbendazim had some effect on soil microflora, the effects were never long lasting and concluded it had low toxicity against microbial activities. Plants readily absorb carbendazim, leading to concerns over phytotoxicity. One study on tobacco found evidence of weak phytotoxicity, meaning it could be damaging to healthy, non-target plants, especially at higher doses.

Resistance is a very serious problem. It has been seen in, for example, apple scab, eyespot and *Botrytis*. To combat resistance, carbendazim is often combined with other fungicides with different modes of action and integrated plant disease management strategies are being developed.

Sources

http://www.pan-uk.org/pestnews/Actives/Carbenda.htm

/www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/JMPR/Download/94/carbend.pdf
http://members.aol.com/rccouncil/ourpage/samples.htm

Mancozeb Fungicide

General Information

Mancozeb is a co-ordination product of zinc ion and manganese ethylene bisdithiocarbamate (EBDCs). Mancozeb is available as dusts, liquids, water dispersible granules, as wettable powders, and as ready-to-use (R-T-U) formulations.

Formulations: Commercial mancozeb products generally contain one or more inert ingredients. An inert ingredient is anything added to the product other than an active ingredient. Dithane M-45 wettable Powder contains: mancozeb (80%: manganese^{++}, 16%; zinc^{++}, 2%; ethylene bisdithiocarbamate ion, 62%) and inert ingredients (20%: talc, 2-3%; related reaction products, 6-8%; calcium lignosulfonate, 3-4%; water, 1-2%)
Some trade names include Dithane M-45, Manzate 200, Mancozeb, Fore, Green-Daisen M, Karamate, Mancofol,Zimaneb, Manzeb, Policar, Dithane- Ultra Nemispot, Nemispor, Riozeb, Mancozin, Manzin. Common names include mancozeb and manzeb.

Uses

The EBDCs are fungicides used to prevent crop damage in the field and to protect harvested crops from deterioration in storage or transport. Mancozeb is used to protect many fruit, vegetable, nut and field crops against a wide spectrum of diseases, including potato blight, leaf spot, scab (on apples and pears) and rust (on roses). It is also used for seed treatment of cotton, potatoes, corn, safflower, sorghum, peanuts, tomatoes, flax and cereal grains. Mancozeb is not taken up from the soil by plants. It is a combination of two other chemicals of this class, maneb and zineb.

Effect
Mode of action: Mancozeb is classified as a contact fungicide with preventive activity. It inhibits enzyme activity in fungi by forming a complex with metal-containing enzymes including those involved in production of adenosine triphosphate (ATP).

Health Effects
The potential for adverse health effects from contacting or consuming treated vegetation, water or animals are considered low because the expected exposure levels are below the lowest level which should cause harmful effects.

Mancozeb has low acute toxicity in humans and experimental animals. Acute poisoning by mancozeb is highly unlikely unless large amounts are ingested. If very large amounts of mancozeb should be ingested, expected effects would be convulsions, temporary kidney failure, and thyroid malfunction. Case studies of long-term exposure to the normal levels of the active ingredient in mancozeb formulations show no discernible effects.

Health effects of exposure to mancozeb formulations may cause irritation of the nose, throat, eyes and skin. Based on the results of animal studies, Mancozeb is not classified as a carcinogen, mutagen, teratogen or reproductive inhibitor.

The ethylene bisdithiocarbamate pesticides (EBDCs), which include mancozeb, are generally considered to have low short-term mammalian toxicity. A major toxicological concern, however, is ethylenethiourea (ETU), an industrial contaminant and a breakdown product of mancozeb and other EBDC pesticides. In addition to having the potential to cause goiter, a condition in which the thyroid gland is enlarged, this metabolite has produced birth defects and cancer in experimental animals.

Environmental Effects
Mancozeb is not generally active in the soil. Mancozeb rapidly degrades in the soil into numerous secondary products,

principally ethylenethiourea (ETU), and eventually CO_2.
Plants can absorb ETU. ETU is fairly stable, water soluble and mobile, and is important because of its specific thyroid toxicity.

Because mancozeb is practically insoluble in water it is unlikely to infiltrate groundwater. Studies do indicate that ETU has the potential to move through the soil as a result of groundwater movement, in a process called leaching.

Reductions in the population of soil organisms, and in soil nitrification have been reported at concentrations ranging from normal to 10 times the normal field application rates. These changes have been temporary and reversed within three months. Mancozeb is toxic to a few plants such as dwarf French marigold at normal field application rates. Pollen germination of muskmelon and cran berries is also sensitive.
Mancozeb is moderately toxic to highly toxic to fish and aquatic invertebrate animals. It is only slightly toxic to crayfish. The fungicide and its metabolite, ETU, breaks down rapidly in water, and neither would be expected to bioaccumulate (build up) in fish and other aquatic organisms.
Mancozeb is practically non-toxic to birds and mammals, and non-hazardous to honey bees. Among beneficial arthropods, only predatory mites are sensitive to mancozeb. Mancozeb is of low toxicity to earthworms. Mancozeb may be a hazard to endangered species if it is applied to areas where they live.

Sources
http://ace.ace.orst.edu/info/extoxnet/pips/mancozeb.htm

PESTICIDES - ORGANOPHOSPHATES

Dimethoate
Chlorpyrifos

DIMETHOATE INSECTICIDE

General Information
Dimethoate is an organophosphate insecticide. The chemical name is $C_5H_{12}NO_3PS_2$. Dimethoate is available in aerosol spray, dust, emulsifiable concentrate, and ULV concentrate formulations. It is applied using ground and aerial equipment.

Trade names include Cekuthoate, Chimigor 40, Cygon 400, Daphene, De-Fend, Demos NF, Devigon, Dimate 267, Dimet, Dimethoat Tech 95%, Dimethopgen, Ferkethion, Fostion MM, Perfekthion, Rogodan, Rogodial, Rogor (300g/L dimethoate), Roxion, Sevigor, Trimetion.

Uses
An insecticide and acaricide which is used in housefly control and against a broad range of agricultural insect and mite pests. It is active after metabolism, both as a contact and as a systemic insecticide. It is used on ornamental plants, vegetables, fruits, tobacco and wheat.

Effect
Dimethoate is one of a class of insecticides referred to as organophosphates. These chemicals act by interfering with the activities of cholinesterase, an enzyme that is essential for the proper working of the nervous systems of both humans and insects.

As a systemic, dimethoate is taken up into the roots of plants and translocated to aboveground parts, where it is toxic to any sucking insect feeding on the plant juices (e.g., aphids, leafhoppers, and thrips). Caterpillars and other chewing pests are not killed by dimethoate because not enough juice-containing tissue is ingested to be effective.

Health Effects
Acute and chronic risks from food treated with dimethoate are expected to be below the level of concern. Drinking water is expected to account for a small portion of dietary risk. When combined with exposure from food, the levels of concern are not exceeded for both acute and chronic

exposures, for moist ures.

The organophosphate insecticides are cholinesterase inhibitors. They are highly toxic by all routes of exposure. When inhaled, the first effects are usually respiratory and may include bloody or runny nose, coughing, chest discomfort, difficult or short breath, and wheezing due to constriction or excess fluid in the bronchial tubes. Skin contact with organophosphates may cause localised sweating and involuntary muscle contractions. Eye contact will cause pain, bleeding, tears, pupil constriction, and blurred vision. Following exposure by any route, other systemic effects may begin within a few minutes or be delayed for up to 12 hours. These may include pallor, nausea, vomiting, diarrhoea, abdominal cramps, headache, dizziness, eye pain, blurred vision, constriction or dilation of the eye pupils, tears, salivation, sweating, and confusion. Severe poisoning will affect the central nervous system.

Some organophosphates may cause delayed symptoms beginning 1 to 4 weeks after an acute exposure, which may or may not have produced immediate symptoms.

Environmental Effects

Except for a few uses with the highest application rates, dimethoate does not pose a significant acute risk to birds. Acute risks to aquatic invertebrates resulting from surface run-off to rivers and streams are high. Acute risks of concern to mammals may result from some uses of dimethoate use, based on study results. Dimethoate is highly toxic to bees on an acute basis.

Since predicted maximum levels of dimethoate are low and not expected to persist in water, the Agency does not have concern for chronic toxicity.

Dimethoate is biodegradable. It undergoes rapid degradation in the environment and in sewage treatment plants. Dimethoate breaks down faster in moist soils. Most soil

8 days, with disappearance possibly due to microbial action or chemical degradation. Dimethoate is not toxic to plants.

Sources
http://www.epa.gov/pesticides/op/dimethoate/dimethsumm.htm
http://pmep.cce.cornell.edu/profiles/extoxnet/dienochlor-glyphosate/dimethoate-ext.html
Encyclopaedia Britannica

Chlorpyrifos Insecticide

General Information
Chlorpyrifos is one of the most widely used insecticides. This product is a broad-spectrum chlorinated organophosphate insecticide. **The chemical name is** O, O-diethyl O-3, 5, 6-trichloro-2-pyridyl phosphorothioate. It is available as granules, wettable powder, dustable powder and emulsifiable concentrate.

Trade names include Brodan, Detmol UA, Dowco 179, Dursban, Empire, Eradex, Lorsban, Paqeant, Piridane, Scout, and Stipend.

Uses
Chlorpyrifos is registered for the control of cutworms, corn rootworms, cockroaches, grubs, flea beetles, flies, termites, fire ants, mosquitoes, and lice. It is used as an insecticide on grain, cotton, fruit, nut, and vegetable crops, as well as on lawns and ornamental plants. It is also registered for direct use on sheep and turkeys, for horse site treatment, dog kennels, domestic dwellings, farm buildings, storage bins, and commercial establishments.

Effect
Chlorpyrifos acts on pests primarily as a contact poison, with some action as a stomach poison. Chlorpyrifos primarily affects the nervous system through inhibition of cholinesterase, an enzyme required for proper nerve

micro-organisms rapidly break it down. In water, dimethoate is not expected to adsorb to sediments or suspended particles, nor to bioaccumulate in aquatic organisms. It is subject to significant hydrolysis, especially in alkaline waters. The half-life for dimethoate in raw river water was functioning. Chlorpyrifos is effective against a wide range of plant-eating insect pests.

Health Effects

Chlorpyrifos is moderately toxic to humans. Poisoning from chlorpyrifos may affect the central nervous system, the cardiovascular system, and the respiratory system. It is also a skin and eye irritant. While some organophosphates are readily absorbed through the skin, studies in humans suggest that skin absorption of chlorpyrifos is limited. Symptoms of acute exposure to organophosphate or cholinesterase-inhibiting compounds may include the following: numbness, tingling sensations, in-coordination, headache, dizziness, tremor, nausea, abdominal cramps, sweating, blurred vision, difficulty breathing or respiratory depression, and slow heartbeat. Very high doses may result in unconsciousness, incontinence, and convulsions or fatality.

Repeated or prolonged exposure to organophosphates may result in the same effects as acute exposure including the delayed symptoms. Other effects reported in workers repeatedly exposed include impaired memory and concentration, disorientation, severe depressions, irritability, confusion, headache, speech difficulties, delayed reaction times, nightmares, sleepwalking, and drowsiness or insomnia. An influenza-like condition with headache, nausea, weakness, loss of appetite, and malaise has also been reported.

Environmental Effects

In animals, chlorpyrifos transforms to chlorpyrifos-oxon, which is about 3000 times as potent against the nervous system as chlorpyrifos itself. Chlorpyrifos is acutely toxic to bees, birds, mammals and aquatic life. It poses a serious

hazard to honeybees. It bio-accumulates in aquatic organisms.

The persistence is moderate in soil. Chlorpyrifos adsorbs strongly to soil particles and it is not readily soluble in water. It is therefore immobile in soils and unlikely to leach or to contaminate groundwater. Chlorpyrifos may be toxic to some plants, such as lettuce. Residues remain on plant surfaces for approximately 10 to 14 days. Data indicate that this insecticide and its soil metabolites can accumulate in certain crops. The half-life of chlorpyrifos in water is relatively short, from a few days to two weeks. It adsorbs readily to sediments and organic matter. The major biological metabolite and environmental breakdown product is TCP.

Sources

http://ace.ace.orst.edu/info/extoxnet/pips/chlorpyr.htm
http://www.beyondpesticides.org
http://www.pan-uk.org/pestnews/actives/chlorpyr.htm

Herbicides - Triazine

Simazine

Simazine Herbicide

General Information

Simazine is a selective triazine herbicide ($C_7H_{12}N_5C_l$) used to control weed especially among crop plants. The chemical class is triazine. Simazine is available in wettable powder, water dispersible granule, liquid, and granular formulations. Methods of application include broadcast, band, soil incorporation, and ground or aerial soil surface spraying Trade names include Aquazine, Caliber, Cekusan, Cekusima, Framed, Gesatop, Primatol S, Princep, Simadex, Simanex, Sim-Trol, Tanzine and Totazine. This compound may also be found in formulations with other herbicides such as amitrole, paraquat dichloride, metolachlor, and atrazine.

Uses
Simazine is used as a pre-emergence herbicide used for control of broad-leaved and grassy weeds on a variety of deep-rooted crops, and on non-crop areas such as farm ponds and fish hatcheries. Its major use is on corn where it is often combined with AAtrex.

Effect
Simazine is absorbed through the roots, and moves up in plants. It accumulates in the leaves and the meristem (growth region) of plants. It is not absorbed through the leaves, and rain can wash it off leaves easily. Once inside the plants, simazine moves to the site of photosynthesis and interrupts food production. The plant then depletes its starch reserve and subsequently dies. Several days are required for absorption. Simazine thus acts by inhibiting photosynthesis.

Health Effects
Simazine is slightly too practically non-toxic. The formulated products, in most cases, are less toxic via all routes. Patch tests on humans have shown that simazine is not a skin irritant, fatiguing agent, or sensitises.

Some of the carriers are nuisance dusts. Breathing nuisance dusts over a long period of time may affect lung function. Inhaling crystalline silica over a long period of time can cause silicosis and lung fibrosis in humans. It may also cause respiratory system cancer.

The exposure levels a person could receive from these sources, as a result of routine operations, are below levels shown to cause harmful effects in laboratory studies.

However, rashes and dermatitis from occupational exposure to simazine have occurred. The triazine herbicides disturb energy metabolism (thiamin and riboflavin functions). Symptoms include difficulty in walking, tremor, convulsions, paralysis, cyanosis, slowed respiration, miosis (pinpoint pupils), gut pain, diarrhoea, and impaired adrenal function.

No cases of poisoning in humans have been reported from ingestion of simazine.

Environmental Effects

Simazine may be released into the environment via effluent at manufacturing sites and at points of application where it is employed as a herbicide.

If released to water, simazine will not bind to sediments or evaporate. It may leach to ground water. Simazine is moderately to poorly bound to soils. It does, however, absorb to clays and mucks. Its low water solubility, however, makes it less mobile, limiting its leaching potential. Simazine has little, if any, lateral movement in soil, but can be washed along with soil particles in runoff. Its persistence varies from a few months to a few years, depending mainly on the rate of degradation by microbes.

Microorganisms break down simazine in the soil. Simazine also breaks down chemically in water.

For unknown reasons, sheep and cattle are especially susceptible to poisoning by simazine. Damage to the testes, kidneys, liver, and thyroid has been observed in test animals. Simazine is practically non-toxic to birds and aquatic species.

Simazine does not appear to be teratogenic. It is likely that simazine is either non-mutagenic or weakly mutagenic. Because of inconsistencies in the data, it is not possible to determine simazine's carcinogenic status.

Resistant plants readily metabolize simazine. Plants that are sensitive to simazine accumulate it unchanged. It is possible that livestock or wildlife grazing on these plants could be poisoned.

Sources

http://ace.ace.orst.edu/info/extoxnet/pips/simazine.htm
http://www.envirotools.org/factsheets/contaminants/simazine.shtml infoventures.com/e-hlth/pestcide/simazine.html

INFORMATION ON RESOURCES

The information on different pesticides is mainly found on the Internet. Below is some information on the resources. The information is directly copied from the web-sites.

ATDSR

http://www.atsdr.cdc.gov/tfacts41.html

The mission of the Agency for Toxic Substances and Disease Registry (ATSDR), as an agency of the US department of Health and Human services is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and disease related to toxic substances.
ATSDR is directed by congressional mandate to perform specific functions concerning the effect on public health of hazardous substances in the environment. These functions include public health assessments of waste sites, health consultations concerning specific hazardous substances, health surveillance and registries, response to emergency releases of hazardous substances, applied research in support of public health assessments, information development and dissemination, and education and training concerning hazardous substances.

Beyond Pesticides

http://www.beyondpesticides.org

Beyond Pesticides provides the public with useful information on pesticides and alternatives to their use. With this information, people can and do protect themselves and the environment from the potential adverse public health and environmental effects associated with the use and misuse of pesticides. The organisation's primary goal is to effect change through local action, assisting individuals and

community-based organisations to stimulate discussion on the hazards of toxic pesticides, while providing information of safe alternatives. Beyond Pesticides is governed directly by members, including individuals and organisations.

ENVIRO -TOOLS

http://www.envirotools.org/factsheets/contaminants/simazine.shtml

The EnviroTools materials are aimed at community assistance leaders outreach assistance providers and citizen leaders. Through the Internet, we provide easy access to the materials in a form that can be distributed to communities.

EnviroTools is being produced at Michigan State University. This is a collaborative effort between the outreach arms of the Hazardous Substances Research Center and the Superfund Basic Research Program. The Hazardous Substance Research Centers (HSRC) program provides free technical assistance to communities with environmental contamination programs. The information in these pages was written by scientists and outreach specialists at Michigan State and others at the 27 HSRC centers around the United States. The Superfund Basic Research Program provides funding to 17 programs at 69 universities and institutions around the United States. The goal of the SBRP is to study the human health effects of hazardous substances in the environment, especially those found at uncontrolled, leaking waste disposal sites. The SBRP is funded under the National Institute for Environmental Health Science.

EMS

http://www.ems.org/pops/ddt.html

EMS (Environmental Media Services) is a non-profit communications clearinghouse dedicated to expanding media coverage of critical environmental and public health issues.

We build relationships with top scientists, physicians, and other experts to bring journalists the latest and most credible information. EMS is a non-profit funded by foundations and individuals working to improve public understanding of environmental and public health issues.

EPA

http://www.epa.gov/oppsrrd1/reregistration/endosulfan/
http://www.epa.gov/pesticides/op/dimethoate/dimethsumm.htm

EPA's (Environmental Protection Agency) mission is to protect human health and to safeguard the natural environment in the United States. EPA leads the nation's environmental science, research, education and assessment efforts. EPA works to develop and enforce regulations that implement environmental laws enacted by Congress. EPA is responsible for researching and setting national standards for a variety of environmental programs, and delegates to states and tribes the responsibility for issuing permits and for monitoring and enforcing compliance. Where national standards are not met, EPA can issue sanctions and take other steps to assist the states and tribes in reaching the desired levels of environmental quality.

Extension Toxicology Network Pesticide Information Profiles (E X T O X N E T)

http://ace.ace.orst.edu/info/extoxnet/pips/ddt.htm
http://ace.ace.orst.edu/info/extoxnet/pips/endosulf.htm
http://ace.ace.orst.edu/info/extoxnet/pips/mancozeb.htm
http://ace.ace.orst.edu/info/extoxnet/pips/chlorpyr.htm
http://pmep.cce.cornell.edu/profiles/extoxnet/dienochlor-glyphosate/dimethoate-ext.html
http://ace.ace.orst.edu/info/extoxnet/pips/simazine.htm

A Pesticide Information Project of Co-operative Extension Offices of Cornell University, Oregon State University, the

University of Idaho, and the University of California at Davis and the Institute for Environmental Toxicology, Michigan State University. Major support and funding was provided by the USDA/Extension Service/National Agricultural Pesticide Impact Assessment Program.

FAO

http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/JMPR/Download/94/carbend.pdf

The Food and Agriculture Organisation of the United Nations works with a mandate to raise levels of nutrition and standards of living, to improve agricultural productivity, and to better the condition of rural populations. Today, FAO is one of the largest specialised agencies in the United Nations system and the lead agency for agriculture, forestry, fisheries and rural development. An intergovernmental organisation, FAO has 183 member countries plus one member organisation, the European Community. Since its inception, FAO has worked to alleviate poverty and hunger by promoting agricultural development, improved nutrition and the pursuit of food security - defined as the access of all people at all times to the food they need for an active and healthy life.

A specific priority of the Organisation is encouraging sustainable agriculture and rural development, a long-term strategy for increasing food production and food security while conserving and managing natural resources. The aim is to meet the needs of both present and future generations by promoting development that does not degrade the environment and is technically appropriate, economically viable and socially acceptable.

Infoventures

http://infoventures.com/e-hlth/pestcide/simazine.html
Information Ventures, Inc prepared this information for the U.S. Department of Agriculture, Forest Service.

PAN *UK*

http://www.pan-uk.org/pestnews/Actives/Carbenda.htm
http://www.pan-uk.org/pestnews/actives/chlorpyr.htm

Pesticide Action Network *UK* (PAN *UK*) promotes healthy food, agriculture and an environment which will provide food and meet public health needs without dependence on toxic chemicals, and without harm to food producers and agricultural workers. PAN *UK* is an independent, non-profit organisation. We work nationally and internationally with like-minded groups and individuals concerned with health, environment and development to: Eliminate the hazards of pesticides, reduce dependence on pesticides and prevent unnecessary expansion of use, Increase the sustainable and ecological alternatives to chemical pest control.

The Rachel Carson Council

http://members.aol.com/rccouncil/ourpage/samples.htm

The Rachel Carson Council seeks to inform and advise people and institutions about the effects of pesticides that threaten the health, welfare, and survival of living organisms and biological systems. The Council promotes alternative, environmentally benign pest management strategies to encourage healthier, sustainable living.

Formerly the Rachel Carson Trust for the Living Environment, the Rachel Carson Council is a clearinghouse and library with information at both scientific and layperson levels on pesticide-related issues, which provides answers to the public, produces various publications clarifying pesticide dangers, brings alternative pest controls to the public's attention, and presents conferences and workshops for the public and the scientific community.

WWF

http://www.worldwildlife.org/toxics/progareas/pop/ddt.htm

World Wildlife Fund (WWF) is dedicated to protecting the world's wildlife and wild-lands. WWF is the largest privately supported international conservation organisation in the world. WWF directs its conservation efforts toward three global goals: protecting endangered species, rescuing endangered species and addressing global threats. From working to save the giant panda, tiger, and rhino to helping establish and manage parks and reserves world-wide, WWF has been a conservation leader for 40 years.

FERTILIZERS

A fertiliser is a natural or artificial substance containing the chemical elements that improve growth and productiveness of plants. Fertilizers enhance the natural fertility of the soil or replace the chemical elements taken from the soil by previous crops.

The use of manure and composts as fertilizers is probably almost as old as agriculture. Modern chemical fertilizers include one or more of the three elements that are most important in plant nutrition: nitrogen, phosphorus, and potassium (NPK). Of secondary importance are the elements sulphur, magnesium, and calcium. Mixed fertilizers contain more than one of the three major nutrients. Mixed fertilizers can be formulated in hundreds of ways.

Sources
Encyclopaedia Britannica

Nitrogen Fertilizers

General Information
Nitrogen (N_2) makes up 78% of the air, by volume. Nitrogen,as a gas, is colourless, odourless, and a generally inert element. As a liquid it is also colourless and odourless, and is similar in appearance to water. The ammonia that is formed out of nitrogen is of the utmost importance as it is used in fertilizers.

Even though there is an abundant supply of nitrogen in the earth's atmosphere, N_2 is unavailable for use by most organisms because the molecule is almost inert. In order for nitrogen to be used for growth it must be "fixed" (combined) in the form of ammonium (NH_4) or nitrate (NO_3) ions.

Lightning produces a relatively small amount of ammonia. Some ammonia also is produced industrially (fertilizers). But the major conversion of N_2 into ammonia, and thence into proteins, is achieved by microorganisms in the process called nitrogen fixation (or di-nitrogen fixation).

Some bacteria can convert N_2 into ammonia by the process termed **nitrogen fixation. O**ther bacteria bring about transformations of ammonia to nitrate, and of nitrate to N_2 or other nitrogen gases. Many bacteria and fungi degrade organic matter, releasing fixed nitrogen for reuse by other organisms.

The three processes above remove nitrogen from the atmosphere and pass it through ecosystems. De-nitrification reduces nitrates to nitrogen gas, thus replenishing the atmosphere. Once again, bacteria are the agents. They use nitrates as an alternative to oxygen for the final electron acceptor in their cellular respiration. Thus they close the nitrogen cycle.

Types of Nitrogen Fertilizers:

· **Nitrogen solutions (28 to 32% N)** are a mixture of urea and ammonium nitrate in water.
· **Urea (46% N)** is the most widely used dry N fertiliser. Once applied to the soil, urea is converted to ammonia,which reacts with water to form ammonium within two to three days (faster under warm conditions). Urea is the most popular source of dry N fertiliser.
· **Ammonium nitrate (33% N)** Calcium ammonium nitrate is a mixture of ammonium nitrate (50%) and crushed limestone. Neither of these materials should be used for fall application.
· **Calcium nitrate (16% N)** contains its entire N in the nitrate form.
· **Potassium nitrate (13% N)** is used as both a K source and N source. The entire N is in the nitrate form.
· **Sodium nitrate (16% N)** contains its entire N in the nitrate form.

Uses

The growth of all organisms depends on the availability of mineral nutrients, and none is more important than nitrogen, which is required in large amounts as an essential component of proteins, nucleic acids and other cellular constituents. Most plants can use it only in the fixed forms of nitrate and ammonium.

Health Effects

Nitrate can accumulate in groundwater and ultimately in drinking water. Nitrate is a potential human health threat especially to infants, causing the condition known as methemoglobinemia, also called "blue baby syndrome". Nitrate is converted in the gut to nitrite, which then combines with hemoglobin to form methemoglobin, thus decreasing the ability of the blood to carry oxygen. Chronic consumption of high levels of nitrate may also cause other health problems, for example some cancers and teratogenic effects.

Environmental Effects

Agriculture may now be responsible for one-half of the nitrogen fixation on earth through the use of fertilizers and the growing of legumes like soybeans and alfalfa. This leads to nitrogen enrichment in ecosystems that disturbs a balanced cycle.

The nitrifying bacteria have some important environmental consequences, because they are so common that most of the ammonium in oxygenated soil or natural waters is readily converted to nitrate. Nitrate is not held on soil particles and so can be washed down the soil profile. In this way, valuable nitrogen can be lost from the soil, reducing the soil fertility. The nitrates can then accumulate in groundwater, and ultimately in drinking water. The runoff problem is often greatest when manure is used as a fertiliser. Water contaminated with nitrate is very difficult and costly to treat. Many bodies of freshwater are currently experience influxes of nitrogen and phosphorus from outside sources. The increasing concentration of available phosphorus allows plants to assimilate more nitrogen before the phosphorus

is depleted. Thus, if sufficient phosphorus is available, high concentrations of nitrates will lead to phytoplankton (algae) and macrophyte (aquatic plant) production.

Nitrate in itself is not toxic to animals, but at elevated levels it causes a disease called nitrate poisoning. Nitrates are normally found in forages. Excessive aquatic plant production may negatively impact fresh water aquatic life because oxygen levels may deplete as a result of nightly plant respiration.

Sources

http://helios.bto.ed.ac.uk/bto/microbes/nitrogen.htm
http://www.msue.msu.edu/msue/imp/modf1/06109727.html
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/NitrogenCycle.html
http://h2osparc.wq.ncsu.edu/info/no3.html

Phosphorus Fertilizers

General Information

The original source of phosphorus fertiliser (P_2O_5) is rock phosphate. There are extensive reserves. The largest deposits are in North Africa (Morocco, Algeria, Tunisia), the United States (largely Florida), and the Soviet Union, but there are also sizeable deposits in numerous other countries.

Rock phosphate is converted in to fertiliser with the help of large quantities of sulphuric acid. The resulting product is called superphosphate. Single Super Phosphate (SSP) is available in powder as well as in granular form. Its colour could be grey or brown and it contains 16 to 20% P_2O_5. The phosphors in this fertiliser are readily soluble. It also contains a small amount of free acid and sulphur (about 12%).

By adding ammonia (NH_3) to the phosphoric acid diammonium phosphate or DAP is produced. DAP is a white crystalline compound $(NH_4)_2HPO_4$. This fertiliser contains

18% N and 46% P2O5. The material is light brown, granular and free flowing. It leaves acidic effect in soil after nitrification of ammonium (NH4+).

Types of Phosphate Fertilizers:

· **Normal superphosphate (20% $P_2 0^5$),** also referred to as ordinary or single superphosphate.
· **Concentrated superphosphate (46% P_2O_5),** also known as triple superphosphate.
· **Diammonium phosphate (18-46-0)** is a dry material being used extensively for bulk blending and for direct application where soils do not need K or where K is broadcast.
· **Monoammonium phosphate (11-48-0)** is a dry material being used for bulk blending or direct applications. Monoammonium phosphate has lower ammonia content. The general agronomic effects of diammonium and monoammonium phosphates are equal for most soils.

Phosphate Solubilizing Microorganisms (PSM):

Phosphorus is the least available element to plants in general. One of the reasons is the precipitation or fixation to insoluble complex minerals and is due to the union of phosphorus with elements such as iron and aluminum in acid soils, and calcium in alkaline soils, denying the plant up to 75% of all soluble phosphorus. This forces many crop raisers to apply up to four times the required amount of phosphorus to plants.

Several researchers have demonstrated the existence of bacterial groups in the rhizosphere of various crops, which have the ability to solubilize the insoluble forms of phosphate compounds through the production of organic acids which are assimilated better by the plant. Therefore, production of bio-preparations could improve the availability of soluble phosphorus. This would have a positive effect on the environment.

Uses

Phosphorus (P) is a nutrient required in relatively large amounts by plants. Plants need phosphorus for growth (especially during the early stages of growth), utilization of sugar and starch, photosynthesis, nucleus formation and cell division, fat and albumen formation. Phosphorus compounds are involved in the transfer and storage of energy within plants. Adequate P results in rapid growth and earlier maturity. Frequently, the quality of vegetative growth is improved. Phosphorus deficiencies are corrected with phosphate fertiliser.

While a phosphorus fertiliser may be completely water-soluble (completely plant available) when manufactured, it does not remain this way very long after it is applied to the soil. This process of available phosphorus being made unavailable to plants is called "phosphorus fixation." This process cannot be avoided, but proper management can increase fertiliser phosphorus efficiency.

Some soil P is contained in soil micro-organisms. A significant proportion of inorganic P may be "biologically fixed" by micro-organisms when soil P levels are low. In some cases, micro-organisms may even compete with plants for P when soil P levels are low. Phosphorus is temporarily tied up in the organic components of micro-organisms; however, the P is eventually returned to soil when the microbes die. After mineralization (conversion from organic P to inorganic P), it may be used again by plants.

Factors such as rate of P fertiliser applied, method of application and chemical form used can all affect P uptake. In general, soil moisture and temperature affect P availability and root growth. In cool, wet soils, P availability and movement are reduced. As a result, crops are more responsive to phosphate fertiliser in cool, wet spring conditions than in warmer, drier spring conditions.

Health Effects

People who work with the fertiliser can endure health effects

when the product is not handed properly. Skin and eye contact may cause irritation. Small-ingested quantities are unlikely to cause toxic effect. Large quantities may give rise to gastro-intestinal disorders. High dust concentrations of air-borne material may cause irritation of the nose and upper respiratory tract with symptoms such as sore throat and coughing. No long-term effects are known.

Environmental Effects

No deleterious impact on soil and crop has been reported due to its use. Possible eutrophication in confined surface waters is possible. Eutrophication is the enrichment of water by the addition of nutrients. The extra nutrients encourage the growth of algae blooms, particularly in stagnant water. Blue–green algae may produce toxins poisonous to animals, including humans. For these algae to grow, phosphorus must be present in the water above a certain level.

Phosphorus is a very stable element and it binds quickly with soil minerals, so is unlikely to leach through soil except under high rainfall in very sandy soils. It is mainly lost from the soil by erosion when soil particles holding the phosphorus are blown or washed away. For this reason fertiliser phosphorus is unlikely to be a major contributor to phosphate pollution of waterways, unless erosion occurs.

Phosphates are translocated in the soil only over very short periods and are then immobilised. Phosphates are converted to calcium or iron/aluminium phosphates or are incorporated with the organic soil matter. It does not show bioaccumulation phenomena and has low toxicity to aquatic life.

Mining of phosphates may damage the landscape. Phosphate rock is usually open-mined, generating large amounts of waste overburden. Large-scale restoration of the landscape is required. Some phosphate rock contains minor amounts of radioactive elements (e.g. uranium) necessitating special storage for mining waste. Leaching of waste may cause water pollution.

Sources

http://www.ianr.unl.edu/pubs/soil/g601.htm
http://www.msue.msu.edu/msue/imp/modf1/06109728.html
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex920
www.telmedpak.com/ agricultures.asp?a=Fertilizers&b=fap
http://www.efma.org/publications/guidance/section12.asp
http://www.agric.nsw.gov.au/reader/soil-sense/ss193-fertilisers-environment.htm
http://www.incitecfertilizers.com.au/environmental_facts.cfm
www.ag.auburn.edu/argentina/ pdfmanuscripts/martinez.pdf

Potassium Fertilizers

General Information

Potassium (K_2O) is one of the sixteen nutrient elementswhich is needed by plants for healthy growth. It is second only to nitrogen in the quantities required by plants. Potassium is very mobile within plants, and performs a wide range of vital roles in plant systems, including photosynthesis, enzyme activation, stomatal control and transporting plant sugars. Potassium also helps maintain the quality of crops that must be stored.

Although potassium occurs naturally as up to 3.5% of the earth's crust, only a small proportion of it is available to plants. After many years of agricultural production, and removal of potassium in produce harvested from the field, even soils, which were naturally well supplied, will become depleted.

The most available but smallest pool is soluble potassium, which is dissolved in the soil water (called the soil solution). Plants take up most of their potassium directly from this pool, and so deplete it very rapidly. Exchangeable potassium is released into the soil solution as plants deplete the soluble potassium, allowing for a regular resupply. But the size of

the exchangeable potassium pool will determine the effectiveness of this resupply. The reverse can also apply, with potassium moving from solution onto exchange sites when soil solution concentrations are high. This can take place within a fertilised band. The exchangeable potassium pool is in turn linked with the fixed potassium pool. A fixed potassium pool is slowly available to plants over time, but soils that do not contain expanding clay types have only a very small pool of fixed potassium. The largest amount of potassium within a soil exists as structural potassium, and is a component of primary minerals. It only becomes available upon long-term weathering.

Types of Potassium Fertilizers:

· **Potassium Chloride (60 to 62% K_2O),** also referred to as **muriate of potash**. Potash varies in colour from pink or red to white depending on the mining and recovery process used. White potash, sometimes referred to as soluble potash, is usually higher in analysis and is used primarily for making liquid starter fertilizers.

· **Potassium sulphate (50% K_2O),** also referred to as sulphate of potash, is used to a limited extent on crops such as tobacco, potatoes and a few vegetable crops where chloride from potassium chloride might be undesirable. Potassium sulphate may also be source of sulphur when sulphur is required.

· **Potassium magnesium sulphate (22% K_2O),** also known as sulphate of potash magnesia, is used for both direct application and in bulk blending, particularly where magnesium is needed. If may also be used as a source of sulphur.

· **Potassium hydroxide,** also known as caustic potash, is used to a limited extent in the production of liquid mixed fertilizers. The present cost of producing potassium hydroxide has limited its use in the fertiliser industry, even though it is a very desirable product due to high solubility and low salt index.

· **Potassium nitrate (44% K_2O)** is also known as nitrate of potash. It has a low salt index and provides nitrate

N which may be desirable for these speciality crops. Production costs have limited general use for most agronomic field crops.

Uses

In most virgin soils, plants rely totally on the soluble and exchangeable potassium pools for their requirements. However, after prolonged periods of agricultural production and removal of produce, these pools are slowly depleted. Once depletion of exchangeable potassium occurs, plants rely on the release of fixed potassium to recharge the exchangeable and soluble pools. However in many soils the size of the fixed potassium pool, or the rate at which it is released, are insufficient to meet plant demand. In these instances, fertiliser potassium is applied to stimulate plant growth.

Muriate of potash is the most common source of fertiliser potassium. It is found as a natural mineral in the sedimentary salt beds of ancient seas and is often interbedded with common salt (sodium chloride). Potash deposits that can be mined economically are known to occur in beds in only a few sedimentary basins in the world. The most extensive of these are the deposits underlying the Canadian province of Saskatchewan. Potash is also mined extensively by China in the Tibetan region of Tsaidam Basin in Amdo. Other mined deposits are found in the US, Western Europe and the former Soviet Union. Evaporation from surface brines and saline waters such as those from the Dead Sea in the Middle East and Great Salt Lake in Utah, USA, also obtain some potash.

Health Effects

No information on possible health effects was found.

Environmental Effects

Mining potash may damage the landscape. Potassium extraction may also lead to water pollution when brines are produced as a by-product. Large stockpiles of common salt (sodium chloride) are often generated during the processing

of potash ores.

Potassium is taken up by plant roots very rapidly and is not used in great quantities, so represents little environmental threat when used on fields.

Sources

http://www.potash-info.com/potassium/potassiuminsoil/potassiuminsoil.htm
http://www.msue.msu.edu/msue/imp/modf1/06109729.html
http://www.incitecfertilizers.com.au/environmental_facts.cfm
http://www.agric.nsw.gov.au/reader/soil-sense/ss193-fertilisers-environment.htm

Zinc Sulphate Fertilizers

General Information

Zinc Sulphate (ZnSO4.7H20- about 21% Zinc) is a crystalline salt with many uses including the making of fertilizers.

Uses

Zinc (Zn) is one among the seven Micronutrient elements that is indispensable for plant growth. Its presence activates a series of enzymes responsible for maintaining the course and tempo of several vital growth events. Zinc asserts in protein synthesis and production of auxins (growth promoting chemicals). Therefore, a low zinc supply encourages protein deficiency and dwarfism in plants. The net results of a zinc deficiency in soils are stunted crop plants, prolonged duration and poor yields. A severe deficiency can kill the crop. Zinc deficiency can be corrected by the application of Zinc Fertilisers to soils.

Man's intervention leading to loss of fertile surface soil or indiscriminate use of certain chemical fertilisers (specifically phosphatic) can aggravate zinc deficiency condition.

Sources
http://www.chakradhar.co.in/zincfaq.html

INFORMATION ON RESOURCES

Nitrogen Sources

J. W. Kimball
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/NitrogenCycle.html

John W. Kimball is a graduate and Ph.D. of Harvard College, and a former teacher at Phillips Academy, Tufts University and Harvard. He has published a general biology text.

NCSU
http://h2osparc.wq.ncsu.edu/info/no3.html

North California State University

MSUE
http://www.msue.msu.edu/msue/imp/modf1/06109727.html Michigan State University Extension

University Of Edinburgh
http://helios.bto.ed.ac.uk/bto/microbes/nitrogen.htm

Biology Teaching Organisation of The University Of Edinburgh

Phosphorus sources

Alberta Department of Agriculture
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex920
Department of agriculture, food and rural development.

EFMA
http://www.efma.org/publications/guidance/section12.asp

The EFMA (European Fertilizer Manufacturers Association) represents the major fertilizer manufacturers in Western Europe.

Incitec Fertilizers
http://www.incitecfertilizers.com.au/environmental_facts.cfm

The Incitec Fertilizers dealer network is part of Incitec Pivot Limited, Australia's leading fertiliser manufacturer and distributor.

MSUE
http://www.msue.msu.edu/msue/imp/modf1/06109728.html

Michigan State University Extension

NSW Agriculture
http://www.agric.nsw.gov.au/reader/soil-sense/ss193-fertilisers-environment.htm
NSW Agriculture is part of the Australian Department of Mines.

TelMedPak
www.telmedpak.com/ agricultures.asp?a=Fertilizers&b=fap

TelMedPak's objective is to create awareness of the educational and reference opportunities available on the internet amongst health professionals and medical students, facilitate electronic access to medical information for the public, facilitate the use of Information Technology at medical colleges and institutions in Pakistan, explore modalities for provision of Telemedicine to the rural areas of Pakistan.

Universidad Javeriana
www.ag.auburn.edu/argentina/ pdfmanuscripts/ martinez.pdf

Research of the Faculty of Sciences. Bacteriology Career. Pontificia Universidad Javeriana. Santa Fe de Bogotá.

University of Nebraska-Lincoln
http://www.ianr.unl.edu/pubs/soil/g601.htm

Published by co-operative extension, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln

Potassium sources

_Incitec Fertilizers
http://www.incitecfertilizers.com.au/ environmental_facts.cfm
The Incitec Fertilizers dealer network is part of Incitec Pivot Limited, Australia's leading fertiliser manufacturer and distributor.

MSUE
http://www.msue.msu.edu/msue/imp/modf1/ 06109729.html
Michigan State University Extension

NSW Agriculture
http://www.agric.nsw.gov.au/reader/soil-sense/ss193-fertilisers-environment.htm

NSW Agriculture is part of the Australian Department of Mines.

Potash-info

http://www.potash-info.com/potassium/potassiuminsoil/ potassiuminsoil.htm

Canadian potash suppliers, Canpotex and their Australian agents, Agrow Australia, support the Potassium in Agriculture web site. It is part of a wider Canpotex Potassium Development program in Australia and New Zealand, which assists in providing agronomic information on potassium nutrition of crops and pastures through publications and workshops. The program also supports research and development into the best management practices for potassium fertiliser use in our agricultural production systems.

Zinc Sources

Chakradhar
http://www.chakradhar.co.in/zincfaq.html

Indian fertilizer company

APPENDICES

CLOSING REMARKS:

Pesticides are Poison and they destroy your health and your environment!

- Don't spray at all harmful pesticides! Some of them can remain for long in water, soil and in flesh
- Feed your field with nutritious compost to give the plants strength to fight any pests
- Use natural pesticides such as neem oil and ash
- Use predators such as weaver ants, frogs, birds, etc
- Use helpful parasites such as trichogramma etc.
- If your life is truly depended on those deadly poisons, you must follow the following guides:
- No Skin Contact with Poison. Always wear basic protective clothings such as goggles, gloves, boots, and rubber cloths.
- Do not Inhale Poison. Make sure to wear masks
- Do not Eat or Drink Poison. Make sure to wash your hands after spraying and before eating.

How Do People Get Sick From Pesticides?

Pesticides can poison people in different ways: through the skin, through the eyes, through the mouth (by swallowing) or through the air (by breathing). Each kind of poisoning needs a different kind of treatment.

Pesticides poisoning can cause many health problems. A person exposed to pesticides can have more than one sign. Some signs show up when the person is exposed. Other signs do not show up until hours, days or even years later.

Farmers should be aware that their children and domestic animals are also in just as much danger of poisoning as farm workers themselves.

Signs of pesticides poisoning

Courtesy: Pesticides are poison by the Hesperian Foundation

Nose and Mouth: runny nose, drooling

Head and Eyes: headaches, vision problems, small pupils in the eyes, tears

Chest and Lungs: pain, breathing problems

Stomach: pain, diarrhea, nausea and vomiting

Legs and Arms: muscle cramps or pains, twitching

Skin: itching, rashes, bumps, redness, blister, burning, sweating too much

Hands: damage to fingernails, rashes, numbness and tingling in fingers

Other general signs of pesticides poisoning are:

Confusion, weakness, trouble walking, trouble concentrating, muscle twitching, restlessness and anxiety, bad dreams and trouble sleeping

If you have any of these problems while working with pesticides, leave the work-site immediately. Do not wait until you feel worse. Get away from the pesticides and go to a hospital or clinic right away!

Signs of severe poisoning:

Unconsciousness, losses of control over bladder and bowels (peeing and shitting without control) blue lips and fingernails, shaking.

Pesticides Damage the Environment in Many Ways

Every farmer knows that pesticides cost money. But there are other costs the farmer may not consider when he buys pesticides. There is the cost to the health of the farmer and other people affected by pesticides. There is the cost of polluted water and sol. And there is the cost to the environment, fish, animals, and other wildlife.

Animals eat, drink and breathe toxic chemicals in the environment just like people do. When large animals such as owls, hawks, and humans eat smaller animal's containing small amounts of pesticides, all of those pesticides collect in their bodies and poison them. This is one way that toxic chemicals spread from one place to another.

Poisons like pesticides collect in the fat of animals, including people. Since larger animals eat more and live longer, they often have more poison in their body. If fish live in water polluted by pesticides, then the large fish that eat the little ones can have so much pesticides collected in them that it may be unhealthy for people to eat a diet based on fish.

Pesticides poison the soil, water, and air

Soil: Farmers know that soil is not just dead material. Healthy soil is full of life. Insects, worms, fungi and bacteria keep the soil alive and create nutrients that make plants grow healthy.

When pesticides kill these creatures, the soil becomes less ale to support growing plants. Plants that grow in this soil do not have the natural ability to protect themselves from pests. Farmers then use even more pesticides. This makes the problem worse. Over time, the soil dies and healthy plants will not grow in it at all.

Water: When pesticides get into streams and rivers, they can kill any animals that live in or use the water, including

people.

Air: Pesticides drift in the air and pollute the environment. Tests on living beings all over the world show that fish, birds and wildlife, livestock and humans, including babies, all have small amounts of pesticides in their bodies. Pesticides affect everyone!

(Courtesy: *Pesticides are poison* by the Hesperian Foundation)

RECIPES FOR BIOLOGICAL PEST CONTROL

Courtesy: Tibetan Sustainable Living Project: from self-reliance in exile to a free Tibet By Mr. Jonathan Halpern and Ms. Johanna Asikainen

The need to use any form of pest control solution indicates an imbalance in the system, however, especially in the time of conversion, they may be helpful.

Many 'organic' pesticide/herbicide solutions are toxic also and must be used with utmost caution. Some are broad-spectrum such as pyrethrum that is also toxic to fish and worms, so take care! Even something as seemingly harmless as garlic spray could interfere with spider populations' etc. which is helping to control insects in the system.

PARTICULAR PESTS

Ants

- scatter equal parts and icing sugar on trail
- jam and derris, camphor, citronella, pepper
- bait of borax and jam
- cloves in sugar repels

Aphids

- when leaves and stems look pale and spindly clay solution sprayed
- custard apple seeds crushed and sprayed

Bacterial leaf-blight of rice

- cow dung slurry (2kg fresh dung in 10litres water)sprayed
- extremely effective

Borers

- sudden wilting of plant tops, cut affected stem and burn
- against fruit borer (Helicoverpa armigera), plant 40 day marigold seedlings (marigold normally flowers after 40 days, but if kept in nursery, won't for 26 days more), with 25 day tomato seedlings on 30cm spacing, plant one row marigold for every 16 row tomato. Marigold flowers for 120 days (= tomato end of tomato growing period)

Cabbage moth and white butterfly

- derris, pyrethrum, nicotine
- flour, salt and pepper dusting, soap, garlic, tomato leaf sprays
- use inter-cropping in garden layout
- bug juice

Caterpillars

- pyrethrum and derris
- garlic, nicotine spray
- handpick and kill
- find patches of eggs under leaves, pick and burn
- kerosene on rag

Cat

- rue is deterrent
- agianst cattle browsing trees, spray sheep orgoat manure (equal parts water + tablespoon soap powder per litre)

Chicken lice

- solution of neem - immerse chickens

Cockroaches

- pyrethrum, nicotine, derris
- bait of 20% paste in treacle, honey or peanut paste

Crickets, grasshoppers, locusts

- pyrethrum, nicotine, derris
- turkeys, guinea fowls , ducks eat them

Cutworm

- mulch and keep weeds down
- dust with derris
- place bottomless cans over seedlings and push into soil

Curly Leaf

- bordeaux spray at bud swell
- pick off infected leaves
- if bad, dust with sulfur powder

Fleas

- wormwood tree, pennyroyal, eucalyptus, lavender, thyme oils diluted and sprayed on
- catmint and pennyroyal pillows for cats and dogs

Flying Foxes (fruit bats)

- silver foil hung in trees and near fruit

Fruit Fly

- bait of equal parts sugar, urine, pure vanilla essence and water at 4-6 jars per tree
- bait #2 - ammonia, borax, sherry, honey
- infested fruit burned or dropped in kerosene and water
- foraging hens
- 0.3 sq.m foliage, splash mixture of 4tsp protein hydrolysate, 2tsp malathion powder, 1 cup water
- trap: live yeast in bottle halved with top inverted and fixed with yellow tape - hang from lower branches
- collect dropped fruits and burn

- 20gms holy basil (tulsi) leaves crushed and placed in coconut shell. Add 100mls water add 0.5gms citric acid for better keeping.
- Add 0.5 gms carbofuran 3Gpoison. 4traps per tree. Change every week. If infestation is heavy, spray with malathion 0.1% and sugar 2%

Gall Wasps

- cut galls from tree and burn

Head lice

- sassafras oil

House Fly

- cover compost - bait of meat and little water next to compost, pour boiling water over magots

Leaf Hoppers

- soap spray, pyrethrum, derris, nicotine

Leaf miners

- damage not serious
- chickens eat pupae
- herbs
- dust leaves with ash

Mealy Bug

- scale insects covering stems of plants, sucking juices
- swab with denatured alcohol (metholated spirits, turpentine)

Mosquitoes

- little kerosene/garlic solution over stagnant water
- controls Larvae

Nematodes

- worm parasites
- rotate crops, high organic mattter in soil
- burn and dispose diseased plants

- plant marigold - Tagetes minuta and patula
- sprinkle sugar on soil - dehydrates worms
- seaweed spray
- trap crops
- sterilize soil
- crotolaria spectabilis , juncea
- molasses and water mixture soaked into soil

Powdery Mildev

- wettable sulphur, sulphur dust, Bordeaux, condies crystals in water
- 7 grains patassium permanganate (condies crys tals) in 71 water, spray on plants at once

Red Spider Mites

- dislike moist humid conditions
- buttermilk, milk, anise, coriander, onion, garlic, glue or pepper sprays

Mealy Bugs, Scales

- white oil, soapy sprays, onion, pyrethrum, nico tine, quassia, garlic
- dab with metholated spirits

Scarab beetles

- magpies! Birds are excellent predators.

Snails

- hand pick and drop into bucket of water and detergent or salt
- barriers of sawdust, slaked lime, wood ash, sharp sand
- collect snail eggs
- baits: beer, milk traps
- spray with weak solution copper sulphate, condies crystals or alum; use once or twice per season
- ducks, frogs, lizards eat snails
- catch slugs under upturned grapefruit or potato shells

Snakes

- oregano and lemongrass

- dogs, cats, geese

Stink bugs
- nicotine, quassia, pyrethrum, derris

Ticks, lice
- mugwort

Weevils
- bay leaves

White ants
- treat posts with kerosene, creosote
- pour kerosene emulsion around nest
- remove unused timber
- set posts in cracker dust

Encourage these insects:
- spiders, praying mantis, dragonflies, ladybirds, lacewings

PARTICULAR RECIPES

Neem
- disinfectant - leaf solution
- stored-grain protcection -dry leaves, protects grain from moths, weevils, red flower beetle, chewing.biting insects
- neem oil/cake - inhibits bacteria
- as a fertiliser
- leaves - Mexican bean beetle, diamond backmoth, beet leaf bug, infection of cacao leaves by ephistia cautella, decrease attacks by termites, v in water, against locusts

Bug Juice
- handful of live (especially diseased ones) and dead bugs in container of water for a week. Di lute with 101 water and spray

White Fly Spray

- boil handful of tansy, rhubarb leaves, mint, 2 clove garlic. Strain and add little liquid pure soap. spray under leaves

Nicotine Spray

- general killer
- boil midribs and stem of tobacco plant in water for a few minutes, or soak for 3-4 days - let it cool
- 2-3 cigarettes + 1 litre water - boil 5 minutes
- soak cigarette ends for a couple of days, add (100gms) soap and spray
- poisonous, and kills many bugs, including useful ones - NOT GOOD!

Garlic Spray

- against beetles, mites, thrips, aphids, white flies, moths, nematodes, army worms, borers
- crush garlic cloves and sttep in equal quantity of oil for a week. Add soap and dilute 1:10 with water and spray

Euclalyptus spray

- general insecticide
- add 1pt eucalyptus oil to 100pts water; shake or whisk, spray

Beer Traps

- flat beer; dilute with 2tps water and add little brown sugar or treacle; plate in saucer or soap dish and sink to ground level

Castor seeds

- mash and heat 10mins with 2:1 water, 2tsp kero sene, and soap. Filter and dilute to 10:1, spray immediately

Chive Tea

- for mildew on gooseberries and squash handful of chives in boiling water, steep for 1hour

Clay

- clay has suffocating effect on aphids, thrips, spi der mites
- mix fine clay with water

Datura (Jimsen weed)

- 1kg fresh leaves, stems, flowers, seeds shredded and soaked in 10: 1 water with 2 tablespoons kerosene and 50gms soap. Soak overnight, filter and spray

Dipel R

- specific insecticide against caterpillars, useful if used strategically, as it is a biological control

Epsom Salts

- for mildew
- dilute with water

Custard Apple

- pulverize seed and mix with water
- spray against aphids, ants, other insects

Gliricidia sepium

- extract juice from leaves and stem
- mix with water and spray against insects
- fresh stems and leaves placed between plants to deter insects
- fermented leaves kill rats

Hibiscus sabdriffa (pulichai)

- sown intermixed with upland dry rice against termite attack

Neem Solution

- Soak 12.5 kg neem cake in 2001 water for 24hrs; add 200gms soap as surfactant at time of spraying - for 1 acre general pest control

Neem leaves

- leaves spread over land as general pest control

and fertiliser
- also pongam seeds crushed and applied to soil

Papaya
- 1kg leaves shredded and soaked in 10:1 water with - 2 tbsp kerosene, some soap. Stand overnight, filter and spray

Pepper powder
- against ants, spiders, caterpillars, tomato worms
- equal part water and soap - spary

Urine
- 1: 8 water. 65 liters urine: 520 liters water/acre
- paddy - sprayed 4 times at interval of 115 days ; no other pesticide used

General pesticide
- cow urine, flat plate cactus (sapati), square ropey cactus (perundai), neem, Callotropis gigantea (eruke)

Tomato
- boil stems and leaves in water (for 5 hrs??) 1 tomato plant: 1 litre- cool it
- spray against caterpillars and black or green flies
- will also deter against future attack

Lantana Camara
- cut branches and sun dry, then burn.
- apply ashes to leaves to control various beetles and leaf miners

Red Peppers, Chilies
- dry, then just before use grind and sprinkle

Onion Brew
- against aphids
- collect roots leaves and stems of many aromatic herbs

- Chop fine: onion, garlic, chili, mustard, mints, etc add 2litres of water and pure soap - pour over infested plant
- if brew ferments, it is more effective

Garlic and Marigold Mixture

- 3-4 cloves garlic, 2 handfuls marigold leaves, 2-3 onions, 2-3 chilies; add water and bring to boil - cool
- dilute 4-5 times : spray as needed (best used in 1-2 days)

Aromatic herbs and soap

- chop one garlic, one onion, one tablespoon chili, mix with water and soak for one hour - add 1 tablespoon liquid soap - keep cool 1 week (soap serves as a sticker)

Kerosene and soap spray

- Mix 1/4-cup soap water, 1/4-tablespoon chili, 1 litre water
- Use spray only when insect infestation is serious

Wood Ash

- root maggots in radish, onions, cabbage (& other brassicas) can be controlled by spreading fresh (not hot !) ash around plants - cover with soil
- snails, slugs, cutworms controlled by encircling plants with 3-4 inch wide trench, 1/2 inch deep with fresh ash
- flea beetles on tomatoes - spray mixture of ash and water
- cucumber beetles - equal quantities wood ash and powdered lime mixed with soapy water

Chrysanthemum

- dried flowers - mix with fine clay and water 6-7 tabs - > 1 gallon water - wide range of in sects

Ocimum santum

- decoction of fresh/dried leaves - insecticides

Artemia vulgaris

- branch cut, sun dried and burnt near or below plants
- repels insects

Tinosperma rumphii

- pound root, leaves, stems, mix with water
- against aphids, flies, moths, worms

Acornus calamus

- powder roots and add water - insecticide

Derris spp

- fresh bark pounded
- 6 tabs juice: 0.751 water - variety of insects

Euphorbia nerifolia

- latex as insecticide

Special Foul Animal Repellent

- 10 parts mutton fat melted down and mixed with 1 part kerosene; use glove and wipe lightly up 1 side of plant stem (lasts maybe 2 months)

MECHANICAL TECHNIQUES OF PEST CONTROL

Include baits, traps, barriers, and allures to reduce pest numbers or interfere with their activities

Barriers

- sawdust, sharp sand, soot, cinders, ash around special plants or beds - barriers to pests such as snails, slugs as they're abrasive & dehydrating

Bands

- wrapped around tree trunks to deter crawling in

sects and pest which over-winter in soil. Grease, resins can be used inside banks

Collars

- from cardboard or cans with both ends cut out and pushed 5cms into soil - against cutworms

Traps

- include upturned citrus shells, sticky yellow boards, half bottles of stale beer
- yellow strongest attractant, then green and red white attracts thrips)
- cellophane bag esp. near water Vs, Leafhoppers, moths

Lures and Baits

- milk is attractive to slugs and snails.
- yeast and sugars and proteins baits for fruit fly - plastic bottle with top cut off and inverted; put vinegar and sugar solution in it. 10/tree will kill fruit fly, but neighbors should do it too!
- pheromones - insect hormones

Handpick

- grubs or eggs daily - very effective

OTHER METHODS OF PEST CONTROL

Cover crops - e.g mustard and rape - remove wire-worm from soil before planting suscep tible crop

Sanitation - remove and destroy deiseased fruit and leaves e.g blackspot, birds on ground (hen, quils, ducks) can break cycles. Keep rotted fruit with worms or fruit fly out of compost heap. Seal fruit inlarge, strong, black plastic bags and leave under sun to cook- then add to compost

Crop rotation - stops build up of pests/disease in soil. Generally, don't follow members of same family in same bed e.g toma toes after potatoes

Avoid peak season - e.g plant early or late to avoid fruit fly

Plant resistant species - select local stong species

Bug Juices - never use mosquitoes or files that can be carrying human disease in bug juices.

Bug Juices act by : a) releasing repellent telling others to leave
b) attracting natural enemies
c) spreading an insect disease

Neem spray - bitter repellent of grasshoppers and locusts; can also upset insect hormo nal balance.

Fungicides - urine: water at 1 : 20 milk, powdered

or fresh at 1 : 9 seaweed tea soaked 2 weeks and washed casuarina needles
1 cup leaves : 1 cup water, boiled 20 minutes,diluted 1 : 20 for ground spray

Attract predators into garden: e.g cook 1kg/acre rice with turmeric powder, place 5 metres apart - must be kept continuously for 2 -3 days. Birds will be attracted, whcih will then consume Pests

Pest predator area in Zone 1, where nobody goes

- stacked tangle of vegetation, with hollow logs and water source
- ornithological societies have informa tion specific bird lure specifications
- No disturbance for spiders-lizards
- rocks and sunny spots, and area of sand for egg laying - snakes
- eat snails and insects

Flowering plants throughout garden, esp. Umbelliferae (turnips, carrots, parsley, dill, fennel, chervil, coriander, caraway, aniseed) and Compositae (daisies, pyrethrum); Crusifferae - cabbages, cauliflower etc for parasitic wasps

Repellent herbs throughout (wormwood should be in separate pot, and not in the ground)

(Courtesy: *Tibetan Sustainable Living Project: from self-reliance in exile to a free Tibet* By Mr. Jonathan Halpern and Ms. Johanna Asikainen)