



# TECHNICAL NOTE

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## Agronomy Technical Note - No. 4

### THE USE OF CHEMICALS FOR WEED CONTROL

This coversheet transmits a copy of technical note originally released by NRCS Hawaii in December 1981.

Although the technical note is dated, it provides useful general information about different types of herbicides.



# TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE

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## THE USE OF CHEMICALS FOR WEED CONTROL <sup>1/</sup>

Today, herbicides are playing a bigger role in agricultural operations. Increased cost of machinery, fuel, and labor is the main reason. Higher operating cost has caused the application of the conservation tillage system to increase dramatically.

Soil Conservation Service personnel must have a good working knowledge of herbicides to assist cooperators to design a conservation tillage system.

The following provides general information on the different types of herbicides. Note that at all times federal and state regulations shall be followed when using herbicides.

### INORGANIC HERBICIDES

Inorganic compounds were the first chemicals used for weed control. Herbicides such as ashes, common salts, and bittern have been used in agriculture since ancient times.

The development of the chemical theory of plant nutrition in the nineteenth century by Liebig resulted in an increase use of chemical fertilizers and insecticides and stimulated the discovery of new chemical weed killers.

As a result of observations by Bonnet, in 1896, copper sulphate was used as a selective weed killer for the destruction of wild mustard (charlock) in cereals.

A. Some inorganic herbicides are:

1. Ashes
2. Common salts
3. Bittern (Bitter solution after salt has been crystallized out of sea water - Bromides, Iodides)
4. Copper sulphate (By Bonnet, 1896)
5. Sodium arsenite (In use from the turn of the century until about 1960)
6. Ammonium sulfamate (Patented in 1942). It is highly water soluble and has low mammalian toxicity; it translocates in plants and is used for brush control.

<sup>1/</sup> Taken from Weed Control - Principles of Plant and Animal Pest Control, Vol. 2. Published by National Academy of Sciences, Washington, D.C.

7. Ammonium thiocyanate
  8. Ammonium nitrate
  9. Ammonium sulfate
  10. Iron sulfate
  11. Copper sulfate
  12. Borates - are absorbed by plant roots and is translocated
  13. Sodium chlorate - used as a soil sterilant
- Foliar sprays, plasmolysis and desiccation may be the mechanisms of action

### ORGANIC HERBICIDES

Petroleum oils have been used many years as a contact herbicide for weed control. However, the development of organic chemicals for weed control essentially began with the introduction of 3, 5-dinitro-0-cresol as a weed killer in 1932. Its sodium salt became widely used under the name of DNOC.

A more significant milestone occurred a few years later with the herbicidal properties of 2, 4D (1941 by Pokorny). It demonstrated that herbicides could be used effectively in small quantities and still be highly selective.

#### A. Arsenical Herbicides

There are two groups of organic arsenicals widely used as herbicides

1. Arsonic acid
2. Arsinic acid

There are many derivatives of these two acids -- only cacodylic acid and methanearsonic acid are widely used as herbicides. Some common herbicides are:

- a. disodium methanearsonate (DSMA)
  - b. monosodium acid methanearsonate (MSMA)
  - c. monosodium methanearsonate (MAMA)
  - d. amine methanearsonate (AMA)
3. calcium acid methanearsonate (CMA)

The methanearsonic acids are contact herbicides and most effective at temperatures above 80° F., applied early on a clear day when plants are growing vigorously. They are selective.

The cacodylic acids are not highly selective. They tend to desiccate plants but translocate to a limited extent at rates below causing plant injury. Injected in trees, they translocate upward rapidly causing defoliation and death in a few weeks.

Generally, methanearsonate and cacodylate kill only tops of weeds; repeated applications at 2-3 week intervals are needed to kill perennial plants. These should be made during periods of high temperatures and high soil moisture conditions. These compounds, when they come in contact with the soil, are made rapidly inactive by absorption and ion exchange. There is no evidence of metabolism of these herbicides by microorganisms nor a significant buildup of toxic residues in the soil.

## B. Phenoxyaliphatic Acids

The phenoxyaliphatic acids and their derivatives make up a major group of organic herbicides of interest. They are selective and have outstanding ability to translocate in plants.

Included in this group is 2, 4D, and its salts, esters, and amides.

Some common herbicides are:

1. Dichlorophenoxyacetic acid (2, 4D)
2. Trichlorophenoxyacetic acid (2, 45T)
3. 2 methyl 4 chlorophenoxyacetic acid (MCPA)
4. 4-(2,4-dichlorophenoxy) butric acid (2, 4DB)
5. 2-(2, 4, 5-trichlorophenoxy) propionic acid (silvex)
6. 4-(2-methyl-4-chlorophenoxy) butric acid (MCPB)
7. 4-(2, 4, 5-trichlorophenoxy) butric acid (2, 4, 5-TB)
8. 4-chlorophenoxy-acetic acid (4-CPA)

The mode of action of the phenoxyaliphatic acids and the mechanism by which herbicidal responses are brought about are still incompletely understood.

## C. Substituted Amides

The amides comprise a diverse group of chemicals. Their biological properties vary widely.

Some common herbicides are:

1. 2-chloro-N, N-diallylacetamide (CDAA)
2. 2-chloro-N, N-diethylacetamide (CDEA)

These are the two earliest representatives of this class of grass-active preemergence herbicides. They are relatively simple molecules easily degraded by plants and soil.

3. N, N-dimethyl-2, 2-diphenylacetamide (Diphenamid)

Diphenamid is absorbed principally through the roots and has little or no contact activity. Most established plants are tolerant and the herbicide has its effect on seedlings. Diphenamid is not tightly absorbed on soil colloids and leaches rapidly in sandy soils. Under warm, moist conditions, its effectiveness remains three to six months.

4. 3', 4'-dichloropropionanilide (Propanil)

A selective postemergence herbicide that controls a broad spectrum of weeds. It translocates only slightly. It increases cell membrane activity.

5. N-1-naphthylphthalamic acid (NPA)

Used as a preemergence spray to control germinating seeds and seedlings of grasses and broadleaf weeds. Certain cucurbits are tolerant.

6. 3',4'-dichlorocyclopropanecarboxanilide (Cypromid)

It is a foliar-applied herbicide of high activity.

#### D. Nitroanilines

Certain substituted dinitrotoluidines have a high preemergence herbicidal action. Two materials of commercial importance are:

1. a, a, a-trifluoro-2, 6 dinitro-N,N-dipropyl-p-toluidine (trifluralin)
2. (Benefin) The ethyl propyl analog. Trifluralin has a low water solubility and is tightly held in the soil. Soils high in organic matter and clay require increased dosage. Trifluralin and benefin both are degraded by ultraviolet light and must be incorporated into the soil immediately upon application. Trifluralin has a low toxicity to mammals, but is toxic to fish.

## E. Ureas

Ureas are strongly absorbed by soil. They are absorbed by roots, but are poorly absorbed by the aerial parts of the plant. One of the important mechanisms of action of the urea herbicide appears to be the inhibition of photosynthesis. The ureas are metabolized by both plants and microorganisms.

Some common urea herbicides are:

1. 3-phenyl-1, 1-dimethylurea (fenuron)
2. 3-(p-chlorophenyl)-1, 1-dimethylurea (Monuron)
3. 3-(3,4-dichlorophenyl)-1, 1-dimethyl urea (diuron)
4. 3-(3, 4-dichlorophenyl)-1-methoxy-1-methylurea (linuron)
5. N-4-(4-chloro phenoxy) phenyl-N,N-dimethylurea (Chloroxuron)
6. 3-(m-trifluoromethylphenol)-1, 1-dimethylurea (fluometuron)
7. 3-(bromophenyl)-1-methoxy-1-methylurea (Metobromuron)
8. 3-cyclooctyl-1, 1-dimethylurea (Cycluron)
9. 1-(2-methylcyclohexyl-3-phenylurea (Siduron)
10. 3-(hexahydro-4, 7-methanoindan-5-yl)-1, 1-dimethylurea (Norea)

Siduron selectively controls germinating annual grasses (crabgrass, barnyardgrass, foxtails) in newly seeded or established plantings of bluegrass, fescue, redtop, smooth brome, perennial ryegrass, and orchardgrass. There is no evidence of residual chemical activity in the soil after one year.

Norea is a tricyclic substituted urea used as a selective herbicide in preemergence and postemergence applications on cotton, grain sorghums, and other crops.

## F. Carbamates

The carbamates are esters of carbanilic acid. They are a diverse group of herbicides having both aryl and alkyl--substituted derivatives as well as oxygen and sulphur containing compounds. They are highly selective in plants they control and most are preemergence. Some common herbicides are:

1. Isopropyl N-phenylcarbamate (IPC)
2. Isopropyl N-(3-chlorophenyl) carbamate (CIPC)

3. 4-chloro-2-butynyl-m-chlorocarbanilate (Barban)
4. 2, 6-di-tert-butyl-p-totyl-methylcarbamate (Terbutol)

These aryl carbamates generally cause cessation of cell division and plant tissue growth. Affected plants do not die immediately, but remain alive for prolonged periods. They are good weed killers, but volatile and restricted to use in cool weather. Most are applied to soils, but foliar uptake can occur. Barban is ineffective in soil application and is applied to foilage. These carbamates are readily broken down by microorganisms in the soil.

5. Ethyl N, N-dipropylthiocarbamate (EPTC)
6. 2-chlorallyl diethyldithiocarbamate (CDEC)
7. (Pebulate)
8. (Vernolate)
9. (Molinate)
10. (Diallate)
11. (Triallate)

The last seven compounds are thiocarbamates that are on the market for weed control in croplands. The thiocarbamates are not too soluble in water, but are very soluble in organic solvents. They are themselves good organic solvents. They are metabolized rapidly in soils and plants and residues rarely remain in crops at harvest.

#### G. Nitrogen Heterocyclics

##### 1. Symmetrical Triazines

The triazines represent a large group of herbicides and have a variety of selectivity and biological activity. They are powerful inhibitors of photosynthesis. Their selectivity appears to depend upon the ability of plants to tolerate the herbicide.

Some common herbicides are:

- a. (Simazine)
- b. (Atrazine)
- c. (Propazine)
- d. (Prometone) 2-methoxy-4, 6-bis(isopropylaminol-s-triazine)
- e. (Prometryne)
- f. (Ametryne)

2. 3-Amino-1, 2, 4-triazole (Amitrole)

Amitrole is absorbed rapidly by plant foliage, but drops at a rapid rate in time. It is translocated in the phloem and affects the plant by chlorosis and stunting. If the plant survives, the new tissues are albino.

3. Substituted Pyridazinones

5-amino-4-chloro-2-phenyl-3(2H)-pyridazinone (Pyrazon)

This is a selective herbicide, often used on beets; it controls many broadleaf weeds. It is relatively stable in soil. Photolytic degradation has not been observed.

4. Substituted Pyridines

a. 4-amino-3, 5, 6-trichloropicolinic acid (picloram)

b. (Pyricolor)

Picloram is perhaps the most active systemic growth-regulating chemical known. It is effective against a broad spectrum of plants and is highly persistent in the soil. It has a low order of mammalian toxicity. It is very mobile in water. Pyricolor is highly active and readily absorbed by roots and foliage. Pyricolor is mildly toxic to animals.

5. Substituted Uracils

These were introduced in 1962. Two representatives of this class are:

a. 5-bromo-3-Sec-butyl-6-methyluracil (bromacil)

b. 3-tert-butyl-5-chloro-6-methyluracil (Terbacil)

Bromacil controls a wide range of grasses and broadleaf weeds. It is applied to the soil surface just before or during active weed growth. It inhibits photosynthesis. Terbacil is a selective weed control in sugarcane, citrus, peppermint, and other perennial crops. It usually remains active for more than one season. Break-down by microorganisms seems to be the method of disappearance from the soil. Loss by photodecomposition or volatilization is negligible.

H. Substituted Aliphatic Acids

Two herbicides representing this class are:

1. Trichloroacetic acid (TCA)

2. 2, 2-dichloropropionic acid (Dalapon)

Both of these compounds are effective against grasses, but they also

control certain dicotyledonous plants. They are absorbed through the roots and dalapon seems to be effective when applied to foliage.

#### I. Arylaliphatic Acids

##### 1. Benzoic and phenylacetic acids

Some common herbicides are:

- a. 2, 3, 6-trichlorobenzoic acid (TBA)
- b. (Fenac)
- c. (Dicamba)
- d. (Amiben)

These are mostly used for soil applications against germinating seeds and seedlings. These substances are systemic growth regulators, but their mode of action is not known.

##### 2. Tetrachloroterephthalic Acid

DCPA is a representative of this class. It is a preemergence herbicide and apparently has no effect on the germination of seeds, but affects seedlings soon after they emerge.

##### 3. Trichlorobenzylchloride (TCBC)

This compound is combined with CDAA for controlling broadleaf weeds.

#### J. Phenol Derivatives

1. Pentachlorophenol
2. (DNC)

Pentachlorophenol is used as a selective weed control in soybeans and corn. It is very sensitive to organic matter in the soil. Where the organic matter content in the soil is above 2 percent, massive application rates are needed.

DNC was first introduced in 1932 as DNBP. These herbicides reduce growth and increase respiration rates followed by inhibition of respiration. They are effective protein-denaturing agents.

#### K. Substituted Nitriles

1. 2, 6 dichlorobenzonitrile (Dichlobenil)
2. (Diphenatrile)

Dichlobenil is a powerful inhibitor of germination and of actively dividing meristems. It is absorbed through seed coats and the

epidermis of shoots. It is effective at low application rates. In organic soils much higher rates must be applied. It has a relatively low toxicity to animals.

Dephenatril is a soil-active herbicide providing control of seedling grasses on certain other plants.

3. (Ioxynil)
4. (Bromoxynil)

L. Bipyridyliums

1. (Diquat)
2. (Paraquat)

These two materials are used as contact sprays and aquatic herbicides. The cations are rapidly and firmly absorbed on clay minerals in soil. Both are contact herbicides that damage plant tissue very rapidly. Tissues become waterlogged because of breakdown of cell membranes. They also affect photosynthesis and are less effective in the dark than in the light. They are so rapidly absorbed by the plant that rainfall soon after spraying does not reduce plant injury. Paraquat is rapidly broken down photochemically by ultraviolet radiation.

M. Saturated Aliphatics

1. Methyl bromide

This is widely used as a seedbed and nursery fumigant for control of weed seeds, vegetative organs, and nematodes, insects, and other soil-borne diseases. It is a gas at normal temperatures.

N. Unsaturated Aliphatics

Allyl Alcohol

This is used as a soil fumigant for killing weeds in nursery seedbeds. It is volatile, water soluble general biocide that is irritating to the eye and respiratory system. It is degraded by soil microorganisms.

Q. Other Chemicals

1. (Endothall)
2. (Bensulide)

Endothall is a contact herbicide used for aquatic weed control and as a selective herbicide in field crops, particularly sugar beets. It is used for preemergence and postemergence. Many plants, fish, and soil microorganisms are capable of decomposing endothall.

Bensulide is used for controlling crabgrass and other weeds in turf, ground covers, and ornamentals. It has little effect on weeds when applied as a foliage spray. It provides preemergence control to many grasses and broadleaf weeds. It persists for relatively long periods of time in the soil and is broken down slowly by microorganisms. There is no loss due to vaporization or photodecomposition from the soil.

