

INDUSTRIAL TOXICOLOGY

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2,4-DICHLOROPHEN-OXYACETIC ACID

2,4-Dichlorophenoxyacetic acid, known as 2,4-D, has come into extensive use within the past 3 years as a plant hormone which kills common lawn weeds such as dandelion, morning glory, thistle, and burdock, without harming ordinary grass. It is reported to hasten the ripening of fruit and has been used in orchards to prevent the premature dropping of apples. This substance is prepared commercially by causing chloroacetic acid and 2,4-dichlorophenol to react to aqueous alkali or by the direct chlorination of phenoxyacetic acid.

Since 2,4-D is a plant hormone, it acts as a plant growth regulator rather than as a contact poison. In its action on leafy plants it appears to be absorbed primarily into the epidermal cells from which it is translocated to various parts of the plant. 2,4-D induces rapid hydrolysis of starch to sugar and increased respiration (1). The killing of plant tissues is usually a slow process and the killing time may require two weeks or even longer. Young, vigorous plants are quickly affected and the most efficient herbicidal effect occurs when plants are treated in a state of active vegetative growth.

Since 2,4-D is not very soluble in water or oil, water-soluble salts or oil-soluble esters prepared in the form of emulsions or as dry dust mixtures are used. Water-soluble salt dusts of 2,4-D have been used extensively in rice and sugar cane fields with uniform weed control. During 1945, the first year in which production figures are given for 2,4-D, 917,000 pounds were prepared in the United States.

Owing to the phenomenal effects of 2,4-dichlorophenoxyacetic acid on weed eradication and the consequent commercial development of this substance as a weed killer, knowledge of its toxicity is important. Workers are exposed to the dust of the sodium or ammonium salts and to the mist from tributyl phosphate-Diesel oil emulsions, in applying this

weed eradicator. Further, an important factor in the use of this material is related to residual 2,4-D on plants intended for human or animal consumption. Hill and Carlisle (2) found that the LD50 dose of 2,4-D by mouth was 375 milligrams per kilogram for mice, 666 for rats, 800 for rabbits, and 1,000 for guinea pigs. Rats were fed up to one-tenth percent by weight of their diet over a period of 1 month without any harmful effects. Guinea pigs tolerated 1 gram of the material administered in divided doses of 100 milligrams over a period of 12 days. The experimental work indicated that the mist or clouds of the dry dust of the sodium salt was relatively nontoxic.

Mitchell and his associates (3) have shown that no harmful effects on the health or performance of farm animals resulted from the consumption of pasture grass liberally sprayed with 2,4-D. The 2,4-D was not found to be secreted into the milk nor was it found in the blood serum of a calf fed milk from the cow that received it in her ration. According to experiments conducted by the U. S. Department of Agriculture, one cow received a special dose of about one-fifth of an ounce of 2,4-D daily. Blood samples showed its presence in her circulation but it did not appear in her milk. Mitchell quotes the experimental work of Kraus concerning the ingestion of 500 milligrams of purified 2,4-D per day by a man over a period of 21 days without ill effect.

The possible presence of poisonous impurities in commercial preparations of 2,4-D should be noted. Methods for the determination of 2,4-dichlorophenoxyacetic acid consisting essentially of the titration of the acid group have been developed by Rooney (4).

References

- (1) Southwick, L. Chemical weed killers. *Chem. Ind.*, 60, 786 (1947).
- (2) Hill, E. V., and Carlisle, H. Toxicity of 2,4-dichlorophenoxyacetic acid for experimental animals. *J. Ind. Hyg. & Toxicol.* 29, 85 (1947).
- (3) Mitchell, J. W., Hodgson, R. E.,

and Gaetjens, C. F. Tolerance of farm animals to feed containing 2,4-dichlorophenoxyacetic acid. *J. Animal Science*, 5, 226 (1946).

(4) Rooney, H. A. Determination of 2,4-dichlorophenoxyacetic acid and its compounds in commercial herbicides. *Ind. Eng. Chem., Anal. Ed.*, 19, 475 (1947).

MAC VALUES

(Continued from page 8)

times, that 1,000 p. p. m. is the most which should be allowed of any unnatural atmospheric contaminant.

"Five substances, benzene, ethylene chlorhydrin, nitroethane, nitromethane, and tetrachlorethane were changed in the light of recent data which certainly can be classed as experimental evidence. Two others, ethylene dichloride and methyl cellosolve, were revised in accordance with previously reported field evidence which had been ignored when the previous list was compiled. Three other substances, arsine, sfbine, and dioxane, were reduced because a very superficial examination of the data available indicated that the values previously given were much too high. Three additional substances, styrene, MIK, and methyl butanone, were reduced to make them all more in line with other similar substances. Finally, two other substances, tri- and tetra-chlorethylene, were reduced on the basis of extensive experience by one of the divisions involved."

Furthermore, the observations of experienced members of the conference derived from various plant surveys have added to our knowledge of the effects of many of these substances on humans and should be considered as valuable supplementary information beyond that obtained by an animal experimentation.

For the benefit of those who would ascribe a legal interpretation to such values, it may perhaps be advisable to use the older expression "threshold limit" rather than "maximum allowable concentration." Furthermore, it is the writer's opinion that the maximum allowable concentration values referred to should not form part of a code itself but should appear as supplementary information in an appendix and should be used only as originally intended, that is, as a guide and not as fixed values.