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UNITED STATES AIR FORCE ACADEMY, COLORADO

Annual Research Progress Report No. 11

July 1976



COVERING PERIOD

1 July 1975 - 30 June 1976

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This is the fifth published Annual Research Progress Report; the editions previous to 1972 were published as Semi-Annual Progress Reports. Further information desired on any project may be obtained by writing to the department listed for the principal investigator, USAF Academy, Colorado 80840

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correlation between elevated serum cholesterol and coronary disease, this finding was indeed encouraging. A positive correlation was also observed between periods of stress (academics, hell week, and Basic Cadet Training) and average cholesterol and uric acid levels. This finding may be useful in diagnosing emotional stress when the patient (subject) is not aware that he is under severe stress conditions. A third general finding was that there was an overall average weight increase in the subjects of this study. While this may not be unexpected, determinations of body fat revealed there was an unexpected decrease in this parameter. Apparently, this weight increase was due to an increase in muscle tissue rather than in fatty deposits. Overall, the data from this study tend to lend support to the current diet and physical conditioning programs at USAFA. Other findings will undoubtedly be forthcoming after all the data have been evaluated.

10. Determination of Parameters for a Model of Environmental Quality for USAF Installations

Principal Investigators: Captain Lawrence J. Biever and Alvin L. Young, and Major Manuel A. Thomas, Department of Chemistry and Biological Sciences.

Sponsored by Frank J. Seiler Research Laboratory (AFSC).

The major effort on this project this year has been to determine what effects non-potable sewage effluent have on ecosystems (e.g., parade fields and golf course) where it is used for irrigation. Data collected so far indicate that inclusions in the water are causing a unfavorable shift in species composition of grasses and are causing damage to tree species. The non-potable irrigation water includes high concentrations of phosphate, nitrate, chlorine, salt, and many heavy

metals, Soil analysis indicated progressive changes in soil chemical composition that may result in degradation of soil quality. Continuation of the program is being proposed to further delineate cause and effect relationships and to provide corrective measures.

11. An Evaluation of Current Capabilities in Genetics and Molecular Biology

Principal Investigators: Captain Lawrence J. Biever, Captain Alvin L. Young, Lieutenant Colonel Eugene L. Arnold, and Major William C. Wilson, Department of Chemistry and Biological Sciences.

Sponsored by the Defense Intelligence Agency.

This study has been initiated to determine the state-of-the-art of current biological technology. An evaluation of the results of the application of current biological research to agriculture, industry, medicine, and the military has been made. The study included an evaluation of the international political, economic, social, and military impact of technological developments in biology. ^{Genetic Engineering}

Data collected from current literature and contacts with researchers has been evaluated by DFCBS personnel. An interim report has been submitted. The final report will be submitted in June, 1976. A follow-on project has been proposed by the sponsor.

12. Disposal of Herbicide Orange by Soil Incorporation and Biodegradation

Principal Investigators: Captain Alvin L. Young, and Lieutenant Colonel Eugene L. Arnold, Department of Chemistry and Biological Sciences.

Sponsored by Air Force Logistics Command/DS.

In August 1972, a site for soil incorporation of 2,4-D and 2,4,5-T herbicides was selected on the Air Force Logistics Command Test Range Complex, Hill Air Force Base, Utah. The site was considered

remote and the land of low-use potential. It was characterized by sandy loam soil with a pH of 8.0 and an organic carbon content of 0.95 percent. The herbicide formulation contained equal amounts of the n-butyl esters of 2,4-D and 2,4,5-T and was applied by simulating sub-soil injection at rates as high as 4,000 lbs ai/A. The replicated plots were periodically sampled and the concentration of ester and acid forms of the herbicides was determined by gas-liquid chromatography. Levels of the toxic contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) were also measured in certain selected samples. Degradation of both ester and acid form of each herbicide was initially rapid (1st year) but tended to taper off in succeeding years. Strict exponential decay kinetics were not followed. Application rate had only minimal effect on the rate or pattern of degradation. The rate of disappearance of 2,4-D was slightly higher than that for 2,4,5-T. In those samples in which it was measured, significant degradation of TCDD was also noted. Soil penetration of the herbicides as either acid or ester forms was negligible.

Publications

Arnold, E. L., A. L. Young, and A. M. Wachinski. 1976. Three years of field studies on the soil persistence and movement of 2,4-D, 2,4,5-T and TCDD. Presentation to the Weed Science Society of America, 3 February 1976, Denver, Colorado. Abstract No. 206.

Arnold, E. L. and A. L. Young. 1976. A rapid gas chromatographic method for the determination of phenoxy herbicide residues from soil disposal plots. Journal of Agriculture and Food Chemistry. In Press.

13. Ecological Studies on a Herbicide-Equipment Test Area (TA C-52A), Eglin AFB Reservation, Florida

Principal Investigators: Captain Alvin L. Young, and Majors Charles E. Thalken and Lorris G. Cockerham, Department of Chemistry and Biological Sciences.

Sponsored by Air Force Logistics Command/DS.

During this past year species diversities and food chain studies were conducted in two aquatic ecosystems draining the unique one-square mile military test area (Test Area C-52A, Eglin AFB, FL) that received 160,948 lbs 2,4,5-T and 169,292 lbs 2,4-D herbicide during the period 1962-1970. Significant levels (10-710 parts per trillion, ppt) 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) were found within the top six inches of the test area soil. Erosion of soil occurred into a pond on the test area and into a stream immediately adjacent to the area. TCDD levels of 10-35 ppt were found in silt of the aquatic systems, but only at the point where eroded soil entered the water. Species diversity studies of the stream were conducted in 1969, 1970, 1973 and 1974. Insect larvae, snails, diving beetles, crayfish, tadpoles, and major fish species from both aquatic systems were analyzed for TCDD. Species diversity studies indicated no significant change in the composition of ichthyofauna between these dates or a control stream. Concentrations of TCDD (12 ppt) were found in only two species of fish from the stream, Notropis hypselopterus, Gunther (sailfin shiner), and Gambusia affinis, Baird and Girard (mosquitofish). Samples of skin, muscle, gonads, and gut were obtained from Lepomis punctatus, Valenciennes (spotted sunfish), from the test grid pond. Levels of TCDD in those body parts were 4,4,18 and 85 ppt, respectively. Gross pathological observations of the sunfish revealed no significant lesions or abnormalities.

Publications

Young, A. L., C. E. Thalken, and W. E. Ward. 1975. Studies of the ecological impact of repetitive aerial applications of herbicides on the ecosystem of Test Area C-52A, Eglin AFB, Florida. AFATL-TR-75-142, Air Force Armament Laboratory, Eglin AFB, Florida.

Young, A. L., P. J. Lehn, and M. F. Mettee. 1976. Absence of TCDD toxicity in an aquatic ecosystem. Presentation of the Weed Science Society of America, 3 February 1976, Denver, Colorado. Abstract No. 107.

14. Radiochemical Bioassay of TCDD Uptake in Plant Material

Principal Investigators: Captains James M. Cupello, and Alvin L. Young, Department of Chemistry and Biological Sciences.

Sponsored by Frank J. Seiler Research Laboratory (AFSC), and Air Force Logistics Command/DS.

The Environmental Protection Agency currently limits the commercial use of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) herbicide due to the lack of environmental data on the teratogenic (birth-deforming) contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) found in many 2,4,5-T formulations. The consequence of such a use limitation directly affects the fate of a large USAF surplus inventory of Herbicide Orange (a 2,4,5-T formulation).

In a study to determine potential plant uptake of TCDD, a 2,000 pounds per acre equivalent application of Herbicide Orange, containing 14 parts per million (ppm) C-14 labelled TCDD, was placed 4" beneath the soil surface in specially constructed growth boxes, containing 100 plants of Sorghum, Sorghum vulgare, per box. The plants were grown under controlled environmental conditions for a period of nine weeks, at which time they were harvested and assayed for TCDD uptake. Analysis of the plant tissue (exclusive of root systems) prior to hexane extraction, and

after hexane extraction for four hours in a Soxhlet extraction apparatus, indicated the presence of an amount of C-14 activity that was equivalent to 430 parts per trillion (ppt) of TCDD in the plant material. This represents the maximum amount of TCDD that could be present in the plant material, but could also represent (1) the preferential plant uptake of a minor impurity in the TCDD formulation that was applied to the soil; (2) a metabolic breakdown product that was formed in the plant material after TCDD incorporation; or (3) the preferential uptake of a soil decomposition or soil microbial degradation product of the original TCDD placed in the soil.

15. Ultrastructural Studies of Liver Tissue from TCDD-Exposed Beach Mice (*Peromyscus polionotus*)

Principal Investigators: Major Lorris G. Cockerham and Captain Alvin L. Young, Department of Chemistry and Biological Sciences.

Sponsored by Air Force Logistics Command/DS.

In support of research on the biological effects of animals exposed to TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin), ultrastructural studies were initiated on beach mice, *Peromyscus polionotus*, collected from a herbicide-equipment testing range (Test Area C-52_A, Eglin AFB, Florida). Liver tissue from 30 mice (from the test and a control area) were examined with an electron microscope for possible ultrastructural changes in mitochondria and smooth and rough endoplasmic reticulum. Similar data were collected from 22 mice brought from the field into the laboratory and exposed to 30 days of external dusting with alumina gel (with or without 2.5 ppb TCDD).

Five representative electron micrographs were made from the liver tissue of each animal and the data were obtained from each micrograph

using a technique known as "point counting". With this method, a transparent grid of intersecting lines was placed at random over the micrographs and all the line intersections which were over the required cell structures were counted. The total area of the cytoplasm was then measured in the same manner. An analysis of variance was conducted to determine whether there was a statistically significant difference between populations of cells, i.e., percentage mitochondria and smooth and rough endoplasmic reticulum, removed from experimental and control animals. Analysis of data indicated no statistical differences between field control and field treatment animals, although differences were noted between field and laboratory animals.

16. Ultrastructural Evaluation of Tissues Removed from Animals Exposed to TCDD

Principal Investigator: Major Glenn M. Buchanan, Department of Chemistry and Biological Sciences

Sponsored by the Frank J. Seiler Research Laboratory (AFSC)

A long-term study of the possible biological hazards of pelage exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) has been initiated on the beachmouse, Peromyscus polionotus. Animals were divided into three experimental groups: untreated controls, a "treated" control group dusted with diatomaceous earth, and a "treated" group dusted with diatomaceous earth containing 2.5 parts per billion TCDD. The animals were dusted three times per week; the TCDD concentration simulating an exposure that was twice that expected from normal rangeland application rates of 0.1 parts per million TCDD contaminated 2,4,5-T herbicide. The effect of TCDD on animal weight, blood components, and

cellular ultrastructure (adrenal cortex, testes, liver and kidney) will be investigated following completion of the study. Animal weight data collected over a nine-week period indicated no effect due to TCDD applications, relative to controls.

D. Department of Civil Engineering, Engineering Mechanics, and Materials

1. Backing Strength of Masonry Shear Walls

Principal Investigator: Captain Richard H. Jolley, Department of Civil Engineering, Engineering Mechanics and Materials

Sponsored by the USAF Academy

Increased interest in using masonry for load-bearing structural systems has necessitated review of existing code design criteria and establishing improved design techniques. The objectives of this project are to (1) formulate a failure criteria for walls subjected to "in plane" loads and (2) establish a deflection prediction criteria for walls subjected to "in plane" loads.

The final report is complete and available to any agency or interested individual. Contact USAF Academy, DFCEM.

2. Validation of the Soil Stabilization Index System with Manual Development

Principal Investigators: Captains John J. Allen, and Dallas Little, and Technical Sergeant Glenn K. Kaneyuki, Department of Civil Engineering, Engineering Mechanics and Materials

Sponsored by the Air Force Civil Engineering Center and the Frank J. Seiler Research Laboratory, Air Force Systems Command (AFSC)

The project scope as detailed in Annual Research Progress Report No. 10 was extended to include required values of residual strength for