Behavior of herbicides in soil

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I. Introduction

During the past 12 years more than a dozen articles have appeared dealing broadly with the topic of this review or with a major segment of the subject matter involved. The first comprehensive review of herbicide behavior in soil was provided by ENNIS (1954) who described the nature of the problem and implications of downward movement, persistence, and volatility in relationship to preemergence herbicide usage. At the Charter Meeting of the Weed Society of America, HILL (1956) presented a thorough examination of soil factors and herbicide action. In addition to the topics which ENNIS covered HILL was able to lay special emphasis on photodecomposition and specific interactions with the clay and organic components of soil. Unfortunately, HILL's presentation was published in abstract form only. The series initiated by ENNIS and HILL has been continued by HOLLY (1962) in a presentation at the Sixth British Weed Control Conference. HOLLY organized his brief review under the topics of losses from soil surface, incorporation into soil, and adsorption and persistence in soil.

In 1960 symposia dealing with herbicides and soil were held in England and in the United States. In the English symposium AUDUS (1960) dealt

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with herbicide detoxication by microbes, FLETCHER (1960) with the influence of herbicides on microbes, HARTLEY (1960) with physicochemical aspects, and VAN DER ZWEEP (1960) with herbicide persistence in soil. In the American symposium DEAN (1960) discussed chemical reactions in soil while SHEETS and DANIELSON (1960) concerned themselves with the fate of herbicides in soil.

The relationship of simple chemical laws to herbicide behavior in soils has been summarized by FREED et al. (1962). More recently HARTLEY (1964) has expanded his physical chemistry approach to herbicide reactions in soil and has made some practical extrapolations.

AUDUS in England and ALEXANDER in America have been foremost in conducting microbiological studies with herbicides. The English work summarized by AUDUS in 1960 was later expanded to a more comprehensive review including both influence of microbes on herbicides and the influence of herbicides on microbes (AUDUS 1964). While the research by ALEXANDER has centered on the alkyloxyaliphatic acids, he has drawn some general conclusions (ALEXANDER 1965).

The topic of herbicide behavior in soils was treated in a presentation before the Seventh British Weed Control Conference (UPCHURCH 1964). Emphasis was placed on the role of electrical charges of herbicides and soil components and the interaction of soil pH with respect to the electrical forces involved.

The matter of herbicide persistence in soil is a recurring theme in the review articles cited above. This aspect of herbicide behavior has been the subject of a recent review (SHEETS and HARRIS 1965).

BAILEY and WHITE (1964) have summarized the status of our knowledge on the adsorption and desorption of herbicides in the presence of soil colloids. They included a consideration of implications of sorption for bioactivity.

The goal of the present review will be to establish a perspective regarding the broad utility of various types of investigations. The scientist with even a casual interest in the behavior of herbicides applied to soil will recognize that there is an almost unlimited number of investigations which may be undertaken especially if the gauntlet is to be rerun with each new herbicide. While any well-conceived investigation has intrinsic utility, a proper perspective of the vast array of possible relationships between soil and herbicide should enhance our ability to assimilate the results of each new investigation. Hopefully, this perspective would also provide a better basis for designing experiments to bear on aspects which are paramount. In addition to the above goal an effort will be made to review pertinent published information not yet included in a general review article.¹

The organization of this review is based on the assumption that consequences of herbicide applications to soil are largely governed by four criteria: namely, placement, sorption equilibria in soil, inherent phytotox-

¹The literature review for this manuscript was concluded on January 1, 1966.