The Incidence of Eradicane Injury in Several Corn Cultivars as Influenced by Seed Placement, Soil Moisture, and Chemical Concentration.

by

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ABSTRACT

The development of the antidote R-25788 has made it possible to use the herbicide, Eptam, in corn production. However, there have been many reported cases of safener failure in field corn treated with Eradicane. The chemical concentration, depth of planting, and soil moisture were not found to directly affect the incidence of Eradicane injury in the Dekalb XL-55 and Dekalb XL-67 cultivars. Twelve commonly used corn cultivars were found to be less susceptible to Eradicane injury than the Dekalb XL-67 cultivar.

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CONTENTS

ILLUSTRATIONS

TABLES page

FIGURES

INTRODUCTION

In the quest for more effective weed control traditionally an emphasis has been placed on the development of new chemical herbicides. However, over the past decade many scientists have initiated research in another area of chemical weed control. These scientists are searching for means by which present herbicides can be adapted to new uses. The corn herbicide, Eradicane, represents an advance in this area. Eradicane is the combination of Eptam (EPTC), a thiocarbamate herbicide, and R-25788, a chemical antidote.

In 1961 Stauffer Chemical Company introduced Eptam (EPTC), the first thiocarbamate herbicide. Eptam's wide spectrum of weed control and relatively short soil persistence made it an exciting new herbicide. Farmers found that by using Eptam they could control tough weeds such as johnsongrass, shattercane, and nutsedge without encountering problems with chemical carry-over into the next crop. This made Eptam an excellent herbicide to use in crop rotation systems. Unfortunately, corn producers were unable to use Eptam due to the corn plant's low tolerance to this chemical.

In an effort to make Eptam (EPTC) more versatile and feasible for use in corn, the chemical antidote, R-25788, also known as N,N-diallyl-2,2-dichloroacetamide, was developed. This chemical has been found to increase the corn plant's tolerance to Eptam four to ten fold (2). The exact mode of action of R-25788 is not yet completely understood. Corn plants

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The style and format of this thesis follows that outlined in <u>Weed Science</u>.

treated with this antidote have been found to have increased concentrations of reduced glutathione and increased activity of glutathione S-transferase (2,8). It has been proposed that Eptam is detoxified in the corn plant through a pathway in which glutathione oxidizes EPTC to its sulfoxide. This compound is then cleaved by glutathione S-transferase to a glutathione conjugate of EPTC which is nontoxic to corn (8).

The chemical combination of R-25788 and Eptam, marketed by Stauffer Chemical Company under the trade name of Eradicane, has been widely accepted by corn producers throughout the United States. Although the antidote R-25788 reduces the risk of chemical injury in corn treated with Eptam, there have been many reported cases of crop injury in corn that has been treated with Eradicane. There is evidence that a phytotoxic interaction between the systemic insecticide Fonofos and the herbicide Eradicane exists in sweet corn (6). There have also been many substantiated reports of injury in field corn treated with Eradicane. However, the conditions that promote this injury in field corn are not as clearly defined as the conditions that promote injury in sweet corn.

In a report of the results of a survey of Maryland corn producers who used Eradicane it was noted that 61% of all the reported acreage indicated some form of herbicide related crop injury (5). This report also indicated that there was a correlation between the soil texture and the amount of injury displayed by the plants. The most severe injury seemed to be associated with the sandy loam and loamy sand soil types (5). This could be due to the deeper depth of planting which is often associated with the coarser soil textures (5). Research conducted by Dr. G.W. Burt tends to substantiate the theory that the planting depth is an influential factor in the occurrence of Eradicane injury in field corn. Corn planted at a depth of 2 cm. displayed less injury than corn planted 4 cm. below the soil surface (3).

Another environmental condition which may influence the incidence of Eradicane injury in field corn is soil moisture. In research conducted using Eptam without an antidote changes in soil moisture were found to have an influence on the amount of injury exhibited by the corn plant (2). This has led Stauffer Chemical Company scientists to theorize that soil moisture will also influence the incidence of injury in corn treated with Eradicane (1). These scientists report that field data suggests that there may be variations in the susceptibility of different corn cultivars to Eradicane injury (1).

This study was intiated to determine the most optimum conditions which would induce injury into known susceptible field corn cultivars. The conditions inducing the greatest amount of injury were then used to screen other cultivars to ascertain their reaction to Eradicane.

MATERIALS AND METHODS

To determine the set of conditions which most consistantly promote Eradicane injury in a greenhouse experiment the Dekalb XL-55 and Dekalb SL-67 cultivars, known for thier susceptibility to this injury, were grown under a number of different conditions. The chemical rate, depth of planting, and soil moisture were the conditions varied in this experiment (see Appendix A). Three different chemical rates of Eradicane were used: the 0 pint/acre, 4.75 pint/acre, and 7.25 pint/acre. The 2 cm. and 4 cm. depths of planting were chosen to duplicate Dr. Burt's previous experiment (3). Watering regimes were developed which would provide drought stress in one regime, normal conditions in another, and excess moisture stress in a third (see Appendix A).

Six inch diameter pots were sterilized and then filled with Norwood silt loam to a depth of two inches. This soil was then covered with three inches of soil which had been treated with Eradicane. To incorporate the Eradicane into the soil the proper amount of chemical (see Appendix B for calculations) was diluted into 1,000 ml of water which was then manually incorporated into 30 lb. of soil. The soil was then placed into the pots, as mentioned previously, to form a three inch layer of treated soil as illustrated in Figure 1. To prevent any differences in plant growth which would be associated with differences in the physical handling of the soil, a three inch layer of soil which had pure water incorporated in it was placed into the control pots following the procedure outlined above.

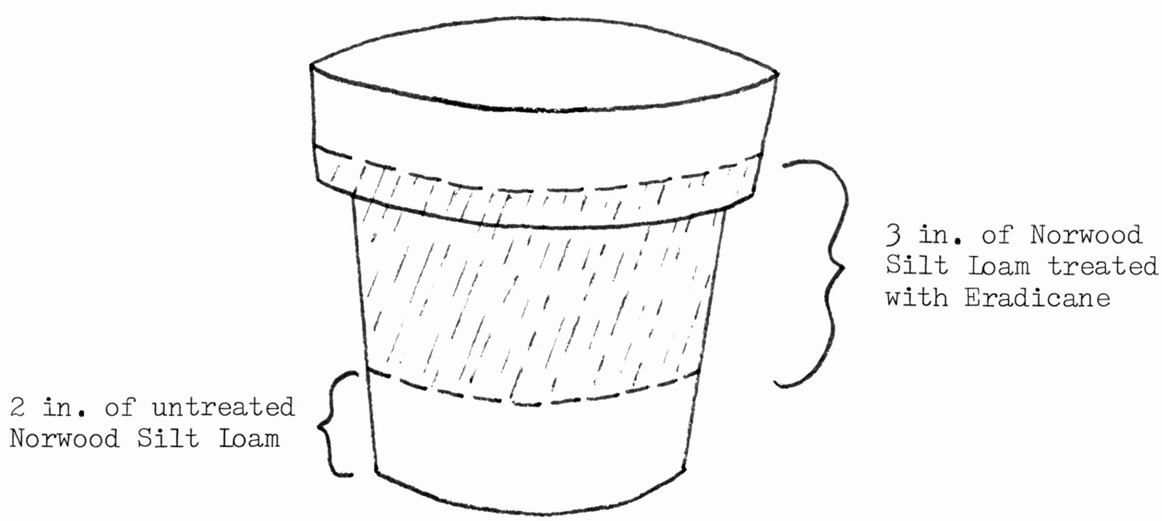

FIGURE 1. An Illustration of the Incorporation Procedure.

The corn was then planted at its respective planting depths with the desired plant population of three plants per pot. The pots were watered daily according to the individual watering regimes (see Appendix A). Due to a shortage of greenhouse space only two replications of this experiment were feasible.

Data collection in this experiment was facilitated by the development of the visual rating system exhibited in Figure 2. Visual ratings of the plants were taken 25 days and 45 days after planting. Each individual plant within the treatments was rated on the one to ten scale. Plant height was also measured during the 25 and 45 day rating periods. The fresh weight of each treatment was measured 45 days after planting. This physical data was taken in an attempt to develop a quantitative system of measurement for this form of injury. Unfortunately, there was no direct correlation between the variations in plant height and weight and the variations in the degree of injury displayed by the plants. Therefore, the physical measurements did not provide an accurate indication of the degree of injury and could not be used to develop a quantitative system of measurement.

Twelve commonly used field corn cultivars were chosen to be screened to ascertain their reaction to Eradicane. A list of these cultivars is presented in Table I. In order to test this material pots were prepared in the manner previously mentioned. The 7.25 pint/acre rate of Eradicane was used and the seeds were placed 2 cm. below the soil surface. The pots were watered with 75 ml of water per pot per day. These conditions were chosen based on the results of the previous experiment that will be discussed in a later section of this paper. Three replicates of the twelve cultivars were grown under these conditions along with the Dekalb

RATING	PLANT DESCRIPTION
1	DEAD PLANTS
2	COMPACTED, CURLED GROWING POINT NO POSSIBILITY OF FUTURE GROWTH
3	CURLED GROWING POINT NORMAL VERTICAL GROWTH IS IMPOSSIBLE LATERAL GROWTH IS OCCURRING
4	UPRIGHT LEAVES FUSED TOGETHER NO POSSIBILITY OF LATER LEAVES FREEING THEMSELVES FROM FUSED LEAVES
5	NO COMPACTED CURLING OF FUSED LEAVES LEAF DAMAGE DUE TO LATER GROWTH BREAKING THROUGH FUSED LEAVES
6	NO COMPACTED CURLING OF FUSED LEAVES SLIGHT LEAF DAMAGE DUE TO LATER GROWTH BREAKING THROUGH FUSED LEAVES
7	FUSED CURLING OF VERTICAL LEAVES GOOD POSSIBILITY OF LATER NORMAL GROWTH
8	CURLING OF LATER LEAVES NO FUSION OF LEAVES NEW GROWTH EMERGES EASILY
9	SLIGHT CURLING OF LEAVES
10	NO SIGN OF ABNORMAL GROWTH

FIGURE 2. A Visual Rating System for Eradicane Injury.

TABLE I. Twelve Field Corn Cultivars Screened for Response to Eradicane.

CULTIVARS SCREENED	
Tx601 x Tx441	T232 x Tx601
Tx127C x Tx441	Va35 x Mo17
Mo17 x B73	Va35 x B84
Mo17 x B84	Tx6252 x Tx5855
Mo17 x Va72	Tx403 x Tx5855
SC43 x SC90	Tx303 x Tx6255

XL-67 cultivar which was used as a standard. The plants were rated visually at 25 days after planting. The mean rating and standard deviation of the cultivars were calculated and the cultivars were ranked in order of their relative susceptibility to Eradicane injury.

RESULTS AND DISCUSSION

To evaluate the data from the initial phase of his study the mean ratings and standard deviations of the treatments were calculated. There was a marked increase in injury in the 4.75 pint/acre treatments over the control pots. However, there was no significant variation between the 7.25 pint/acre treatments and the 4.75 pint/acre treatments (Table II). The lack of variation in injury between these two chemical rates is an indication that varying the level of Eradicane within recommended rates will not influence the incidence of the chemical injury.

Contrary to the results observed by Dr. Burt in his earlier experiment (3), the data displayed in Table III shows that there was no significant injury variation that could be directly associated with the difference in depth of planting. This data leads one to question if there is a direct correlation between the depth of planting and the incidence of Eradicane injury.

As with the depth of planting, varying the soil moisture did not cause a significant variation in the degree of injury displayed by the corn plants. However, both Table III and IV show the wide deviation in the degree of injury displayed by the plants within the treatments. This is very interesting because it might mean that there are other factors not associated with the depth of planting and soil moisture that influence the occurrence of Eradicane injury. Two such factors could be light and

TABLE II. The Effect of Chemical Rates on the Incidence of Eradicane Injury in Dekalb Hybrids, XL-55 and XL-67.

RATE OF ERADICANE	MEAN VISUAL RATINGS	
	XL-55	XL-67
0 PT/ACRE (0 lb/acre)	10.0 ± 0.0*	10.0 ± 0.0
4.75 PT/ACRE (3.99 lb/acre)	6.8 ± 1.8	4.0 ± 2.0
7.25 PT/ACRE (6.07 lb/acre)	6.1 ± 2.1	3.8 ± 1.4

* Standard Deviation of the Replications

TABLE III. The Effect of Planting Depth on the Incidence of Eradicane Injury in Dekalb Hybrids, XL-55 and XL-67.

PLANTING DEPTH	MEAN VISUAL RATINGS	
	XL-55	XL-67
2 CM	6.9 ± 2.9*	5.3 ± 2.8
4 CM	7.5 ± 2.4	4.9 ± 3.0

* Standard Deviations of the Replications

TABLE IV. The Effect of Soil Moisture on the Incidence of Eradicane Injury in Dekalb Hybrids, XL-55 and XL-67.

SOIL MOISTURE	MEAN VISUAL RATINGS	
	XL-55	XL-67
DRY+	7.3 ± 2.3*	4.7 ± 3.0
NORMAL	6.9 ± 2.3	4.8 ± 3.0
WET	7.2 ± 2.3	5.8 ± 2.7

* Standard Deviation of the Replications

+ See Appendix A for Watering Regimes

temperature; conditions which could not be controlled in this experiment. Further study using these conditions as variables may provide the answer to many questions.

The data from the initial experiment in this study indicated that Eradicane injury could be induced in the greenhouse. However, none of the treatments used had a greater effect in inducing this injury. Although we could not be certain that the conditions used in the second phase of this study would promote injury we decided to proceed with the experiment in the hope of detecting differences in degrees of susceptibility between the corn cultivars. The mean rating and standard deviation of each cultivar is listed in Table V. It is very easy to see that none of the twelve cultivars displayed any form of chemical injury while the Dekalb XL-67 cultivar was injured. Based on this information the twelve cultivars appear to be more tolerant to Eradicane than is Dekalb XL-67.

TABLE V. The Amount of Eradicane Injury Displayed by Popular Field Corn Cultivars.

CULTIVAR	MEAN VISUAL RATING
Tx601 x Tx441	10.0 ± 0.0*
Tx127C x Tx441	10.0 ± 0.0
T232 x Tx601	10.0 ± 0.0
Mo17 x B73	10.0 ± 0.0
Mo17 x B84	10.0 ± 0.0
Mo17 x Va72	10.0 ± 0.0
Tx6252 x Tx5855	10.0 ± 0.0
Tx403 x Tx5855	10.0 ± 0.0
Tx303 x Tx6252	10.0 ± 0.0
SC43 x SC90	10.0 ± 0.0
Va35 x Mo17	10.0 ± 0.0
Va35 x B84	10.0 ± 0.0
Dekalb XL-67	6.0 ± 1.0

* Standard Deviation of the Replications

The data from this study, although inconclusive, raises several questions. The chemical concentration, depth of planting, and soil moisture are not factors which directly influence the incidence of Eradicane injury. What factors do directly influence this injury? Are there any such factors? Will it be found that no set of conditions will promote Eradicane injury consistantly? These are all questions for which the corn producer wants answers. Further research is needed before the answers can be provided. However, this study has laid the groundwork for future research in this area.

APPENDIX A

TREATMENTS

Three general conditions, the chemical rate, depth of planting, and soil moisture were used in this experiment.

I. Three recommended rates of Eradicane were used.

  A. 0 pint/acre (0 lb/acre)

  B. 4.75 pint/acre (3.99 lb/acre)

  C. 7.25 pint/acre (6.07 lb/acre)

II. Two planting depths were used.

  A. 2 cm. below the soil surface

  B. 4 cm. below the soil surface

III. The soil moisture was varied in the following watering regimes.

  A. Dry (50 ml per pot per day)

  B. Normal (100 ml per pot per day)

  C. Wet (150 ml per pot per day)

APPENDIX B

SAMPLE CALCULATIONS

4.75 pint/acre rate:

$$\frac{4.75 \text{ pint}}{1 \text{ acre}} \times \frac{1 \text{ acre-3 inches deep}}{1 \times 10^{6} \text{ lb. of soil}} = 4.75 \times 10^{-6} \text{ pint/lb. of soil}$$

$$\frac{4.75 \times 10^{-6} \text{ pint}}{1 \text{ lb. of soil}} \times \frac{1 \text{ quart}}{2 \text{ pint}} \times \frac{1 \text{ liter}}{1.056 \text{ quart}} = \frac{2.249 \times 10^{-6} \text{liter}}{\text{lb. of soil}}$$

$$= .002249 \text{ ml/lb. of soil}$$

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