Uptake and Residue of 3, 4-Dichloro-5-Isothiazole Carboxylic Acid in Cotton Plants and Soils Under Field Conditions

P.G. Bartels and J. Olvey

Abstract

DICA (3, 4-dichloro-5-isothiazole carboxylic acid) is being used as a chemical hybridizing agent in the cotton breeding program of Chembred Seed Company. This compound produces male sterile flowers. Registration of this compound by EPA requires that a plant residue study be conducted to provide data on the quantitative amounts of residues in F_1 plants and seeds, F_2 seeds and in the soil. This study was carried out in Arizona because the hybrid F_2 cotton seeds will be grown in Arizona.

INTRODUCTION

In cotton, genetic (cytoplasmic) male sterility or incompatibility is absent or intractable. However, male sterility can be produced in cotton by chemically treating plants with the hybridizing agent, 3, 4-dichloro-5-isothiazole carboxylic acid (DICA). At specific rates, this agent selectively renders pollen and/or anthers non-functional leading to male sterile flowers. This prevents self pollination and avoids laborious hand emasculations. Chembred Seed Company, a division of American Cyanamid, is currently using this chemical in their breeding program to produce female flowers for making crosses.

The registration of this compound by EPA requires that a plant residue study be conducted to provide data on the quantitative amounts of residues in F_1 plants and seeds, F_2 seeds and in the soil. This residue study was conducted in Arizona because the hybrid F_2 cotton seeds will be grown in Arizona.

The purpose of this study was to determine the uptake and translocation of DICA and its derived residues in F_1 cotton plants and seed, to assess carryover of DICA and related residues in F_2 plants and seeds and to determine the quantity of DICA and residues in soil.

MATERIALS AND METHODS

The investigation was conducted at a remote site at the Maricopa Agricultural Center in field one. Prior to sowing the cotton seed, the soil in the field was cultivated to a depth of 25cm and freed of weeds and debris. Fertilizer and herbicides were incorporated into the soil at time of soil preparation. Cotton variety Delta Pine 91 was sown in 1m beds. Three separate plots each measuring 120cm by 300cm were used in this study and designated I, II, III. The plots were enclosed within a 2.5m high chain-link fence measuring 30m by 30m. Each plot was bordered with a wooden frame constructed from 2.5cm by 20cm wide pressure treated boards. The wooden frames were buried in the soil to within 8cm of the soil surface. Appropriate radioactive material

caution signs were posted on the chain-link fence. Appropriate pesticides were used to control foliar and boll insects and diseases.

Radioactive DICA was prepared by New England Nuclear (Boston) with carbon-14 in the 4,5 position of the isothiazole ring. The specific activity of DICA was 82.1 mCi/mg. DICA spray solution was formulated as potassium salt just before each application and diluted with water to a volume which covered the plant foliage with minimal runoff. The nominal final specific activity of all treatment preparations was 4.05 Mc Ci/mg. Seven applications were conducted during the growing season and the total amount of DICA applied did not exceed 2 lb ai/acre (Table 1). The specific rates and time intervals between treatments were based on sterility status of the anthers of the flowers. The formulated spray solution was applied with a pressurized (40psi) backpack sprayer fitted with tee jet flat fan nozzle. DICA was sprayed over the top of the young cotton plants and over the top and sides for larger older cotton plants. Before each spray application, a 180cm high plastic sheet was placed around plot I to prevent drift of radioactive DICA to adjacent areas. Plot II and III were the control plots and they were sprayed with distilled water.

To ensure plant fertilization, female flowers on cotton plants in Plot I were manually pollinated on a daily basis following the first treatment. Researchers used protective clothing and gloves during this procedure.

In September and November, three cotton plants were randomly harvested from both plots I and II. Each plant was divided into vegetative structures, green bolls, intermediate bolls and mature bolls and then prepared for residue analysis. Each sample was identified with protocol number, placed in a plastic bag and frozen on dry ice. At the final harvest, all green, intermediate, mature bolls were harvested from the remaining plants in plots I and II. These bolls were air dried for about 4 weeks. The mature bolls were ginned and seed cotton delinted with concentrated H_2SO_4. In addition, soil cores from plots I and II were taken to a depth of 60cm using a JMC steel zero contamination tube with acetate liner. Also, soil samples were collected in June, September and November and then prepared for the residue analysis. All of residue analyses of plant and soil samples were conducted at American Cyanamid Company, Agricultural Research Center, Metabolism Laboratory, Princeton, New Jersey. The radioactive residue present in the plant foliage, cotton seeds and bracts, lint and soil samples were determined by combusting 0.5gm samples.

After completion of the harvest and sample collections, the remaining vegetative parts in plots I and II were chopped into small pieces and buried in the soil for carry over studies in the following year.

RESULTS AND DISCUSSION

The results of this residue study are currently being reviewed by EPA and are not available at this time for this report.

Table 1. Treatment Schedule for DICA Cotton Study

Date	Treatment Number	Dose Rate (lb/A)	Millicuries C-14
June	1	0.2	0.464
June	2	0.3	0.697
July	3	0.3	0.697
July	4	0.3	0.697
August	5	0.3	0.697
August	6	0.3	0.697
September	7	0.3	0.697
TOTAL		2.0	4.646