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Propachlor Herbicide Residue Studies in Cabbage Using Modified Analytical Procedure

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Propachlor or Ramrod (2-chloro-N-isopropylacetanilide) is a pre-emergence herbicide of the Monsanto Chemical Company which controls most annual grasses and certain broadleaf weeds. It has been found to be effective for weed control in direct-seeded cabbage. Propachlor has label clearances for use on sweet corn and English peas. At present, it is not approved for use on cabbage and no harvest residues have been determined. In the work reported, commercially grown cabbage which had been field-treated with propachlor was harvested and possible residues of the herbicide were determined.

MATERIALS AND METHODS

Cabbage (Brassica oleracea var. capitata; cultivars "King Cole" and "Little Rock") was seeded in plots in double rows near Geneva, New York in April and May, 1982. Within two days following the seeding, the herbicide was applied to the soil as Monsanto's Ramrod in a 65% wettable powder formulation at a rate equivalent to six pounds of the active herbicide per acre. The herbicide treatments were applied with a hand held, CO_2 pressurized, small plot sprayer with a T-Jet 8004 flat fan nozzle delivering 45 gpa at 35 psi. The treated plots and accompanying untreated control plots were replicated three times. In August, several mature heads of cabbage were randomly harvested from each treatment replicate and frozen prior to analysis.

The method used was a modification of the method developed by the Monsanto Chemical Company for residues of the herbicide in crops (PAM, 1970). It involved alkaline hydrolysis of propachlor to N-isopropyl aniline, isolation of the latter compound by distillation and determination of it by gas chromatography using an NP detector.

Halves from each of six heads from each treatment replicate were finely chopped in a food cutter and the total mixed and subsampled for determination of propachlor. Fifty grams of the subsample were blended with 200 ml of acetone for three minutes and the mixture was filtered through a Buchner funnel. The filter was rinsed with acetone to a total filtrate volume of 250 ml. One-half of the filtrate (125 ml) was transferred to a 300 ml round bottomed flask and the acetone was evaporated with nitrogen in a water bath (50°C).

Seventy-five ml of 50% sodium hydroxide was added. The flask was connected to a reflux-distillation unit employing a West condenser, 30 cm long and the mixture was refluxed for one hour. The flask was allowed to cool and 50 ml of distilled water was added. The mixture was then distilled so that 50 ml of distillate was collected with the distillation delivery stem remaining immersed in 10 ml of (1 and 1) hydrochloric acid throughout the distillation.

The distillate was then extracted successively with 25, 15 and 10 ml of chloroform in a separatory funnel and the chloroform layers were discarded. Ten ml of 6 N sodium hydroxide was added, the solution was mixed and transferred to a 100 ml volumetric flask. Three ml of toluene was added and the mixture was shaken for three minutes. Distilled water was then added to bring the upper toluene layer to the mark. The toluene was then analyzed by gas chromatography.

A Tracor Model MT-220 gas chromatograph equipped with a Model 702 NP detector was used. A borosilicate glass column, 6 feet long, 2 mm i.d. and containing 4% Carbowax 20 M/0.8% potassium hydroxide on 60/80 mesh Carbopack B was used. The operating temperatures for the column, flash heater and detector were 195°, 210° and 250°C, respectively. The gas flow rates for helium, hydrogen and air were 50, 4.7 and 125 cc per min, respectively. The retention time of N-isopropylaniline was 8.2 minutes.

RESULTS AND DISCUSSION

Propachlor provided excellent control of common ragweed and other species without injury to the cabbage. Table 1 summarizes the results of analysis for harvest residues of propachlor in the cabbage. Residues of the herbicide were below 0.06 ppm on a fresh weight basis in all cabbage samples analyzed which was judged to be the limit of detection of the analytical method. The recoveries of 0.1, 0.5 and 1.5 ppm (fresh weight) of propachlor added to control cabbage prior to extraction with acetone were 79, 85 and 76%, respectively.

Propachlor is stated to persist in soils for four to six weeks and be completely metabolized in plants within five days. It is adsorbed to soil colloids and undergoes mainly microbial but some chemical degradation (HERBICIDE HANDBOOK, 1979).

LAMOUREUX et al. (1971) found evidence for the presence of at least three water-soluble transitory metabolites of propachlor in corn seedlings and the excised leaves of corn, sorghum, sugarcane and barley which had been treated with the herbicide. One appeared to be the γ-glutamylcysteine conjugate and another the glutathione conjugate of propachlor. These metabolites were no longer detected 72 hours following herbicide treatment. Residues of intact propachlor were not found in field-treated onions but conjugates of N-isopropylaniline were found in onions in relation to the rate of herbicide application. Conjugates were also found in organic soil up to two years following application (FRANK et al., 1977).

LAMOUREUX AND RUSNESS (1981) found that propachlor formed an N-malonylcysteine conjugate in treated onions. The presence of such conjugates in the acetone extracts of the cabbage in this study would expectedly be hydrolyzed during the base refluxing step to yield N-isopropylaniline. The absence of detectable residues of the latter compound would indicate that propachlor was degraded in the soil or in the plant shortly after absorption.

Table 1. Residues of the herbicide, Propachlor, in cabbage.

Cultivar	Treatment	No. rep. field plots	Interval to harvest (days)	ppm Propachlor (fresh wt)*
King Cole	(see text)	3	109	<0.06, <0.06, <0.06
King Cole	none	3	109	<0.06, <0.06, <0.06
Little Rock	(see text)	3	96	<0.06, <0.06, <0.06
Little Rock	none	3	96	<0.06, <0.06, <0.06

*Each result represents an individual analysis of cabbage from each of the three replicated plot treatments.

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