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# Dinoseb Presence in Agricultural Subsurface Drainage from Potato Fields in Northwestern New Brunswick, Canada

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Dinoseb, 2-sec-butyl-4,6 dinitrophenol, has been used in the potato growing industry of New Brunswick as a pre-emergent herbicide and as a potato vine dessicant prior to harvest. It has been observed in ground water as a result of agriculture both in Canada (Prince Edward Island), and in the United States (New York State) (Gillis and Walker, 1986). Krawchuck and Webster (1987) have reported the presence of carbofuran in ground water and chlorothalonil in ground water and subsurface drainage outflow. It was felt that analysis of outflow from on-farm subsurface drainage systems would provide an indication of the ability of various pesticides to migrate through upper soil horizons to surface or subsurface water bodies under field conditions. A joint project to investigate water quality effects of agriculture was undertaken in 1987 with Agriculture Canada and the New Brunswick Department of Agriculture, (NBDA) who were both interested in nutrient and pesticide export from potato fields as indicated by the quality of subsurface water leaving the root zone.

Zitko et al. (1976) reported a lethal dinoseb threshold to lobster larvae of 7.5 µg/L. Woodward (1976) reported that the 96 hr LC 50 concentration was pH dependent and ranged from 32 to 1400 µg/L for cutthroat (Salmo clarki). A decrease in pH from 8.5 to 6.5 increased dinoseb toxicity by a factor of 43. Yolk sac absorption and growth of lake trout (Salvelinus namaycush) fry was reduced in flow-through tests at concentrations as low as 0.5 µg/L dinoseb (Woodward 1976). Woodward (1976) proposed a MATC of less than 0.5 µg/L. Call et al. (1984) reported 24, 48, 96 and 192 hr LC 50 median concentrations of 0.8, 0.7, 0.7 and 0.5 mg/L respectively for fathead minnows (Pimephales promelas) in flow-through tests. In early life stage toxicity testing, Call et al. (1984) determined a no effect concentration for fathead minnows of between 14.5 and 48.5 µg/L. Milner and Goulder (1986) have shown that dinoseb inhibited bacteria growth in freshwater.

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## MATERIALS AND METHODS

Five privately owned, and systematically tile drained fields ranging in area from 3.0 ha to 10.4 ha (tile depth 1m, spacing 15m) were selected as study sites and designated by the letters A to E. All fields were located in Northwestern New Brunswick in what is commonly referred to as the "potato belt". Detailed five year crop and pesticide histories, and detailed crop plans for 1987 and 1988 were determined through personal on-farm interviews. Lay collectors engaged for the project sampled the tile outlets on a 4-hour basis whenever there was effluent flow. Each tile system outlet was instrumented with a flume and stage recorder for flow rate determination. Based on the farmers crop plans, the Water Quality Branch targeted dinoseb, metribuzin and chlorothalonil as the pesticides of interest. However, dinoseb was the only agent that was actually used. Tile effluent was collected in the spring from each site during saturated soil conditions, prior to any pesticide application and during pre- and post-application rain events. The study was a true field study in that the pesticide selection and application was left up to the private farmer and rainfall dictated the extent of drainage outflow. In total 133 water samples were collected between April 1987 and May 1988: 21 from Site A, 22 from Site B, 16 from Site C, 42 from Site D and 32 from Site E.

One litre samples were collected using 1.14 L pre-washed green glass bottles. Upon collection the bottles were kept in a cooler with freezer packs and shipped to the Environment Canada Atlantic Region Water Quality laboratory in Moncton. Upon receipt the samples were numbered and refrigerated at 4°C. All samples were extracted within seven days of receipt. Spikes and replicate samples were employed for QA/QC purposes.

Dinoseb was extracted using *in situ* acetylation (Stokker 1987) followed by capillary column gas chromatography and ECD detection. Quantitation of dinoseb acetate was carried out using SPB-5-30 m and SPB-608-30 m columns with a temperature program consisting of an initial temperature of 120°C, a ramp rate of 1.5°C per minute to 160°C for 5 minutes, and a final ramp rate of 10°C per minute to 240°C for 10 minutes. The analytical detection limit for dinoseb was determined to be 0.02 μg/L. Major ion and nutrient samples were collected with each pesticide sample to characterize the water, and were quantitated using Water Quality Branch methodologies.

## RESULTS AND DISCUSSION

Three sites, C, D and E, had application histories indicating the use of dinoseb (Dytop 300) during the 1986 growing season. Dinoseb had been used as a pre-emergent herbicide in the spring of 1986 at site C and had been used as a dessicant at sites D and E in the early fall of 1986. Sites A and B had had no dinoseb application within the previous 3 years.

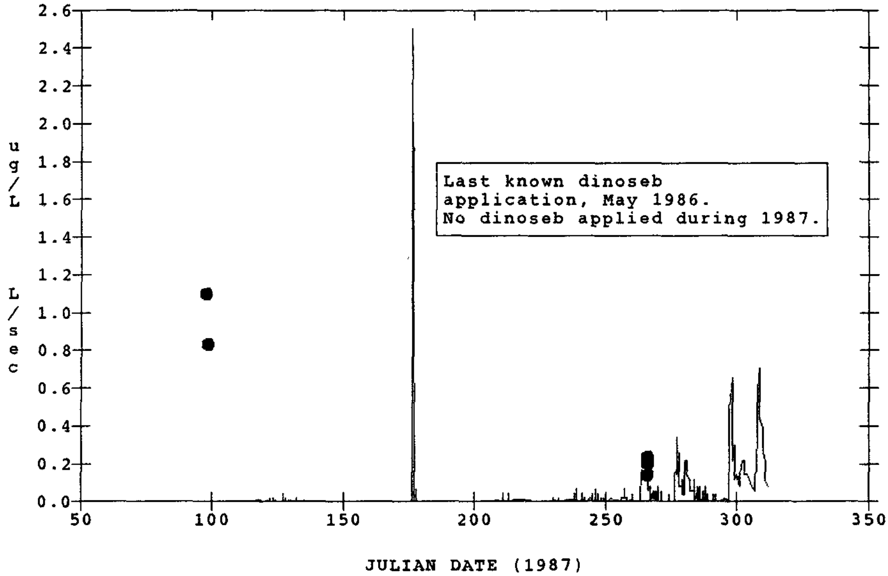


FIGURE 1: Dinoseb concentration (•) in ug/L and discharge (—) in L/sec from site C.

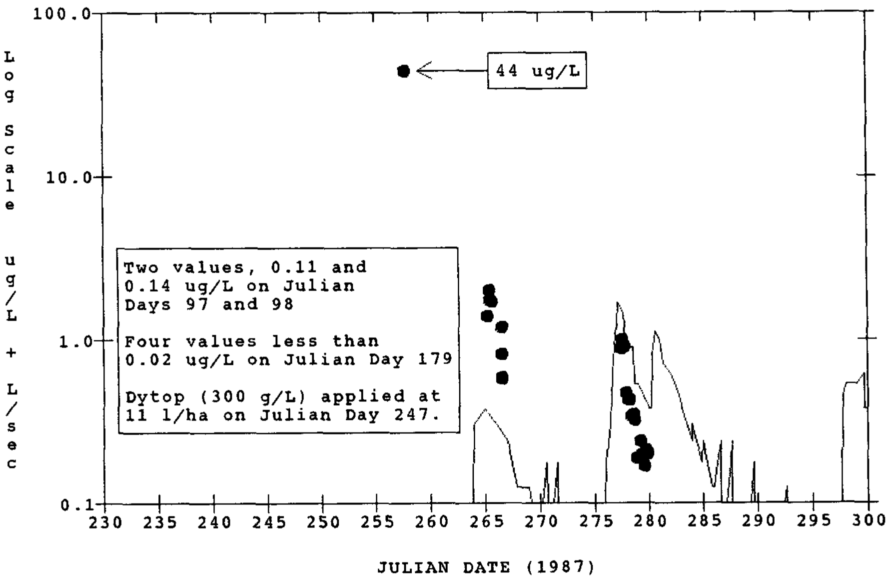


FIGURE 2: Dinoseb concentration (•) in ug/L and discharge (—) in L/sec from site D.

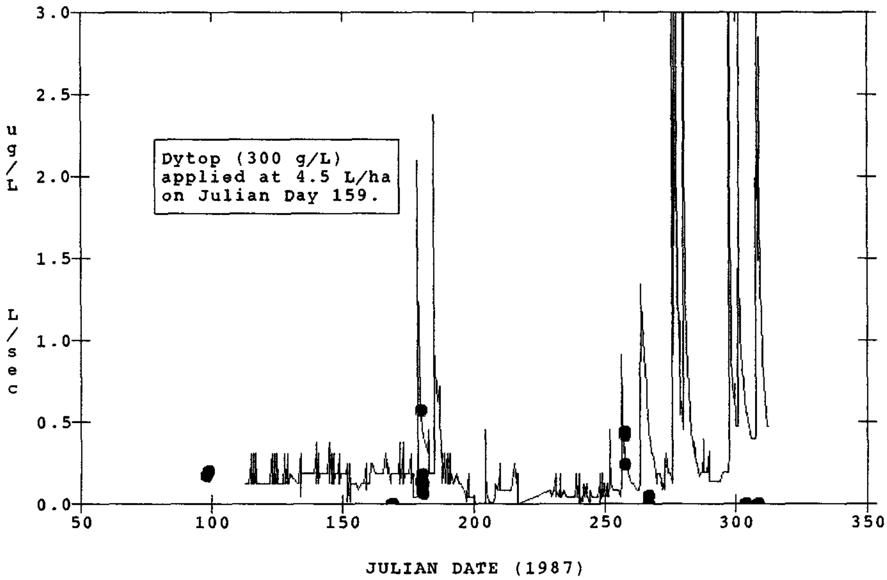


FIGURE 3: Dinoseb concentration (•) in ug/L and discharge (—) in L/sec from site E.

Figures 1-3 present the results of sample collection in 1987. Figure 1 illustrates that at site C, where no dinoseb was used in 1987, residuals were present in tile outflow during the spring and again in the fall. No samples were collected during the growing season as dinoseb was not used during 1987. Dinoseb had not been applied since May of 1986, eleven months previous.

Site D, Figure 2, also displayed carry over from the previous growing season, but had had "Dytop" (300 g/L) 11 L/ha applied on Julian day 247 as a vine dessicant. Four samples from a pre-application rain event on Julian day 179 were below the detection limit of 0.02 μg/L. The highest single observation was 44 μg/L on day 257, 10 days post application during very low flow conditions. Subsequent samples between day 265 and 280 indicated lower concentrations yet higher tile outflow. The highest observation and five subsequent ones were confirmed by GCMS at the National Water Quality Laboratory at CCIW in Burlington (M. Forbes, pers. comm).

Figure 3 illustrates dinoseb concentrations observed at site E where "Dytop" (300 g/L) was applied as a pre-emergent herbicide at 4.5 L/ha on day 159. The first rain event triggering tile outflow on day 178 yielded dinoseb concentrations ranging between 0.57 μg/L and 0.06 μg/L. Subsequent samples indicated concentrations between 0.44 μg/L and 0.05 μg/L. Site E was subject to ground water inputs as indicated by the almost continuous flow of 0.1 to 0.2 L/sec and major ion data. The difference between the levels observed at sites D and E is felt to be due to the different application rates at each site and dilution by ground water. Two sites, one (A) with no known dinoseb history and the second (B) where dinoseb had been used 3 1/2 years previously were used as controls and none of the 45 samples collected between the two sites had measurable dinoseb concentrations. Four sets of duplicate samples and three sets of triplicate samples from the study sites were reported as less than detection indicating good precision. Five spiked samples yielded a median recovery of 73 percent.

It is also apparent that at sites D and E dinoseb was detected in tile outflow from the first major post-application rain event. This was mirrored by the detection of elevated nutrient levels in samples taken at the same time. Dinoseb concentrations in water collected from the tile outlets is an indication of the amount of dinoseb that is intercepted by the tiles and confirms that dinoseb had migrated through 1 m of soil. Deep percolation is implied but was not part of the project scope. On nineteen occasions, the concentration of dinoseb emanating from the tiles has been observed in excess of the maximum acceptable toxic concentration of 0.5 $\mu$g/L proposed by Woodward (1976). Of significance also is the carry over from one growing season to the next. Samples collected in the spring of 1988 indicated the presence of dinoseb at Sites D and E confirming the carry-over from one growing season to the next and at Site C, residual carry-over of 23 months. Site B, where dinoseb had been applied 42 months prior, did not indicate measurable dinoseb concentrations. On soils typical to this part of New Brunswick, a soil persistence of 24 to 42 months is implied.

As none of the study sites drained into a stream, a direct aquatic effects study could not be undertaken. It is proposed that aquatic effects would be mitigated by the dilution capability of any receiving water course.

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