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INFLUENCE OF SOIL pH INTERACTIONS ON RAPTOR CARRYOVER IN AGED SOIL RESIDUES

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Sorption is the most important process affecting the persistence of herbicides in the field. Sorption controls availability of the herbicide to the target plant, soil microorganisms, and for movement through the soil profile. Organic carbon (OC) is the most important soil property affecting sorption of nonpolar, nonionizable organic chemicals (Koskinen & Harper, 1990). For polar, ionizable chemicals, such as the weak acid imidazolinone herbicides (Raptor, Pursuit, others), the most important factor affecting sorption is soil pH. However at lower pH levels, sorption of ionizable chemicals can also be influenced by soil OC content (Oliveira et al., 1999). Low soil moisture content may also affect persistence of Raptor (Cobucci et al., 1998; O'Sullivan et al., 1998) and a number of other herbicides. Sorption of some pesticides has also been shown to increase with aging of residues in soil (Cox et al., 1998; Pignatello et al., 1992; McCall & Agin, 1985). Aging is defined as the length of time a pesticide has been in contact with soil.

Research conducted on Pursuit bioavailability and persistence in aged soil residues suggested that although persistence was independent of soil pH, bioavailability of Pursuit residues was affected by soil pH interactions (Bresnahan et al., 2000). Sorption increased with aging, but at low soil pH levels the Pursuit was more readily desorbable than at high pH levels. Thus, in low pH soils, Pursuit was more available to sugarbeet plants resulting in increased injury.

The objective of the current research was to determine the influence of soil pH interactions as a function of aging on Raptor persistence as indicated by sugarbeet injury and yield.

Field study 2002 and 2003:
Experimental test plots 22 feet wide and 50 feet long were established in Mooreton April 17, 2002. Soil samples were taken from each plot April 17 to determine soil pH for each plot. ‘Clearfield AgriPro 601’ wheat at 88 lb/A was seeded into the entire plot area April 25, 2002. Raptor at 0, 4 or 8 fluid oz/A was applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center 20 feet of each plot May 22, 2002 the air temperature was 57F, relative humidity was 37%, soil temperature at six inches was 54F, wind velocity was 16 mph, sky was 90% cloud cover, soil moisture was good and wheat was in the 2 to 3 leaf stage (3-4 inches tall). Wheat was mowed and plot area tilled in August 2002 with a disk operated the same direction as herbicides were applied. All plots were tilled with a rototiller set 3 inches in September 2002. Spring 2003 tillage was one pass in the same direction as herbicides were applied with a ‘Kongskilde Triple K’ field cultivator with rolling baskets. ‘Crystal 955’ sugarbeet was seeded 1.25 inches deep in 22 inch rows April 24, 2003. Counter 15G insecticide at 12 lb product per acre was applied modified in-furrow at planting. Betamix+UpBeet+Stinger+Select+MSO at 0.08 + 0.004 + 0.03 + 0.03 + 1.5% lb ai/A was applied to the entire plot area May 15, May 20 and May 29, 2003. Betamix+UpBeet+Select+MSO at 0.08+0.004+0.03+1.5% lb ai/A was applied to the entire plot area June 5, 2003. Progress+UpBeet+Select+MSO at 0.08 + 0.004 + 0.03 + 1.5% lb ai/A was applied to the entire plot area June 12, 2003. Betanex at 0.75 lb ai/A was applied to the entire plot area July 1, 2003. Eminent at 13 fl oz/A, Super Tin at 5 oz/A and Eminent at 13 fl oz/A were applied to the entire plot area July 18, July 31 and August 21, 2003 respectively. Sugarbeet was hand thinned to an eight inch spacing May 23, 2003. Sugarbeet injury was evaluated June 3, June 18 and July 7, 2003. The three evaluations were averaged and are presented in Table 1. Sugarbeet from 15 feet of the center two rows of each plot was counted and harvested September 15, 2003

Raptor applied in 2002 caused sugarbeet injury in 2003 (Table 1). Injury increased as soil pH decreased. Injury ratings from Raptor 1t 0.06 lb/A were 49% at pH 5.8 to 6.1, 27% at pH 6.2 to 6.4 and 0.0% injury rate at pH 7.0 to7.7 at the 0.06 lb/A rate. Minimal sugarbeet injury was observed above pH 6.9.

Table 1. Effect of raptor carryover on sugarbeet injury, 2003

Raptor rate/A		Soil pH	Sugarbeet injury[1]
fl oz/A	lb ai/A		%
0	0.0	5.8-6.1	1
4	0.03	5.8-6.1	15
8	0.06	5.8-6.1	49
0	0.0	6.2-6.4	2
4	0.03	6.2-6.4	2
8	0.06	6.2-6.4	27
0	0.0	6.5-6.9	1
4	0.03	6.5-6.9	4
8	0.06	6.5-6.9	4
0	0.0	7.0-7.7	0
4	0.03	7.0-7.7	0
8	0.06	7.0-7.7	0
C.V %			72
LSD (0.05)			9

[1]averaged over three visual evaluations of injury.

Percent sucrose increased as soil pH increased (Table 2). Percent sucrose of untreated sugarbeet was 15.5% at pH 5.8 to 6.1, 16.3% at pH 6.2 to 6.9 and 18.0% at pH 7.0 to 7.7. Sugarbeet root yield was significantly reduced by Raptor only at pH 5.8 to 6.1 when comparing Raptor treated to untreated at the same soil pH. Sugarbeet root yield was reduced 6.7 tons/A by Raptor at 0.06 lb/A at pH 5.8 to 6.1. Untreated sugarbeet at pH 5.8 to 6.1 yielded 2 tons/A less than untreated sugarbeet at pH 7.0 to 7.7. As soil pH increased, extractable sucrose also increased. In untreated plots, extractable sucrose increased 2,130 lb/A when comparing pH 5.8 to 6.1 to pH 7.7 to 7.7. Plots with pH 5.8 to 6.1 treated with Raptor at 0.03 lb/A yielded 2,154 less and at 0.06 lb/A yielded 3,743 lb/A less than plots with the same herbicide rate at pH 7.0 to 7.7.

Table 2. Effect of raptor carryover on sugarbeet sucrose percent, root yield and extractable sucrose, 2003

Raptor rate/A		Soil pH	Sucrose	Root yield	Extractable sucrose
fl oz/A	lb ai/A		%	ton/A	lb/A
0	0.0	5.8-6.1	15.5	22.2	5551
4	0.03	5.8-6.1	16.1	20.8	5493
8	0.06	5.8-6.1	15.9	15.5	4055
0	0.0	6.2-6.4	16.3	23.0	6018
4	0.03	6.2-6.4	16.1	21.1	5431
8	0.06	6.2-6.4	16.4	22.9	6088
0	0.0	6.5-6.9	16.5	24.2	6550
4	0.03	6.5-6.9	16.3	25.7	6800
8	0.06	6.5-6.9	16.4	24.6	6492
0	0.0	7.0-7.7	18.0	24.7	7681
4	0.03	7.0-7.7	17.3	26.6	7647
8	0.06	7.0-7.7	17.7	25.6	7798
C.V %			4.9	14.1	14
LSD (0.05)			1.2	4.7	1223

These results indicate that soil pH plays a large part in sugarbeet health and subsequent yield as well as in herbicide carryover Sugarbeet herbicide injury shown in low pH soils may be explained by the nature of the chemical itself. Raptor is an amphoteric molecule; therefore cations, anions, and molecular species would exist simultaneously at any soil pH. In low pH soils, greater amounts of cation would be in solution than in high pH soils. The Raptor cations, once formed, would be sorbed immediately by the soil colloid by cation exchange mechanism during the aging process. As the cations are sorbed, more cations would be formed in solution to reestablish the equilibrium. In low pH soil, greater amounts of cation are formed and sorbed by the soil colloid than in high pH soil during the aging period, a process that is reversible. This increased sorption due to more cation formation allows for slow desorption of the herbicide from the soil colloid over time and subsequent increased sugarbeet injury from the herbicide in low pH soils.

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