

ASSESSING CHANGES IN SOIL NITROGEN AND RATES OF DECOMPOSITION DUE TO DIFFERENCES BETWEEN BT AND NON-BT CORN RESIDUES

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Genetically-modified corn hybrids expressing insecticidal proteins derived from *Bacillus thuringiensis* (Bt) have several advantages for crop production, including increased insect resistance, reduction of insecticide application, higher yields and other improvements in plant growth. The planted area of Bt corn has increased from approximately 40,000 acres in 1996 to 15.6 million acres or 22% of all corn planted in the USA in 2002. A possible consequence of Bt corn production due to reductions in corn borer damage or differences in the amount and composition of Bt corn residues is an increased amount of residues remaining on or in the soil. The different quality and quantity of Bt residues may affect rates of decomposition and nitrogen turnover. Advantages of leaving a higher proportion of crop residues in the field include increased soil and water conservation and higher inputs of organic materials that can have beneficial impacts on soil biological and biochemical properties. However, agricultural producers commonly observe that Bt corn residues do not decompose as fast as non-Bt residues and the Bt residues may pose a physical obstacle for harvest of the subsequent soybean crop in the rotation. The objectives of this research were to: (1) determine differences in the composition and quantity of Bt corn residues grown under a corn-soybean rotation, and (2) to evaluate the effects of the incorporation of Bt crop residues on rates of decomposition and N turnover among different soil types in which Bt corn may be grown in Missouri.

In a study initiated in 2002 and then repeated in 2003 at the Greenley Agricultural Experiment Station, we compared grain and aboveground biomass yield, lignin, and total N contents of five Bt corn varieties with their respective non-transgenic isolines (Table 1). In 2002, grain yield for three of the five Bt hybrids was 17 to 27% greater than the non-Bt isoline while total aboveground biomass production for two of the five Bt hybrids was 25 to 32% greater than the non-Bt isoline. This increased yield was probably the result of higher European corn borer (ECB) infestation in the non-Bt varieties in 2002 (Table 1). In 2003, ECB infestation was much lower and therefore, no grain or aboveground biomass yield differences were observed between Bt hybrids and their respective isolines. Significant differences in lignin content of stem tissue at harvest were also observed among the Bt and non-Bt corn hybrids in 2002 and 2003 (Table 1). However, only the M-00112Bt Bt corn hybrid had a significantly higher lignin content compared to its isoline, M-00110, in 2002. In contrast, the Pioneer Bt variety had lower lignin content in 2002 and the Golden Harvest Bt variety had lower lignin content in 2003 compared to their respective isolines.

An additional laboratory study was conducted using stem, leaf and root tissue harvested in 2002 from the M-00112Bt and non-Bt M-00110 corn hybrids and whole plant material from Roundup Ready and conventional soybean varieties. The plant materials were mixed with soils of three soil textural classes, a silt loam soil similar to the claypan soil at the Greenley Station, a sandy loam soil and a silty clay soil and then incubated at ideal soil temperature and soil moisture for 73 days. Cumulative N mineralization and rates of decomposition (data not shown) were measured. Cumulative N mineralized was higher in the silt loam soil compared to soils with other textures and was also affected by the type of plant material added (i.e. root, leaf or stem) (Fig. 1A-C). A significant interaction was observed between the soil and plant material treatments. However, no consistent differences in N mineralization were observed between residues from transgenic and non-transgenic sources.

These data do not show consistent differences in the composition of crop residues due to the introduction of the Bt trait that some other researchers have observed. Moreover, no differences in soil N mineralization or rates of decomposition among crop residues were observed because of the Bt trait. As expected, stalk damage due to higher ECB infestation in 2002 compared to 2003 in non-transgenic corn resulted in higher grain yields and greater aboveground biomass in most of the Bt corn varieties. We are currently evaluating the effects of the Bt and non-Bt corn residues produced in 2003 on soybean growth in 2004 under either no-till or reduced tillage systems and have been evaluating any possible differences in soil microbial diversity and activity after the addition of the Bt corn residues.

Table 1. Corn grain and total aboveground biomass yields and composition of stem tissue from Bt and corresponding non-Bt isolines grown at the Greenley Center in 2002 and 2003.

Corn Variety	Grain yield		Aboveground biomass		Stem tissue N content		Stem tissue lignin		ECB tunnel counts [†]	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
	— bu/acre —		— tons/acre —		— % —		— % —		— n plant ⁻¹ —	
M00110 ^{††}	101	90	4.4	6.6	0.56	0.47	6.7	6.9	5.58	0.25
M00112Bt	112	88	6.5	6.6	0.49	0.51	7.7	6.3	0.23	0.00
M6114 ^{††}	93	88	4.8	7.6	0.51	0.47	7.9	6.8	5.30	0.70
M6114Bt	129	93	6.5	8.0	0.44	0.46	7.7	5.7	0.18	0.03
H9229 ^{†††}	104	97	5.4	8.8	0.51	0.55	6.2	6.4	6.95	0.90
H9274Bt	118	108	6.1	9.2	0.53	0.56	6.0	3.2	1.30	0.13
Garst 8464	107	106	5.1	8.5	0.84	0.63	6.6	5.7	4.25	0.23
Garst 8484Bt	129	94	6.9	7.8	0.71	0.58	6.5	6.4	0.63	0.03
Pioneer 33P66	97	83	5.5	8.6	0.60	0.53	7.5	5.0	5.83	0.48
Pioneer 33P67Bt	119	95	5.9	11.7	0.52	0.55	5.9	6.3	0.15	0.00
LSD_(0.05)	15	14	1.6	3.2	0.17	NS	1.4	2.2	0.29	0.32

[†] Number of European corn borer tunnels per plant

^{††} Merschman Seed Company

^{†††} Golden Harvest Seed Company

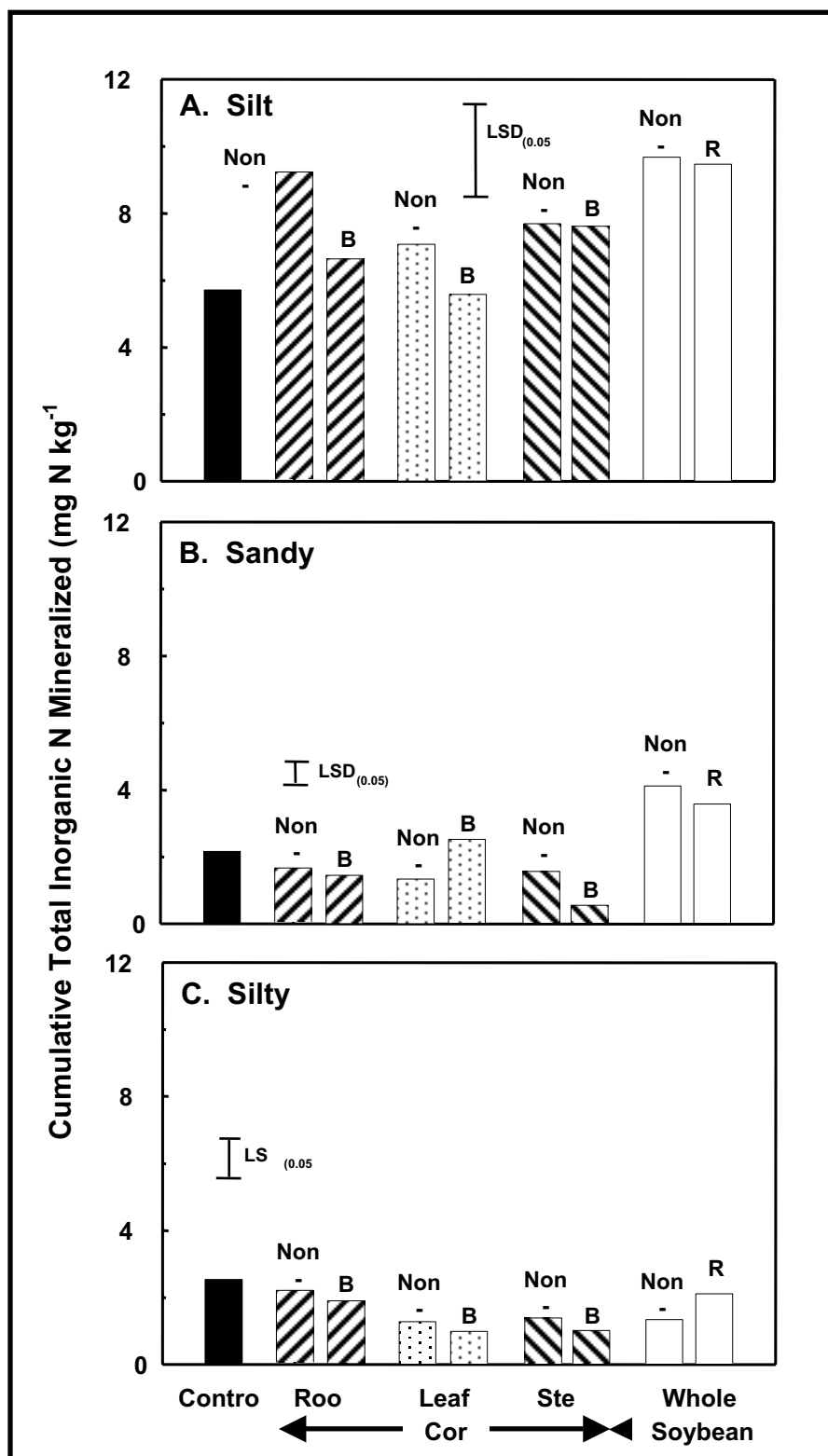


Figure 1 A-C. Cumulative total inorganic N mineralized after 73 days of incubation after application of plant materials for each soil texture. RR=Roundup Ready.