Effect of Rotation and Nitrogen Application on Corn and Soybean on an Irrigated Sandy Soil.

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Justification:

Nitrogen (N) credit of 45 lbs N/acre is given when corn follows soybeans in Nebraska. Research to support this was mainly conducted on silt loam and silty clay loam soils. Support for this recommendation is needed when grown on irrigated sandy soils.

Objectives:

Determine the rotation effect of soybean on corn and the value of both a corn/soybean and corn/corn/soybean rotation on sandy loam soils.

Sub-objectives:
1. Estimate the 'N credit' of soybean for the following corn crop.
   a. N to reach continuous corn (CC) yield?
   b. N to reach maximum yield?
2. Determine if there is a difference in potential yield due to soybean in a corn/soybean and corn/corn/soybean sequence compared to corn/corn/corn.
3. Determine the effect of continuous soybean on soybean yields.
4. Determine the effect of nitrogen application during early reproductive stage to soybean.

Results:

1. N to reach C/C/C yields: Corn in rotation needed from 89 to 148 lbs N/ac to reach 191 bu/acre compared to CC which needed 212 lbs N/acre (Table 2).

   However, difference in N needed to reach maximum yields was similar for C/C/C, C/SB, SB/C/C needing 212, 214, and 204 lbs N/acre, respectively. The SB/C/C response to N was still increasing at 250 lbs/N acre so the best fit equation reached a maximum at 288 lbs N/acre (Table 2).
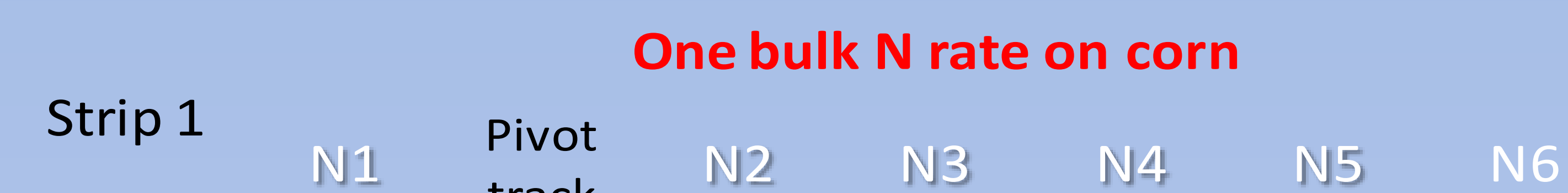
   Using a Corn:Nitrogen ratio of 8 ($4/bu corn and $ 0.50/lb N), optimum N rates were 10 lbs N less for SB/C compared to C/C/C. Yields were increased from 190 to 214 bu/acre and return to fertilizer cost increased from $535 to $614.

2. The rotation with two years corn, one year soybeans yielded an average of 174 bu/ac/corn year compared to 159 for the C/C/C and 185 for SB/C.

3. There were no differences in soybean yields due to rotation (Figure 3).

4. Applying nitrogen to soybeans at R3 did not affect yield (Figure 4).
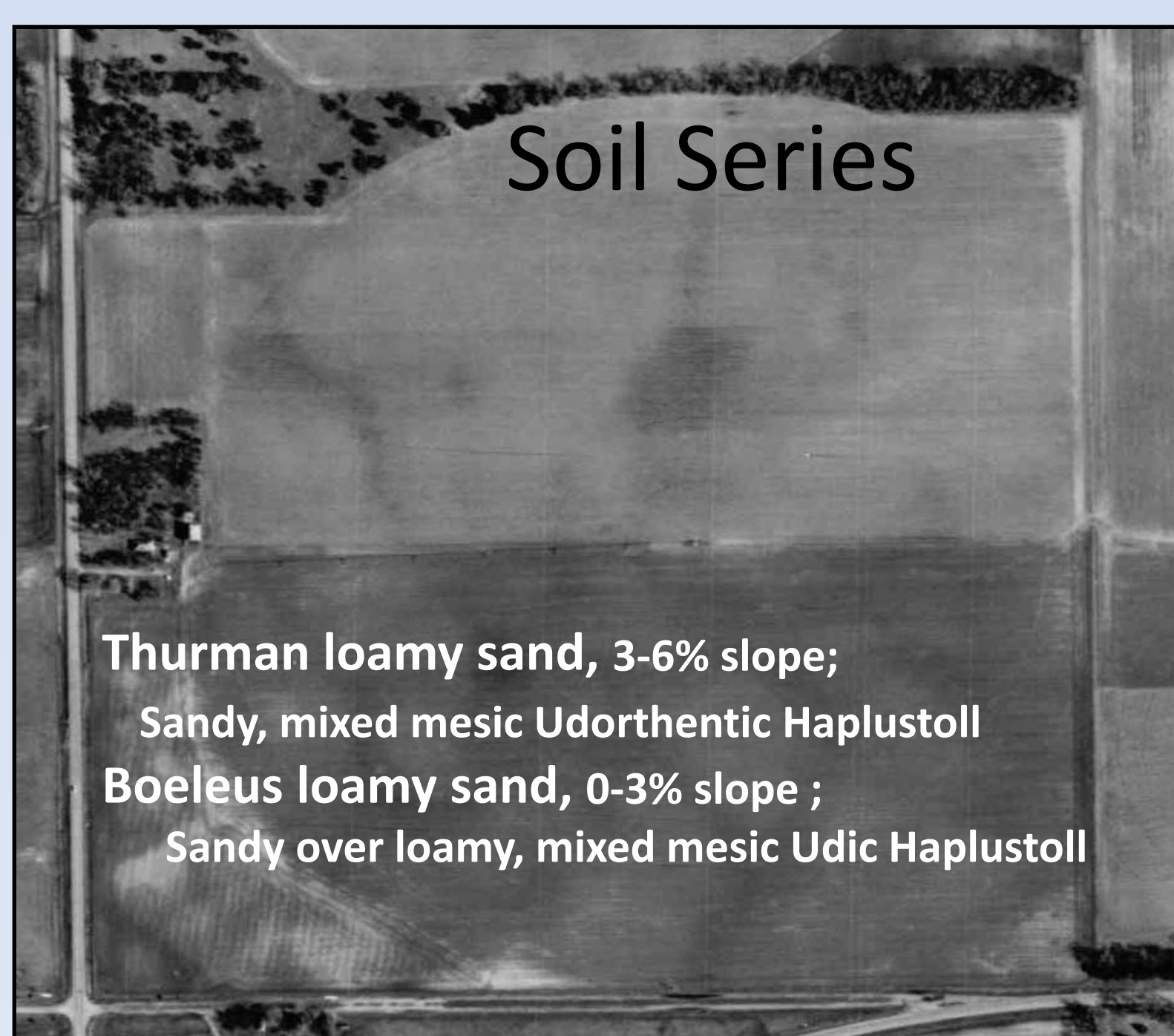
Design: Split plot with rotations as whole plots and N rate as sub-plots

First year: two strips, six N rates and 6 rows bulk

One bulk N rate on corn

Strip 1   N1   Pivot track   N2   N3   N4   N5   N6

One bulk N rate on corn

Strip 2   Pivot track   N1   N3   N2   N6   N5   N4

Second year: two strips, six N rates and six rows bulk with new N rate randomization

Strip 1   N6   Pivot track   N5   N4   N2   N3   N1

One bulk N rate on corn

Strip 2   Pivot track   N2   N3   N6   N4   N1   N5

One bulk N rate on corn

Figure 1. Example of experimental design for 2 of 7 strips over a 2-year period. Note that the location of the N application rates is re-randomized and that the bulk N plots were relocated each year. The same design was used for the N application to soybeans.

Table 1. Crop rotation treatment set for each year of study:

Treatment	2003	2004	2005	2006	2007	2008
1 Cont. Corn	SB	Corn	Corn	Corn	Corn	Corn
2 SB/Corn	SB	Corn	SB	Corn	SB	Corn
3 Corn/SB	SB	SB	Corn	SB	Corn	SB
4 Cont. SB	SB	SB	SB	SB	SB	SB
5 SB/C/C	SB	SB	Corn	Corn	SB	Corn(1st)
6 C/SB/C	SB	Corn	SB	Corn	Corn(2nd)	SB
7 C/C/SB	SB	Corn	Corn	SB	Corn (1st)	Corn(2nd)

Notes:
1. Crop strips are 12 30-inch rows wide. Wide enough to avoid the border effect between corn and soybean strips.
2. Nitrogen was applied both by hand and with fertilizer spreaders, split 40% at planting, 30% at V6, and 30% V10. Subplot length was 30 ft.
3. Due to the need to avoid continuous treatments with lower N rates than optimum, creating a permanent deficit plot, the rotation blocks were split into two six-row subplots. One side received a constant N rate and the other side received one of the 6 N rates. These areas were switched every year so the N rate plots would be on ground that was treated uniformly the previous year. The uniform rate applied was slightly below the UNL recommendation so excess nitrogen did not carry over to the future year.
4. The design was a split-plot with rotation as whole plots and N rates as the subplots. There were four replications.
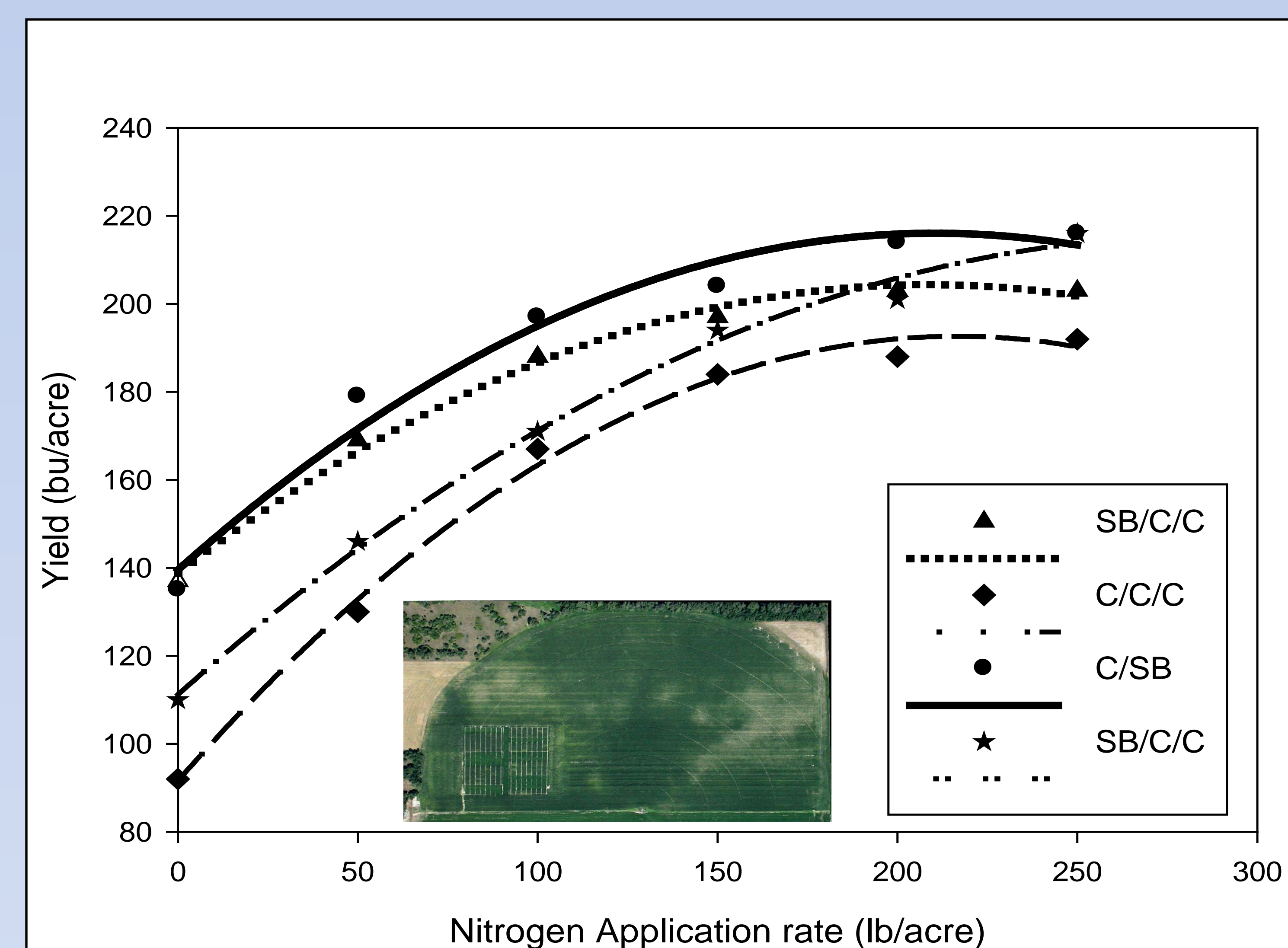

Figure 2. Graph of best-fit quadratic equations for each of the 3-year rotations for the 2006-2008 growing seasons. (*Approximately 50 lbs N was applied through pivot as nitrate in the groundwater in addition to what was applied as treatments*.)

Table 2. Regression results for grain yield versus N application rate for the 2006-2008 growing seasons.

3-Year Crop Rotation[1]	Quadratic Equation[2]	R^2	Maximum Yield[3]	Nitrogen Rate[4]	N Required to equal max yield of C/C/C[5]
			-- bu/ac --	------ lbs N/ac ------	
1. SB/C/C	$138.7 + 0.6306N - 0.0015N^2$	0.99	204	208	113
2. C/C/C	$91.5 + 0.9341N - 0.00216N^2$	0.99	191	212	-
3. C/SB	$139.5 + 0.7276N - 0.00173N^2$	0.97	217	214	89
4. SB/C/C	$111.2 + 0.7264N - 0.00126N^2$	0.99	216	288	148

[1] 2 or 3-Year crop rotations for the 2006-2008 period. Example: SB/C/C = Soybean in 2006, Corn in 2007, and Corn in 2008. The C indicates the phase of the rotation for the two corn years following soybeans. The two C/SB rotations are combined into the SB/C presented in Line 3 and the two SB/C/C rotations are included in Line 4.
[2] Best-fit quadratic equation for corn grain yield versus N application rate as graphed in Figure 2.
[3] Predicted maximum grain yield using the best-fit quadratic equations.
[4] Predicted N rate needed to produce the maximum yield using the appropriate quadratic equations.
[5] Predicted N rate needed to produce the equivalent level of corn yield for the C/C/C rotation of 191 bu/ac using the best-fit quadratic equations.

Soil Series

Thurman loamy sand, 3-6% slope;
   Sandy, mixed mesic Udorthentic Haplustoll
Boeleus loamy sand, 0-3% slope ;
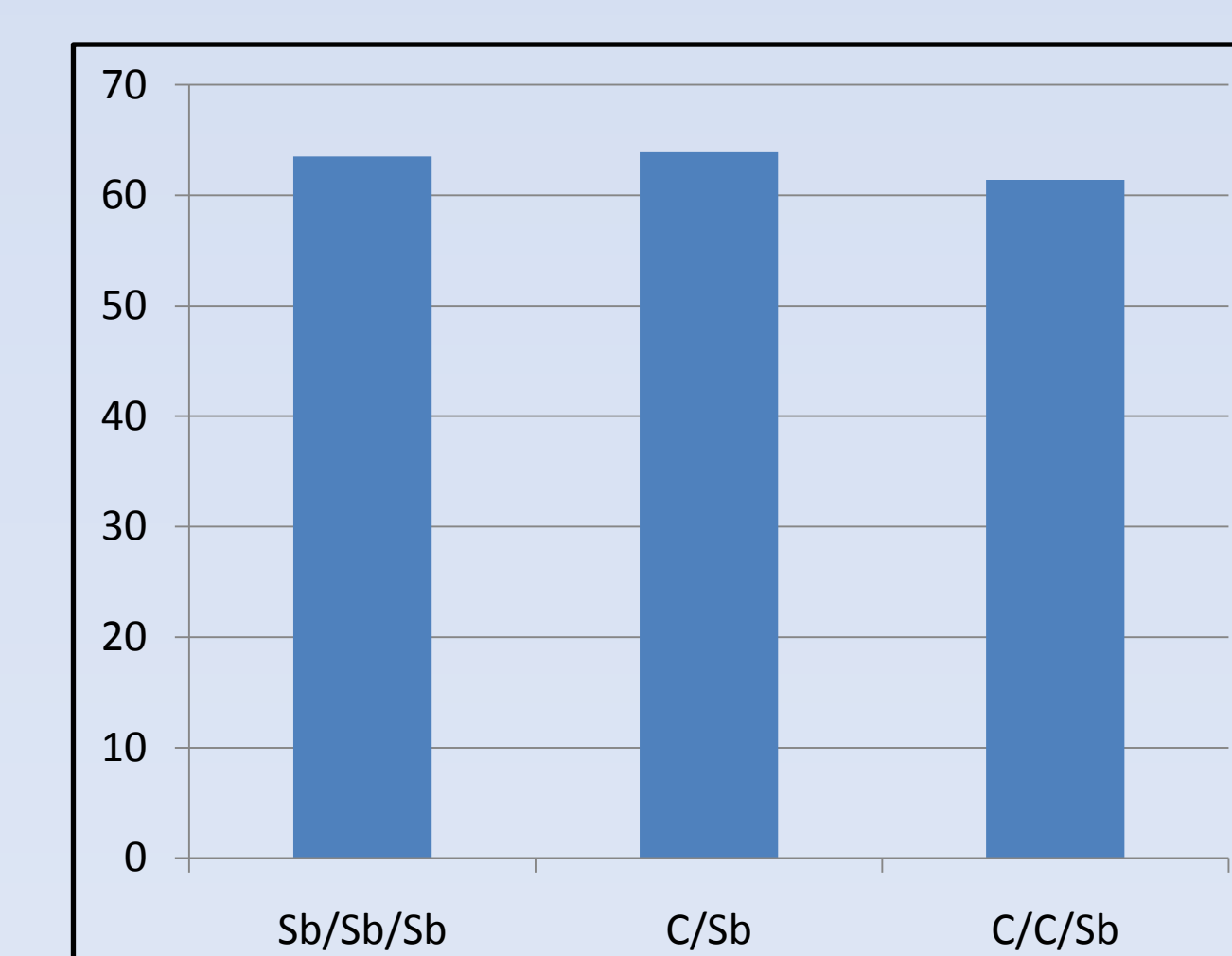   Sandy over loamy, mixed mesic Udic Haplustoll

Figure 3. Effect of rotation on three Year average soybean yield (bu/ac).
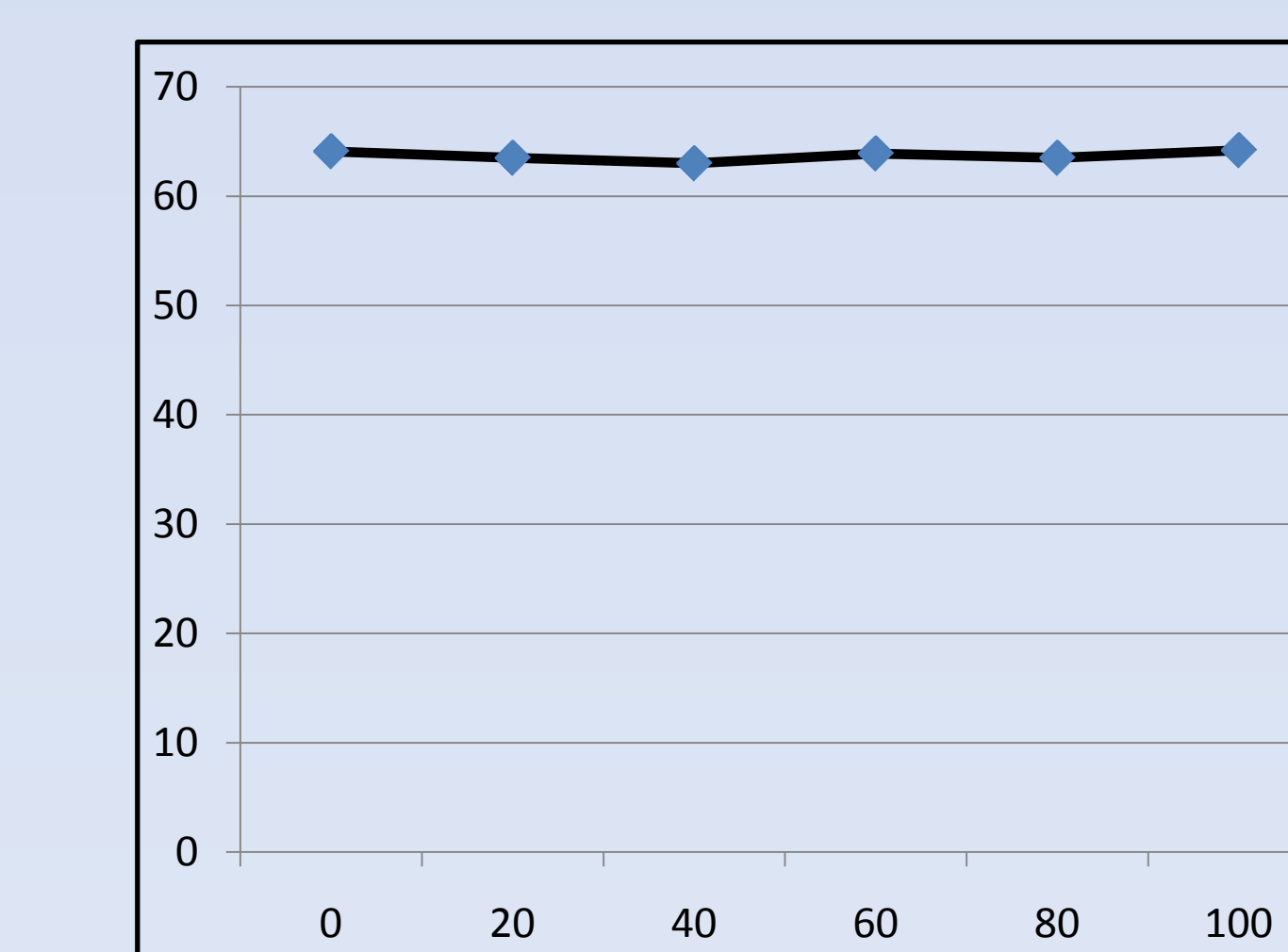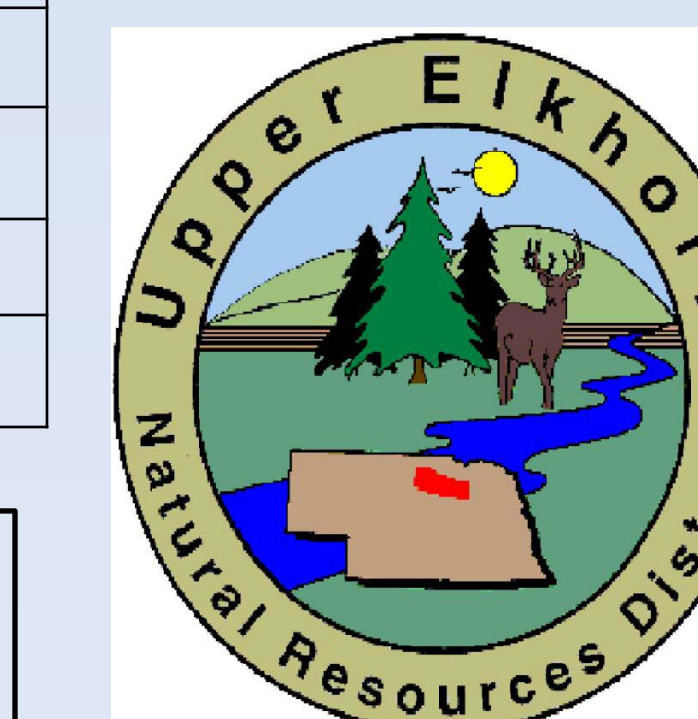
Figure 4. Effect of N rate (lbs N applied at R3) on three year average soybean yield (bu/ac).

Table 3. Summary of key crop production weather information for the 2006-2008 growing seasons.

Weather Variables	Year			
	2006	2007	2008	10-Year Average
86-50 GDD (F°)	2496	2503	2482	2647
Incident Radiation (Langleys/day)	353	350	347	334
Estimated Corn ET (in)	25.6	22.2	23.0	24.0
Estimated Soybean ET (in)	25.2	20.8	22.0	22.1
Total Water Applied (in)	28.1	34.3	31.4	28.7