# Nitrogen Management with Sugar Beet Varieties as Influenced by Rhizomania

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**Justification of Research:**

The influence of nitrogen and rhizomania on sugar beet production throughout the sugar industry has been well documented. However, the interaction between nitrogen and rhizomania needs to be investigated. Varieties resistant to rhizomania tend to give low quality and high tonnage. The management of these varieties for increased quality giving greater sugar production per acre is essential to the survival of the sugar beet industry. To manage for maximum sugar production in the presence of rhizomania one needs to correctly apply the appropriate quantity of nitrogen, and understand the influence of the rhizomania complex and resistant cultivars on nitrogen uptake, and assimilation.

The lack of knowledge in reference to the adverse effect of the rhizomania disease complex on nitrogen management in sugar beets emphasizes the need for evaluation. Current nitrogen recommendations on sugar beet were made in the absence of both Rhizomania and rhizomania cultivars. Nitrogen studies conducted with cultivars of varying resistance and in the presence of the rhizomania complex could significantly add to the knowledge needed to manage nitrogen.

Nitrogen management with rhizomania resistant varieties in the presence of rhizomania has primarily occurred in light textured soils which characteristically give high quality sugar beet production. Recent, detection of the rhizomania disease has been in areas of soils with higher soil quality (higher organic matter and moisture) which adds some difficulty to nitrogen management. Producing sugar beets of high quality in the presence of rhizomania will be much more difficult in these areas. Therefore, to manage nitrogen in the presence of rhizomania, rhizomania resistant varieties, high organic matter, and high moisture, one needs to possess a greater understanding of the nitrogen/rhizomania complex interaction.

**Objectives:**

1. Determine correct nitrogen fertilizer management practices in the presences and absence of Rhizomania.
2. Determine nitrogen fertilizer management as influenced by varieties with varying degrees of Rhizomania resistance.
3. Determine nitrogen fertilizer management in relation to the degree of Rhizomania disease pressure.
4. Determine information necessary for diagnostic delineation between Rhizomania and nitrogen deficiencies via crop canopy reflectance.

**Materials and Methods:**

To meet above mentioned objectives, small plot studies were conducted in the Southern Minnesota Beet Sugar Cooperative growing area during the 2003 and 2004 growing seasons. The treatments included a factorial arrangement of three to six nitrogen fertility levels and three sugar beet varieties. The nitrogen levels were based on the soil test nitrate-N in the surface four feet plus fertilizer N applied. The residual soil nitrate-N level was 56 pounds per acre all three 2003 sites. The N levels at the three locations in 2003 were 56, 70, 90, 110, and 130 pounds N per acre. In 2004 the residual nitrate-N levels were different at each of the three sites. The residuals in 2004 were 90, 110, and 70 at the Maynard, Cosmos, and Raymond

site, respectively. The N levels were 90, 110, 130, and 150 at Maynard, 110, 130, and 150 at Cosmos, and 70, 90, 110, 130, and 150 at Raymond. The nitrogen fertilizer source was urea (45-0-0). The varieties represented different resistance levels to rhizomania and relative quality. We used non-resistant-high quality, resistant-high quality, and resistant-low quality varieties. The treatments were applied in a split plot design with the N levels as the whole plots and varieties as the split plot with five replications. At harvest, sugar beet top samples were taken from each plot to determine the top yield and N uptake of the tops to evaluate the effect of N levels and varieties on plant nitrogen dynamics. The plots were harvested to determine root yield, sucrose concentration, and purity. To assess the N assimilation differences caused by rhizomania varieties, soil samples were taken to a depth of 4 feet and analyzed for nitrate-N after harvest.

**Results and Discussion:**

Root yield, sucrose, purity, extractable sucrose, and top yields for the 2003 sites are reported in Tables 1, 2, and 3. Root yield and extractable sucrose per acre were affected by both N level and variety at the Prinsburg site, Table 1. The optimum N level for root yield and extractable sucrose per acre was 110 pounds residual nitrate-N to four feet plus fertilizer. The non-resistant high quality variety had the greatest root yield and extractable sucrose. The resistant varieties have similar root yields and extractable sucrose. Sucrose concentration and extractable sucrose per ton were the least for the resistant-low quality variety while the other two varieties were similar. Root purity top yield were not affected by the treatments.

Table 1. Root yield, sucrose, purity, extractable sucrose, and top yield for the Prinsburg site in 2003.

| | Soil nitrate-N plus fert. N | Root yield | Root sucrose | Root purity | Extractable sucrose | | Top yield |
|---|---|---|---|---|---|---|---|
| Variety | Lb/A | Tons/A | % | | lb/ton | lb/A | lb/A |
| Nonresistant | 56 | 20.6 | 17.4 | 92.5 | 303 | 6233 | 2489 |
| | 70 | 23.6 | 17.6 | 93.2 | 309 | 7280 | 2590 |
| | 90 | 24.3 | 17.4 | 92.0 | 304 | 7426 | 2704 |
| | 110 | 27.4 | 17.9 | 92.8 | 313 | 8571 | 2767 |
| | 130 | 27.1 | 17.6 | 92.5 | 306 | 8313 | 3212 |
| Resistant-high quality | 56 | 20.6 | 17.4 | 92.3 | 301 | 6210 | 2073 |
| | 70 | 20.9 | 17.5 | 92.3 | 303 | 6291 | 2493 |
| | 90 | 21.9 | 17.5 | 92.8 | 306 | 6715 | 2619 |
| | 110 | 26.3 | 17.8 | 93.4 | 313 | 8260 | 2791 |
| | 130 | 26.2 | 17.8 | 92.5 | 309 | 8111 | 2918 |
| Resistant- low quality | 56 | 21.0 | 17.1 | 92.9 | 298 | 6270 | 2353 |
| | 70 | 21.7 | 17.2 | 92.8 | 299 | 6510 | 2348 |
| | 90 | 22.5 | 17.6 | 92.6 | 306 | 6885 | 2322 |
| | 110 | 26.3 | 17.5 | 92.8 | 305 | 8033 | 2369 |
| | 130 | 26.0 | 17.5 | 91.9 | 301 | 7829 | 2850 |
| | | | | | | | |
| | 56 | 20.7 | 17.3 | 92.5 | 301 | 6238 | 2305 |
| | 70 | 22.1 | 17.4 | 92.8 | 304 | 6694 | 2477 |
| | 90 | 22.9 | 17.5 | 92.8 | 305 | 7009 | 2548 |
| | 110 | 26.7 | 17.7 | 93.0 | 311 | 8288 | 2642 |
| | 130 | 26.4 | 17.6 | 92.3 | 305 | 8084 | 2993 |
| | | | | | | | |
| Nonresistant | | 24.6 | 17.6 | 92.8 | 307 | 7565 | 2752 |
| Resistant-high quality | | 23.2 | 17.6 | 92.7 | 307 | 7117 | 2579 |
| Resistant- low quality | | 23.5 | 17.4 | 92.6 | 302 | 7105 | 2448 |
| | | | | | | | |
| N rate | | 0.002 | 0.26 | 0.27 | 0.30 | 0.002 | 0.11 |
| Variety | | 0.09 | 0.03 | 0.52 | 0.04 | 0.04 | 0.20 |
| NXVar | | 0.94 | 0.61 | 0.13 | 0.77 | 0.82 | 0.97 |
| C.V. (%) | | 9.6 | 2.0 | 0.6 | 2.6 | 9.4 | 22.4 |
| Mean | | 23.8 | 17.5 | 92.7 | 305 | 7363 | 2593 |

Nitrogen level affected sucrose and extractable sucrose per ton at Hector site in 2003, Table 2. Both parameters increased by N level between the 70 and 90 lb per acre levels. No increase occurred beyond the 90 lb per acre level. Root yield, top yield, and extractable sucrose per acre were increased for the non-resistant-high quality and resistant-low quality varieties. The optimum N level was 130 pounds N per acre for the two responding varieties. The resistant-high quality variety did not respond to N.

Table 2. Root yield, sucrose, purity, extractable sucrose, and top yield for the Hector site in 2003.

| | Soil nitrate-N plus fert. N | Root yield | Root sucrose | Root purity | Extractable sucrose | | Top yield |
|---|---|---|---|---|---|---|---|
| Variety | Lb/A | Tons/A | % | | lb/ton | lb/A | lb/A |
| Nonresistant | 56 | 21.4 | 17.3 | 91.3 | 296 | 6333 | 2329 |
| | 70 | 19.7 | 17.4 | 92.4 | 302 | 5950 | 2385 |
| | 90 | 21.0 | 17.8 | 92.6 | 309 | 6504 | 2283 |
| | 110 | 23.0 | 17.9 | 93.1 | 314 | 7233 | 2482 |
| | 130 | 24.1 | 17.8 | 92.0 | 306 | 7381 | 2161 |
| Resistant-high quality | 56 | 20.3 | 17.3 | 92.1 | 300 | 6069 | 2098 |
| | 70 | 19.0 | 17.4 | 92.8 | 303 | 5776 | 1958 |
| | 90 | 19.9 | 17.9 | 92.3 | 311 | 6207 | 2816 |
| | 110 | 20.3 | 17.8 | 92.5 | 310 | 6296 | 2320 |
| | 130 | 20.8 | 17.6 | 92.3 | 305 | 6369 | 2864 |
| Resistant- low quality | 56 | 20.0 | 17.6 | 91.9 | 304 | 6096 | 2075 |
| | 70 | 19.9 | 17.4 | 92.3 | 302 | 6003 | 1992 |
| | 90 | 20.7 | 17.8 | 92.5 | 309 | 6392 | 2268 |
| | 110 | 23.8 | 17.7 | 92.6 | 307 | 7322 | 2366 |
| | 130 | 23.8 | 17.8 | 92.4 | 309 | 7385 | 3005 |
| | | | | | | | |
| | 56 | 20.6 | 17.4 | 91.8 | 300 | 6166 | 2167 |
| | 70 | 19.6 | 17.4 | 92.5 | 302 | 5909 | 2122 |
| | 90 | 20.5 | 17.8 | 92.5 | 310 | 6368 | 2456 |
| | 110 | 22.4 | 17.8 | 92.7 | 310 | 6950 | 2389 |
| | 130 | 22.9 | 17.7 | 92.3 | 307 | 7045 | 2677 |
| | | | | | | | |
| Nonresistant | | 21.8 | 17.6 | 92.3 | 306 | 6680 | 2328 |
| Resistant-high quality | | 20.1 | 17.6 | 92.4 | 306 | 6143 | 2417 |
| Resistant- low quality | | 21.7 | 17.7 | 92.3 | 306 | 6640 | 2341 |
| | | | | | | | |
| N rate | | 0.0004 | 0.0005 | 0.18 | 0.008 | 0.0002 | 0.04 |
| Variety | | 0.0001 | 0.96 | 0.86 | 0.98 | 0.0005 | 0.76 |
| NXVar | | 0.05 | 0.96 | 0.63 | 0.96 | 0.21 | 0.05 |
| C.V. (%) | | 6.1 | 2.9 | 1.0 | 3.8 | 7.6 | 19.2 |
| Mean | | 21.2 | 17.6 | 92.3 | 306 | 6488 | 2362 |

Nitrogen level increased top yield up to the 130 lb per acre level at Raymond in 2003, Table 3. Variety affected sucrose and root purity. The non-resistant-high quality variety has the least sucrose concentration while the other two varieties were similar. Purity was the greatest in the non-resistant-high quality variety followed by the resistant-low quality variety and the resistant-high quality had the least purity. Nitrogen and variety affected root yield and extractable sucrose per acre. The optimum N level was 110 pounds N per acre. The non-resistant-high quality variety had to least root yield and extractable sucrose per acre while the other two varieties had similar root yields and extractable sucrose. Extractable sucrose per ton was affected by any treatment.

Table 3. Root yield, sucrose, purity, extractable sucrose, and top yield for the Raymond site in 2003.

| | Soil nitrate-N plus fert. N | Root yield | Root sucrose | Root purity | Extractable sucrose | | Top yield |
|---|---|---|---|---|---|---|---|
| Variety | Lb/A | Tons/A | % | | lb/ton | lb/A | lb/A |
| Nonresistant | 56 | 18.1 | 17.1 | 90.7 | 276 | 5000 | 2286 |
| | 70 | 18.4 | 17.0 | 90.5 | 273 | 5033 | 1829 |
| | 90 | 18.8 | 17.5 | 90.6 | 282 | 5307 | 2494 |
| | 110 | 20.8 | 17.5 | 90.8 | 283 | 5856 | 2056 |
| | 130 | 21.8 | 17.5 | 91.6 | 286 | 6231 | 3083 |
| Resistant-high quality | 56 | 19.6 | 17.4 | 89.8 | 275 | 5372 | 1697 |
| | 70 | 21.1 | 17.8 | 90.2 | 284 | 5983 | 2022 |
| | 90 | 24.1 | 17.6 | 90.2 | 281 | 6802 | 1889 |
| | 110 | 25.3 | 17.8 | 90.4 | 285 | 7201 | 1627 |
| | 130 | 24.7 | 17.7 | 90.1 | 281 | 6943 | 3420 |
| Resistant- low quality | 56 | 20.1 | 17.4 | 90.5 | 279 | 5604 | 1988 |
| | 70 | 21.0 | 17.3 | 90.0 | 275 | 5794 | 1807 |
| | 90 | 22.6 | 18.0 | 91.0 | 293 | 6607 | 2112 |
| | 110 | 24.4 | 17.7 | 90.4 | 285 | 6984 | 1983 |
| | 130 | 24.3 | 17.6 | 90.4 | 281 | 6863 | 2959 |
| | | | | | | | |
| | 56 | 19.3 | 17.3 | 90.3 | 277 | 5325 | 1990 |
| | 70 | 20.2 | 17.4 | 90.2 | 277 | 5603 | 1886 |
| | 90 | 21.8 | 17.7 | 90.6 | 285 | 6239 | 2165 |
| | 110 | 23.5 | 17.7 | 90.5 | 284 | 6680 | 1889 |
| | 130 | 23.6 | 17.6 | 90.7 | 283 | 6679 | 3154 |
| | | | | | | | |
| Nonresistant | | 19.6 | 17.3 | 90.8 | 280 | 5485 | 2350 |
| Resistant-high quality | | 23.0 | 17.7 | 90.1 | 281 | 6460 | 2131 |
| Resistant- low quality | | 22.5 | 17.6 | 90.5 | 283 | 6370 | 2170 |
| | | | | | | | |
| N rate | | 0.0006 | 0.41 | 0.76 | 0.51 | 0.003 | 0.01 |
| Variety | | 0.0001 | 0.02 | 0.003 | 0.59 | 0.0001 | 0.52 |
| NXVar | | 0.82 | 0.62 | 0.22 | 0.30 | 0.77 | 0.80 |
| C.V. (%) | | 10.9 | 2.4 | 0.76 | 3.2 | 11.2 | 32.3 |
| Mean | | 21.7 | 17.5 | 90.5 | 281 | 6105 | 2217 |

The results for the sites in 2004 are reported in Tables 4, 5, and 6. Nitrogen level did not affect any parameter at the Maynard site in 2004, Table 4. Variety affected root yield, sucrose, purity, extractable sucrose per ton, and extractable sucrose per acre. Root yield was greatest for the resistant-high quality variety, least with the resistant-low quality variety, with the non-resistant-high quality intermediate. The resistant-low quality variety had the least, followed by the resistant-high quality variety, and the non-resistant-high quality variety with the greatest values for sucrose, recoverable sucrose per ton, and recoverable sucrose per acre. Purity was the greatest for the non-resistant-high quality variety while the other two varieties had similar lower values. Top yield was not affect by any treatment.

The Cosmos site had a limited number of nitrogen rate treatments because of a greater residual nitrate (Table 5). The resistant-high quality variety had the best root yield while the non-resistant-high quality had the best sucrose, purity, sucrose per ton, and sucrose per acre. The reduced root yield of the non-resistant variety was compensated by the better root quality. Top yield was not affected by the N or variety treatments.

In 2004, there was a large response to nitrogen fertilizer for root yield and extractable sucrose per acre between the 70 and 90 pound N per acre levels at the Raymond site, Table 6. This response was 7 tons per acre and close to 2000 pounds of extractable sucrose per acre. The resistant varieties had better root yields, extractable sucrose per acre, and somewhat less sucrose than the non-resistant-high quality variety. Top yield increased with increasing amounts of nitrogen fertilizer.

Table 4. Root yield, sucrose, purity, extractable sucrose, and top yield for the Maynard site in 2004.

| | Soil nitrate-N plus fert. N | Root yield | Root sucrose | Root purity | Extractable sucrose | | Top yield |
|---|---|---|---|---|---|---|---|
| Variety | lb/A | Tons/A | % | | lb/ton | Lb/A | lb/A |
| Nonresistant | 90 | 25.6 | 16.1 | 91.4 | 275 | 4447 | 2034 |
| | 110 | 27.7 | 16.2 | 91.8 | 278 | 4520 | 2176 |
| | 130 | 25.8 | 15.9 | 91.5 | 271 | 4328 | 1834 |
| | 150 | 26.2 | 15.9 | 91.6 | 272 | 4325 | 2048 |
| Resistant-high quality | 90 | 28.6 | 15.7 | 91.0 | 265 | 4155 | 1987 |
| | 110 | 27.1 | 15.5 | 90.4 | 260 | 4030 | 2050 |
| | 130 | 28.3 | 15.7 | 90.4 | 263 | 4119 | 2126 |
| | 150 | 27.9 | 15.5 | 90.5 | 260 | 4046 | 2292 |
| Resistant-low quality | 90 | 23.2 | 15.2 | 90.9 | 256 | 3877 | 2353 |
| | 110 | 25.0 | 14.9 | 90.9 | 250 | 3726 | 2061 |
| | 130 | 25.6 | 15.0 | 90.8 | 252 | 3804 | 2273 |
| | 150 | 26.6 | 14.8 | 90.1 | 247 | 3668 | 2411 |
| | | | | | | | |
| | 90 | 25.8 | 15.7 | 91.1 | 265 | 4159 | 2125 |
| | 110 | 26.6 | 15.5 | 91.0 | 263 | 4092 | 2096 |
| | 130 | 26.6 | 15.5 | 90.9 | 262 | 4084 | 2078 |
| | 150 | 26.9 | 15.4 | 90.7 | 260 | 4013 | 2250 |
| | | | | | | | |
| Nonresistant | | 26.3 | 16.1 | 91.6 | 274 | 4405 | 2023 |
| Resistant-high quality | | 28.0 | 15.6 | 90.6 | 262 | 4087 | 2114 |
| Resistant-low quality | | 25.1 | 15.0 | 90.7 | 251 | 3769 | 2274 |
| | | | | | | | |
| N rate | | 0.62 | 0.29 | 0.56 | 0.26 | 0.28 | 0.86 |
| Variety | | 0.02 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.23 |
| NXVar | | 0.57 | 0.63 | 0.43 | 0.67 | 0.65 | 0.80 |
| C.V. (%) | | 11.0 | 2.0 | 0.7 | 2.7 | 4.6 | 21.5 |
| Mean | | 26.5 | 15.5 | 91.0 | 262 | 4087 | 2137 |

At the time of this report, the nitrogen information for tops was available only for the 2003 sites. Nitrogen concentration and N uptake was not affected by N level or variety at the Prinsburg site in 2003, Table 7. Nitrogen concentration of the sugar beet top was decreased with increasing nitrogen fertilizer amounts at Hector and Raymond. The amount of N Uptake was increase by N level at both sites with the largest amount of N uptake at occurring at Hector with the 110 pound N per acre and at Raymond with the 130 pound N per acre. Variety affected the N concentration at Raymond. The non-resistant variety had the least N concentration when compared the resistant varieties.

Each fall, soil nitrate-N was determined from soil samples taken to a depth of 4 feet, Table 8. Soil nitrate-N values following sugar beet are small. In 2003 the average value was 45 pounds N per acre while in 2004 the average value was less at 19 pounds N per acre. This difference could be attributed to the climate difference between the two years. The August – September moisture conditions in 2003 were dry reducing crop growth and nitrate-N utilization by the plant while in 2004 the conditions moist to wet, with at large amount of plant growth and thus utilization of soil nitrate-N. Only the Prinsburg site had a soil nitrate-N difference caused by a treatment. In this case, the resistant-high quality variety plots had a greater residual nitrate-N than the plots where the other two varieties were grown. The difference occurred in the surface one foot of soil. This difference was not reflected in N uptake at the Prinsburg site.

Table 5. Root yield, sucrose, purity, extractable sucrose, and top yield for the Cosmos site in 2004.

| | Soil nitrate-N plus fert. N | Root yield | Root sucrose | Root purity | Extractable sucrose | | Top yield |
|---|---|---|---|---|---|---|---|
| Variety | lb/A | Tons/A | % | | lb/ton | lb/A | lb/A |
| Nonresistant | 110 | 21.7 | 15.8 | 92.0 | 272 | 4306 | 4819 |
| | 130 | 24.0 | 15.6 | 92.1 | 268 | 4203 | 6192 |
| | 150 | 23.4 | 15.3 | 91.8 | 261 | 4003 | 5275 |
| Resistant-high quality | 110 | 26.0 | 14.9 | 90.8 | 250 | 3720 | 5304 |
| | 130 | 24.7 | 15.2 | 91.6 | 258 | 3912 | 5373 |
| | 150 | 25.9 | 15.0 | 90.7 | 253 | 3804 | 5749 |
| Resistant-low quality | 110 | 21.6 | 14.9 | 91.6 | 253 | 3761 | 5197 |
| | 130 | 22.9 | 15.0 | 91.6 | 256 | 3849 | 5321 |
| | 150 | 23.4 | 14.8 | 90.9 | 249 | 3679 | 5623 |
| | | | | | | | |
| | 110 | 23.1 | 15.2 | 91.5 | 258 | 3929 | 5107 |
| | 130 | 23.9 | 15.3 | 91.8 | 260 | 3988 | 5629 |
| | 150 | 24.3 | 15.0 | 91.1 | 254 | 3828 | 5549 |
| | | | | | | | |
| Nonresistant | | 23.1 | 15.6 | 92.0 | 267 | 4171 | 5428 |
| Resistant-high quality | | 25.5 | 15.0 | 91.0 | 253 | 3812 | 5475 |
| Resistant-low quality | | 22.6 | 14.9 | 91.4 | 252 | 3763 | 5380 |
| | | | | | | | |
| N rate | | 0.50 | 0.37 | 0.07 | 0.17 | 0.25 | 0.59 |
| Variety | | 0.005 | 0.0001 | 0.006 | 0.0001 | 0.0001 | 0.93 |
| NXVar | | 0.53 | 0.30 | 0.67 | 0.41 | 0.32 | 0.15 |
| C.V. (%) | | 9.8 | 2.4 | 0.80 | 3.0 | 5.2 | 12.7 |
| Mean | | 23.8 | 15.2 | 91.5 | 258 | 3915 | 5428 |

**Summary:**

The preliminary results indicate that nitrogen recommendations do not need to be modified for rhizomania resistant varieties. The varieties do not consistently use nitrogen differently. The residual nitrate-N, top N concentrations, and top N uptake do not reflect differences in N use. If disease is severe enough, the use of a resistant variety is highly recommended. In those conditions, the nonresistant variety does not produce adequate extractable sucrose compared to the resistant variety.

Table 6. Root yield, sucrose, purity, extractable sucrose, and top yield for the Raymond site in 2004.

| | Soil nitrate-N plus fert. N | Root yield | Root sucrose | Root purity | Extractable sucrose | | Top yield |
|---|---|---|---|---|---|---|---|
| Variety | lb/A | Tons/A | % | | lb/ton | lb/A | lb/A |
| Nonresistant | 70 | 18.5 | 13.8 | 90.0 | 228 | 4012 | 2050 |
| | 90 | 26.5 | 14.4 | 91.0 | 242 | 6433 | 4017 |
| | 110 | 24.6 | 14.1 | 92.4 | 241 | 5961 | 3580 |
| | 130 | 27.3 | 14.0 | 91.1 | 236 | 6435 | 3988 |
| | 150 | 22.4 | 14.1 | 91.0 | 238 | 5317 | 4294 |
| Resistant-high quality | 70 | 19.0 | 13.6 | 90.6 | 227 | 4334 | 2243 |
| | 90 | 28.0 | 13.9 | 91.2 | 234 | 6560 | 3669 |
| | 110 | 26.2 | 14.0 | 90.5 | 233 | 6080 | 3893 |
| | 130 | 27.8 | 14.0 | 91.1 | 235 | 6535 | 3999 |
| | 150 | 27.2 | 14.0 | 92.7 | 241 | 6552 | 4289 |
| Resistant-low quality | 70 | 22.0 | 13.2 | 91.4 | 222 | 4916 | 2399 |
| | 90 | 25.9 | 14.2 | 91.5 | 241 | 6216 | 3090 |
| | 110 | 26.8 | 13.9 | 91.4 | 234 | 6270 | 4108 |
| | 130 | 28.6 | 13.7 | 91.6 | 232 | 6628 | 3683 |
| | 150 | 25.9 | 13.7 | 91.8 | 232 | 6019 | 3934 |
| | | | | | | | |
| | 70 | 19.8 | 13.5 | 91.7 | 226 | 4421 | 2231 |
| | 90 | 26.8 | 14.2 | 91.2 | 239 | 6403 | 3561 |
| | 110 | 25.9 | 14.0 | 91.4 | 236 | 6104 | 3860 |
| | 130 | 27.9 | 13.9 | 91.3 | 234 | 6533 | 3890 |
| | 150 | 25.2 | 14.0 | 91.8 | 237 | 5963 | 4172 |
| | | | | | | | |
| Nonresistant | | 23.9 | 14.1 | 91.1 | 237 | 5632 | 3568 |
| Resistant-high quality | | 25.6 | 13.9 | 91.2 | 234 | 6012 | 3619 |
| Resistant-low quality | | 25.8 | 13.8 | 91.5 | 232 | 6010 | 3443 |
| | | | | | | | |
| N rate | | 0.0001 | 0.24 | 0.21 | 0.20 | 0.0001 | 0.0001 |
| Variety | | 0.004 | 0.02 | 0.26 | 0.12 | 0.02 | 0.63 |
| NXVar | | 0.09 | 0.68 | 0.02 | 0.63 | 0.06 | 0.60 |
| C.V. (%) | | 8.5 | 2.8 | 1.0 | 3.5 | 8.4 | 18.1 |
| Mean | | 25.1 | 13.9 | 91.3 | 234 | 5885 | 3543 |

Table 7. Top N concentrations and N uptakes for 2003.

| | | Prinsburg | | Hector | | Raymond | |
|---|---|---|---|---|---|---|---|
| | Soil nitrate-N plus fert. N | N concentration | N uptake | N concentration | N uptake | N concentration | N uptake |
| Variety | lb/A | % | lb N/A | % | lb N/A | % | lb N/A |
| Nonresistant | 56 | 1.42 | 35 | 1.62 | 38 | 1.39 | 32 |
| | 70 | 1.45 | 37 | 1.44 | 35 | 1.48 | 26 |
| | 90 | 1.52 | 40 | 1.79 | 41 | 1.41 | 35 |
| | 110 | 1.39 | 39 | 1.53 | 38 | 1.23 | 254 |
| | 130 | 1.31 | 41 | 1.51 | 33 | 1.28 | 40 |
| Resistant-high quality | 56 | 1.91 | 39 | 1.71 | 36 | 1.84 | 30 |
| | 70 | 3.40 | 73 | 1.43 | 29 | 1.71 | 34 |
| | 90 | 1.61 | 40 | 1.77 | 50 | 1.37 | 25 |
| | 110 | 1.35 | 37 | 1.58 | 35 | 1.70 | 27 |
| | 130 | 1.32 | 37 | 1.30 | 37 | 1.17 | 38 |
| Resistant- low quality | 56 | 1.76 | 41 | 1.90 | 39 | 1.86 | 36 |
| | 70 | 1.76 | 42 | 1.49 | 29 | 1.73 | 30 |
| | 90 | 1.70 | 38 | 1.74 | 39 | 1.70 | 35 |
| | 110 | 1.52 | 36 | 1.48 | 35 | 1.62 | 31 |
| | 130 | 1.71 | 49 | 1.59 | 49 | 1.61 | 48 |
| | | | | | | | |
| | 56 | 1.70 | 38 | 1.74 | 38 | 1.70 | 33 |
| | 70 | 2.20 | 51 | 1.45 | 31 | 1.64 | 30 |
| | 90 | 1.61 | 40 | 1.77 | 44 | 1.49 | 32 |
| | 110 | 1.42 | 37 | 1.53 | 36 | 1.52 | 28 |
| | 130 | 1.45 | 42 | 1.47 | 39 | 1.35 | 42 |
| | | | | | | | |
| Nonresistant | | 1.42 | 38 | 1.58 | 37 | 1.36 | 32 |
| Resistant-high quality | | 1.92 | 45 | 1.56 | 37 | 1.56 | 31 |
| Resistant- low quality | | 1.69 | 41 | 1.64 | 38 | 1.70 | 36 |
| | | | | | | | |
| N rate | | 0.49 | 0.59 | 0.009 | 0.05 | 0.08 | 0.06 |
| Variety | | 0.32 | 0.53 | 0.63 | 0.90 | 0.0002 | 0.16 |
| NXVar | | 0.55 | 0.45 | 0.86 | 0.19 | 0.18 | 0.72 |
| C.V. (%) | | 68.6 | 51.2 | 19.4 | 26.5 | 17.4 | 32.0 |
| Mean | | 1.68 | 42 | 1.59 | 37 | 1.54 | 33 |

Table 8. Soil nitrate-N in the surface 4 feet, 2003 and 2004.

| | Soil nitrate-N plus fert. N | Prinsburg 2003 | Hector 2003 | Raymond 2003 | Maynard 2004 | Cosmos 2004 | Raymond 2004 |
|---|---|---|---|---|---|---|---|
| Variety | lb/A | Soil nitrate-N in surface 4 feet (lb/A) | | | | | |
| Nonresistant | 56 | 62 | 47 | 46 | | | |
| | 70 | 43 | 46 | 55 | | | 18 |
| | 90 | 43 | 47 | 47 | 19 | | 18 |
| | 110 | 36 | 44 | 50 | 18 | 17 | 19 |
| | 130 | 46 | 38 | 38 | 18 | 20 | 18 |
| | 150 | | | | 16 | 29 | 18 |
| Resistant-high quality | 56 | 43 | 49 | 39 | | | |
| | 70 | 39 | 50 | 42 | | | 21 |
| | 90 | 38 | 38 | 46 | 19 | | 18 |
| | 110 | 35 | 43 | 59 | 22 | 21 | 18 |
| | 130 | 43 | 32 | 49 | 19 | 18 | 16 |
| | 150 | | | | 17 | 20 | 17 |
| Resistant- low quality | 56 | 58 | 38 | 52 | | | |
| | 70 | 46 | 47 | 47 | | | 17 |
| | 90 | 38 | 46 | 48 | 18 | | 18 |
| | 110 | 47 | 45 | 55 | 19 | 18 | 17 |
| | 130 | 45 | 37 | 46 | 21 | 21 | 18 |
| | 150 | | | | 19 | 20 | 22 |
| | | | | | | | |
| | 56 | 54 | 45 | 45 | | | |
| | 70 | 43 | 48 | 48 | | | 19 |
| | 90 | 40 | 44 | 47 | 19 | | 18 |
| | 110 | 39 | 44 | 55 | 20 | 19 | 18 |
| | 130 | 45 | 36 | 44 | 20 | 20 | 17 |
| | 150 | | | | 17 | 23 | 19 |
| | | | | | | | |
| Nonresistant | | 46 | 44 | 47 | 18 | 20 | 18 |
| Resistant-high quality | | 39 | 42 | 47 | 19 | 20 | 18 |
| Resistant- low quality | | 47 | 43 | 50 | 19 | 20 | 18 |
| | | | | | | | |
| N rate | | 0.11 | 0.43 | 0.66 | 0.31 | 0.34 | 0.76 |
| Variety | | 0.02 | 0.68 | 0.75 | 0.49 | 0.56 | 0.89 |
| NXVar | | 0.31 | 0.27 | 0.45 | 0.66 | 0.15 | 0.19 |
| C.V. (%) | | 21.2 | 18.7 | 26.2 | 21.5 | 29.2 | 18.0 |
| Mean | | 44 | 43 | 48 | 19 | 20 | 18 |