

NITROGEN REQUIREMENT FOR SUGAR BEETS: A SUMMARY OF PAST AND PRESENT RESEARCH FINDINGS

D. Tarkalson¹

¹USDA-ARS, Northwest Irrigation & Soils Research Lab, Kimberly, ID

INTRODUCTION

Nitrogen management is an important management factor in row crop production. In sugar beet production it is especially important due to decreased profits associated with under and over supply of N relative to crop requirements. Under supplying N greatly affects root yield, and over supplying N results in increased root impurities (decreases sucrose extraction efficiency) and decreased sucrose content. Much research has been conducted over time to determine optimum N supplies for sugar beet in various climates, soils, and management practices. One measure of N requirement or efficiency for sugar beet is the lbs of N needed to produce a ton of beets (Nr). This paper seeks to highlight changes in N use within the U.S. sugar beet production and the Nr values determined from studies conducted in the U.S. sugar beet production areas over time.

RESULTS AND DISCUSSION

Yield Improvements

Improvements in genetics and overall management have resulted in increased sugar beet yields in the U.S. over time (Figure 1). Improvement of N management has likely been a contributing factor to this steady increase over time. Fitting a linear regression model to this data set (1909-2010) results in a slope (average tons root yield increase/year) of 0.16. This corresponds to a 1 ton/acre increase every 6.25 years.

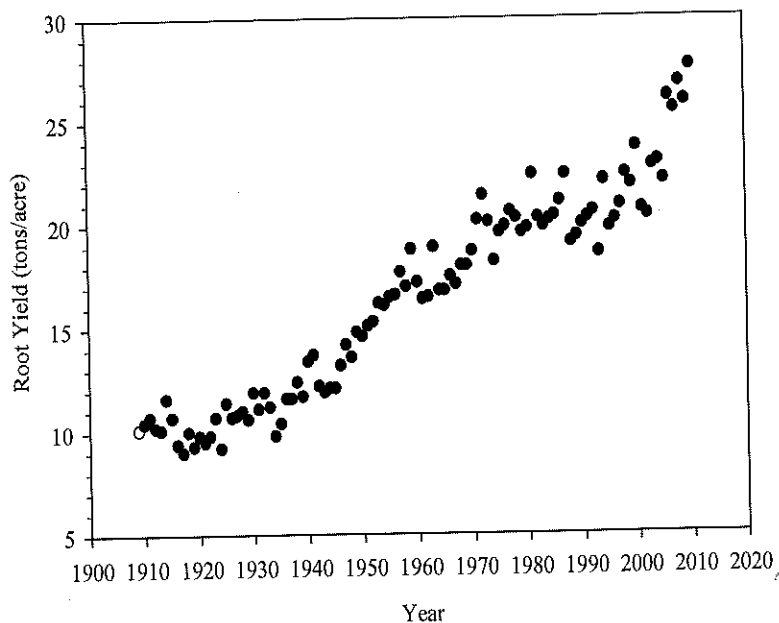


Figure 1. Average U.S. sugar beet root yield over time (USDA-NASS, 2011).

Yield and Available N

In the sugar beet growing area of North Central U.S. (American Crystal Sugar Company growing area), root and sucrose yields increased at an average rate of 0.28 tons roots/acre/yr and 119 lbs sucrose/acre/yr from 1980 to 2010 with total available N (pre-season soil NO₃-N to 4 ft. + applied N fertilizer) remaining constant over time (Figure 2).

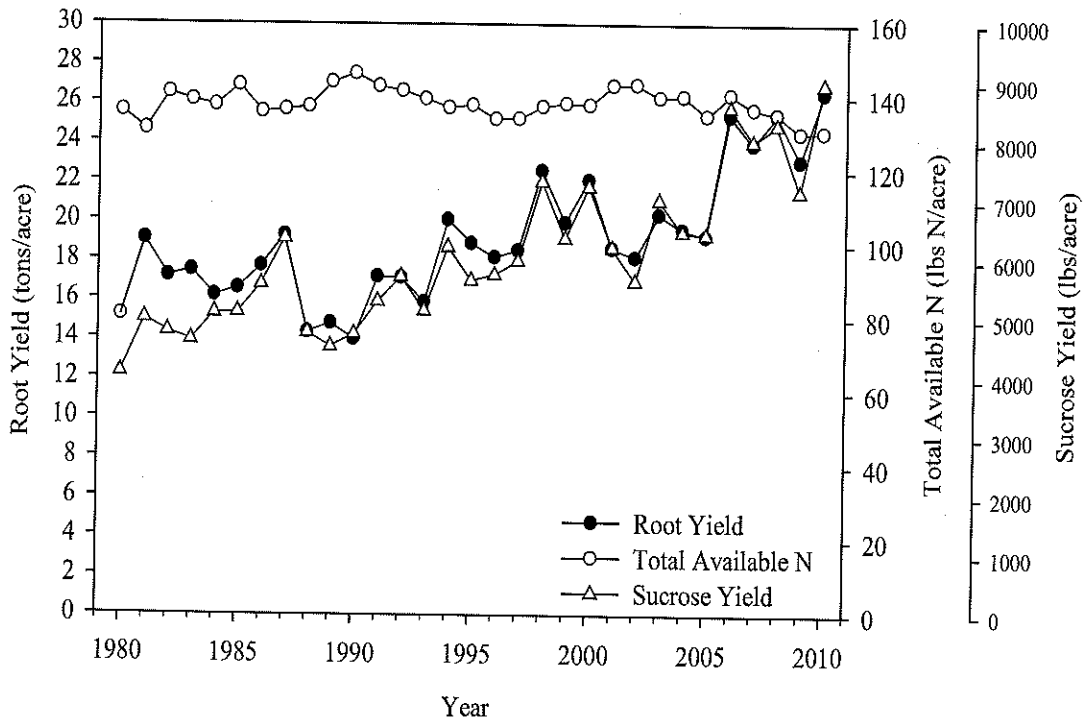


Figure 2. Average sugar beet root yield, sucrose yield, and total available N (pre-season soil NO₃-N to 4 ft. + applied N fertilizer) over time in the American Crystal Sugar Company growing area (MN and ND). (Data supplied by American Crystal Sugar Company).

This data and the calculation of Nr values from this data set gives added evidence that N use efficiency (NUE) has increased over time (Figure 3). This increase in NUE has positive economic and environmental implications; decreased potential N losses to the environment and increased economic returns for producers. It is likely that other sugar beet growing areas are seeing the same trends. Past and current research has likely had a great influence on these positive trends.

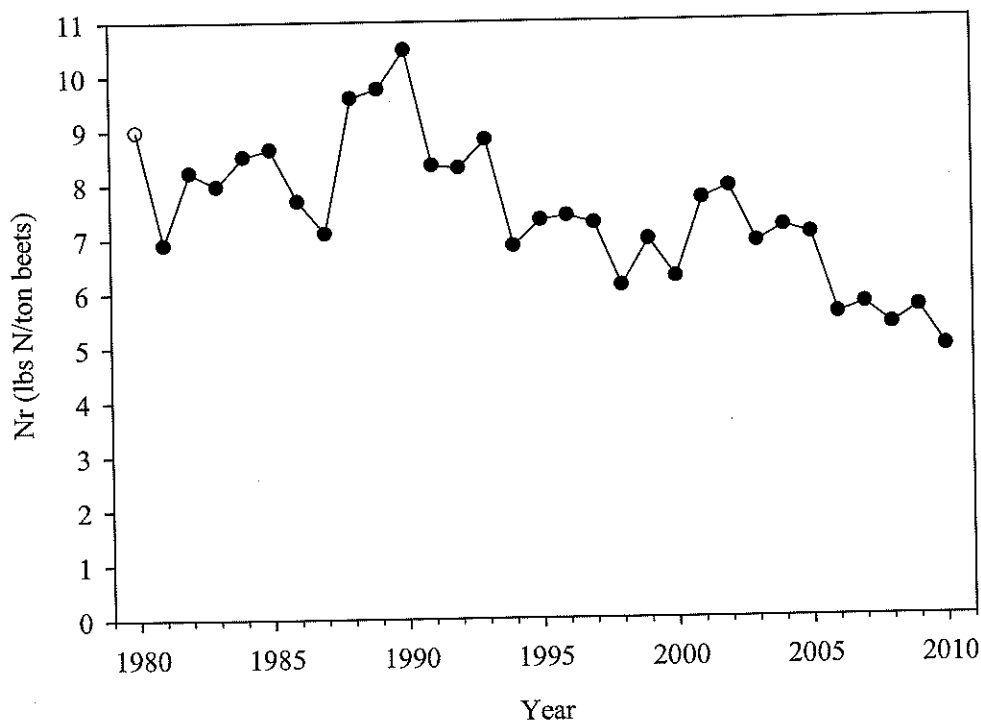


Figure 3. Average N requirement (Nr) of sugar beet over time in the American Crystal Sugar Company growing area (MN and ND). The N requirement supply was calculated based on actual root yields, measured soil NO₃-N to 4 ft., and applied N fertilizer rates. (Data supplied by American Crystal Sugar Company).

A research literature search was conducted to obtain data sets where Nr to achieve maximum root or sucrose yield could be extracted. The ranges (minimum to maximum) of the Nr values are presented in Figure 4. There is no clear pattern of reduced Nr over time and there are large variations in Nr within a study and across studies. The reasons for these observations are likely a result of variability in climate, soil properties, and growth conditions. N requirements need to be evaluated on a site-specific basis. Producers can use information from research under similar conditions as found in their fields to estimate initial Nrs, then adjust as needed based on historical N rate, root yield, sugar yield, and sugar beet root sugar and quality. To fine-tune Nr, producers need to keep good records of sugar beet production in fields over time.

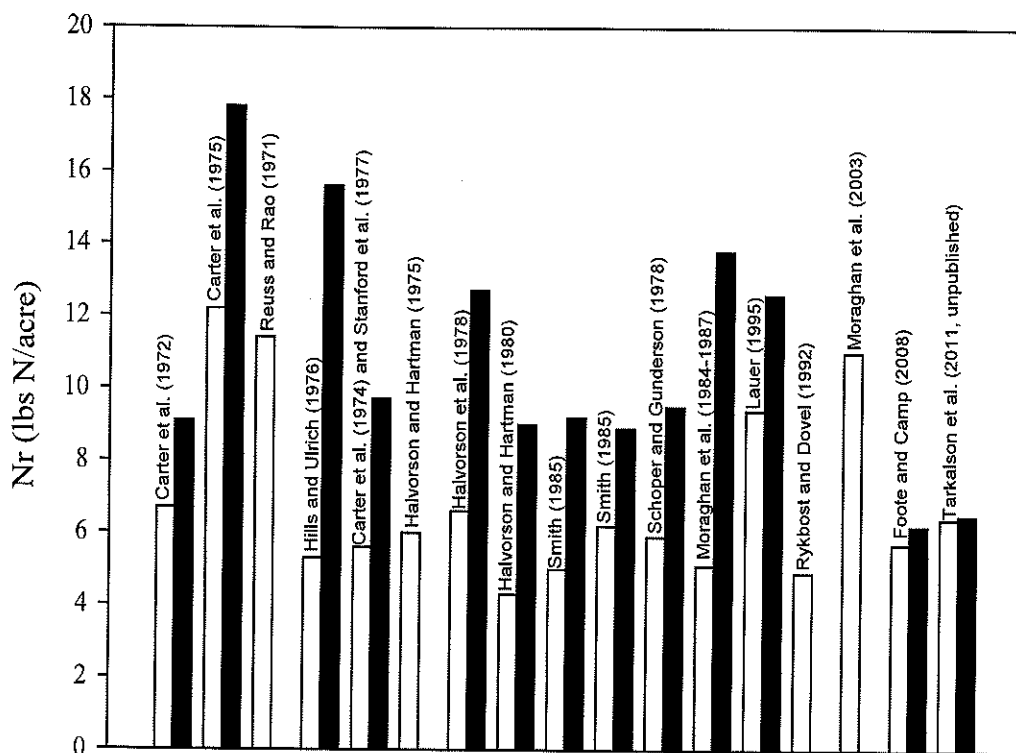


Figure 4. Nr values reported or calculated from research studies in North America. For each study the white bar is the minimum and the black bar is the maximum Nr value in the study.

REFERENCES

- Carter, J.N., C.H. Pair, and D.T. Westermann. 1974. Effects of irrigation method and late season nitrate-nitrogen concentration on sucrose production by sugar beets. *Journal of Sugar beet Research*. 18:332-342.
- Carter, J.N., D.T. Westermann, M.E. Jensen, and S.M. Bosma. 1975. Predicting nitrogen fertilizer needs for sugar beets from residual nitrate and mineralizable nitrogen. *Journal of Sugar beet Research*. 18:232-244.
- Carter, J.N., M.E. Jensen, and S.M. Bosma. 1975. Determining nitrogen fertilizer needs for sugar beets from residual soil nitrate and mineralizable nitrogen. *Agronomy Journal*. 66:319-323.
- Foote, P., and S. Camp. 2008. The response of sugar beet varieties to different nitrogen rates. *The Sugar beet Spring Issue*. Amalgamated Sugar Co.
- Halvorson, A.D. and G.P. Hartman. 1975. Long-term nitrogen rates and sources influence sugar beet yield and quality. *Agronomy Journal*. 67:389-393.
- Halvorson, A.D. and G.P. Hartman. 1980. Response of several sugar beet cultivars to N fertilization: Yield and crown tissue production. *Agronomy Journal*. 72:665-669.
- Halvorson, A.D., G.P. Hartman, D.F. Cole, V.A. Haby, and D.E. Baldrige. 1978. Effect of N fertilization on sugar beet crown tissue production and processing quality. *Agronomy Journal*. 70:876-880.

- Hills, F.J. and A. Ulrich. 1976. Soil nitrate and the response of sugar beets to fertilizer nitrogen. *Journal of Sugar beet Research*.19:118-124.
- Lauer, J.G. 1995. Plant density and nitrogen rate effects on sugar beet yield and quality early in harvest. *Agronomy Journal*. 87:586-591.
- Moraghan, J.T., A.L. Sims, and L.J. Smith. 2003. Sugar beet growth as affected by wheat residues and nitrogen fertilizer. *Agronomy Journal*. 95:1560-1565.
- Moraghan, J. 1984. Nitrogen studies with sugar beets. Sugar beet Research and Extension Board of Minnesota and North Dakota Sugar beet Research and Extension Reports. 15:86-96.
- Moraghan, J. Smith, and A. Cattanaach. 1985. Nitrogen fertilizer trials. Sugar beet Research and Extension Board of Minnesota and North Dakota Sugar beet Research and Extension Reports. 16:87-95.
- Moraghan, J. 1986. Nitrogen fertilizer trials. Sugar beet Research and Extension Board of Minnesota and North Dakota Sugar beet Research and Extension Reports. 17:75-84.
- Moraghan, J. 1987. Nitrogen fertilizer trials. Sugar beet Research and Extension Board of Minnesota and North Dakota Sugar beet Research and Extension Reports. 18:89-97.
- Reuss, J.O. , and P.S.C. Rao. 1971. Soil nitrate nitrogen levels as an index of nitrogen fertilizer needs of suagrbeets. *Journal of Sugar beet Research*.16:461-470.
- Rykbost, K.A. and R.L. Dovel. 1992. Sugar beet response to nitrogen fertilizer rates. Oregon State University Research in the Klamath Basin, 1992 Annual Report. p.72-73. Online at: <http://oregonstate.edu/dept/kbrec/sites/default/files/10>
- Schoper, R.P., and O.M. Gunderson. 1978. Nitrogen fertilization of sugar beets in West-Central Minnesota. Sugar beet Research and Extension Board of Minnesota and North Dakota Sugar beet Research and Extension Reports. 9:162-169.
- Smith, L.J. 1985. Sugar beet response to vaious soil nitrogen levels. Sugar beet Research and Extension Board of Minnesota and North Dakota Sugar beet Research and Extension Reports. 16:73-77.