NITROGEN FERTILIZATION EFFECT ON SUGARBEET CROP YIELD AND QUALITY

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Introduction

Nitrogen is an essential element in sugarbeet crop growth and yield. However, over-fertilization may increase input costs and reduce root quality and sugar production efficiency (Gordo, 2003). Moreover, excess nitrogen causes environmental impacts, so an improved N management is essential to achieve crop sustainability. The aim of this work was to study the effect of nitrogen fertilization on sugarbeet crop yield and quality in the North cultivation zone of Spain.

Materials and Methods

Five trials in soils with different soil fertility levels were carried out on fields located in Duero Basin (Burgos and Valladolid provinces, Spain) in commercial farms. Years, locations, and soil and crop characteristics of each trial are shown in Tab. 1. Different nitrogen rates were tested: 0 (control), 50% RR, RR and 150% RR. RR is the recommended rate by the Spanish Institute for Sugarbeet Research (AIMCRA), based on soil N-nitrate and soil organic matter before sowing, and calculated as follows: $RR = 310 - 6\ NO_3 - 70\ MO$, where RR is the recommended rate in kg N ha^{-1}, NO_3 is the soil N-nitrate content in mg kg^{-1} and MO is the soil organic matter content in %. With the considered treatments a sufficient range of available N was achieved. Nitrogen application was split in three in three equal parts: one at pre-planting and two side-dressings at 4-6 and 10-12 leaves per plant stages, respectively. Trial layout was randomized blocks with four replicates. Plot size was 30 m^2 (12 crop rows 5 m length). Agricultural practices were carried out by farmers according to AIMCRA research staff recommendations and control. Nitrogen applications and harvest operations were done by researchers. On November, a surface area of 10 m^2 of each plot was harvested and crop yield (fresh root weight, sugar content and yield) and quality parameters (invert sugars, α-amino N, sodium and potassium and quality index) were measured. Farmer economic return was computed as economic value of root yield with 16 % of sucrose.

Tab. 1. Data of the five trials (SOM: soil organic matter, in %; N-nitrate in soil in mg kg^{-1}; recommended rate in kg N ha^{-1}).

Year	Location	SOM	N-nitrate	Cultivar	Recommended rate
2003	Moradillo	1.5	4.2	Fresca	180
2004	Nava Rey	0.6	1.0	Plata	220
2004	Torrepadierne	2.1	6.0	Brigitta	120
2005	Moradillo	1.5	10.0	Esperanza	140
2006	Torregalindo	2.1	6.0	Esperanza	120

Results

Root yield increased with nitrogen application (Tab. 2), but it was observed a different effect depending on soil fertility, being higher in low fertility soils. In high fertility soils trials, the application of the recommended rate showed the potential root yield, while in low fertility ones the yield increased until the over-fertilized rate. Sucrose content was negatively affected by increasing N application, especially in very high rates, as described previously in other

work (Gordo, 2003). Sugar yield and the economic return for the farmer showed a pattern similar to root yield, because these parameters are highly correlated.
By the other hand, root quality index was reduced for higher N rates, because of the increment of the α-amino nitrogen content (Tab 2.). This lower root quality implies lower extraction yield during industrial processing of sugar. The effect of nitrogen on root quality was slightly larger in high fertility soils, while in low fertility soil trials α-amino N did not increased significantly with N fertilization, maybe due to the high response to nitrogen application, so root quality was not reduced.

Tab. 2. Crop yield and crop quality parameters in two contrasting trials: Torrepadierne 2004 (high soil fertility) and Nava Rey 2004 (low soil fertility). Different letters within each parameter denote significant differences $P \leq 0.05$.

N Rate (kg ha^{-1})	Root yield (t ha^{-1})	Sugar content (%)	Sugar yield (t ha^{-1})	Economic return (t ha^{-1})	α-amino N (mmol 100g^{-1})	Quality index (%)
High fertility						
0	78.7^{b}	17.7	13.9^{b}	90.4^{b}	0.53^{a}	87.2^{a}
60	93.9^{a}	17.6	16.5^{a}	107.3^{a}	0.62^{a}	87.5^{a}
120	97.9^{a}	18.0	17.6^{a}	115.7^{a}	0.57^{a}	87.2^{a}
180	98.4^{a}	17.6	17.3^{a}	112.1^{a}	1.08^{b}	85.9^{b}
Low fertility						
0	48.9^{b}	18.0^{b}	8.8^{b}	57.8^{b}	0.47	87.7
110	76.7^{a}	18.4^{a}	14.7^{a}	97.0^{a}	0.54	87.6
220	87.3^{a}	18.1^{b}	15.8^{a}	103.7^{a}	0.51	87.7
330	99.5^{a}	17.5^{c}	17.5^{a}	113.3^{a}	0.77	87.3

Conclusions

There was a significant effect of nitrogen application rate on sugarbeet yield and quality, but the effects were different depending on soil fertility. Trials on high soil fertility showed the maximum sugar yield and economic return when the recommended rate was applied, and with the higher rate root quality was reduced. By the other hand, in trials on low fertility soils crop response to nitrogen application was observed until the over-fertilizer rates (50% more than the recommended one) and quality was not affected significantly by it. These different nitrogen effects on crop yield and quality may support a better N management, increasing farm economic sustainability and sugar processing efficiency.

References

Gordo, L. 2003. La calidad tecnologica de la remolacha azucarera. AIMCRA, Valladolid, Spain, 194 pp.