NITROGEN FERTILIZATION EFFECT ON SUGARBEET CROP GROWTH AND RADIATION INTERCEPTION

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Introduction

Nitrogen is an essential element in crop growth, yield and quality, while, an improved N management must reduce potential environmental impact. Crop yield is highly correlated with the amount of solar radiation intercepted by the canopy during crop growth cycle, so foliage development is important for growth and yield (Malnou et al., 2006). The aim of this work is to study the effect of nitrogen fertilization on sugarbeet crop growth and radiation use efficiency and interception in a temperate cultivation zone.

Materials and Methods

Five trials in soils with different soil fertility levels have been carried out on commercial fields located in Duero Basin (Burgos and Valladolid provinces, Spain). 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 equal parts: one at pre-planting and two side-dressings at 4-6 and 10-12 leaves $plant^{-1}$ stages. Agricultural practices were carried out by farmers according to AIMCRA research staff recommendations and control, while nitrogen applications were done by researchers. Trials design was randomized blocks with four replicates. Plot size was 30 m^2 (12 crop rows 5 m length). Crop growth was analysed in plant samples from 0.5 m^2 (5-6 plants) taken along the crop growth cycle: first and second side-dress, two and four weeks later, one month later and at harvest. Aerial biomass (crowns + petioles + leaf blades) and root biomass production were measured in oven-dried samples. Number of green leaves and leaf area were measured and leaf area index (LAI) was computed. Crop growth rate and net assimilation rate were computed with those data. In addition, photosynthetic active radiation (PAR) intercepted by crop canopy was measured at each sampling date (with a LI-COR quantum sensor) and PAR fraction intercepted was calculated. Radiation use efficiency was computed as the ratio of crop dry biomass by intercepted PAR. PAR data were calculated from solar radiation data from weather stations located near the trials.

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

Nitrogen fertilization had a great effect on biomass production (Fig. 1), as described in Werker at al. (1999). This effect was higher in those trials were soil fertility was low. Aerial biomass was more affected by nitrogen than root biomass, especially during the first half of crop growth cycle, where the canopy growth predominates over root growth. Leaf area was also affected by nitrogen availability and LAI reached maximum values with the recommended and over-fertilized rates (Fig. 2). Leaf expansion was more affected by nitrogen deficiency than leaf biomass, so specific leaf weight increased. The under-fertilized treatments showed a lower canopy development and they intercepted less PAR during the crop growth cycle (Malnou et al., 2006). On the other hand, radiation use efficiency was not affected significantly by N fertilization, except in some trials and always before full canopy development.

Conclusions

There was a significant effect of nitrogen rate application on sugarbeet crop growth. The main factor affecting biomass production was radiation interception, which was affected by a lower canopy development in under-fertilized treatments. Aerial biomass and leaf expansion was affected mainly during the first half of crop growth cycle and when nitrogen could be available for the crop in order to achieve maximum biomass production. Consequently, this must be the main issue to take into account in crop N management.

References

Malnou C.S. et al. 2006. A canopy approach to nitrogen fertilizer recommendations for the sugarbeet crop. Eur. J. Agr., 25: 254-263.

Werker A.R. et al. 1999. Modelling partitioning between structure and storage in sugar beet: effects of drought and soil nitrogen. Plant Soil, 207: 97-106.