STUDY OF EARLY SUGAR BEET NITROGEN UPTAKE

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SUMMARY

Although much work has been carried out on nitrogen absorption by sugar beet during the advanced stages of vegetation, very few studies have focused on early absorption of nitrogen by the crop. Field plots were carried out during two years in France to better characterise early nitrogen absorption. Nitrogen was brought at rates of 100, 200 and 300 kg/ha in irrigated (drop by drop) and non-irrigated plots, three weeks before sowing. It was also added at a rate of 100 kg/ ha just before sowing in localised and generalised modes. Seedling emergence was observed and leaf areas were measured from emergence to the 16 leaf stage. Growth curves were established by sampling beets at different stages during the crop. Time was calculated as thermal time (base 3.5 °C) from 80% emergence. Nitrogen concentrations in the 0-60 cm layers in the ground and the roots of the beets were also measured. The results showed early differentiation between the various nitrogen treatments regarding the level of fresh and dry matter and regarding the level of the quantity of nitrogen in the leaves and roots. The drop by drop irrigated beets showed faster growth and higher absorption of qnitrogen. These results could be used to define nitrogen application methods, making it possible to reduce the nitrogen amount brought before sowing without decreasing growth and productivity.

RESUME

Contrairement aux nombreux travaux sur l'absorption de l'azote par la betterave à sucre durant les stades avancés de la végétation, très peu d'études ont été publiées sur l'absorption précoce de l'azote par la plante. Des essais aux champs ont été menés durant deux années dans une région betteravière de France. Pour une même variété de betterave, l'azote a été apporté à raison de 100, 200 et 300 Kg/Ha en mode irrigué (goutte à goutte) et en non irrigué. La modalité 100 Kg/Ha a également été apportée au moment du semis en mode

localisé et généralisé. Les courbes de croissance ont été établies en réalisant des prélèvements de betteraves à des périodes déterminées. Le temps a été exprimé en °Cj, à partir du jour correspondant à 80 % de la levée théorique, en utilisant les températures moyennes journalières, base 3.5 °C. La dynamique de la levée a été observée et les surfaces foliaires ont été mesurées depuis la levée jusqu'au stade 16 feuilles. Un suivi de la concentration en azote à différents horizons dans le sol et de l'enracinement des betteraves a été également réalisé.

Les résultats montrent une différentiation précoce entre les différents traitements d'azote aussi bien au niveau de la matière fraîche et sèche qu'au niveau de la quantité d'azote absorbée par les feuilles et les racines. Les betteraves irriguées, en goutte à goutte, ont montré une croissance plus rapide et une absorption d'azote plus grande. Ces résultats pourraient être exploités pour identifier des modalités d'application permettant de réduire encore la dose d'azote apportée au semis sans altérer la croissance et la productivité.

INTRODUCTION

Although much work has been carried out on nitrogen absorption by sugar beet during crop growth, very few studies have focused on early absorption of nitrogen. Field observations are reporting early differences in growth, especially in nitrogen and localised fertilisation trials. The objectives of the work were to analyse early nitrogen absorption and its influence on growth during both early and late periods.

1.- MATERIAL AND METHODS

Two field experiments were carried out with sowing on 08 May 2001 (Trial I) and 29 March 2002 (Trial II) near Reims (France) in calcareous clay soils. Two factors (replicated three times) were tested.

Factor 1: nitrogen. Nitrogen was supplied at rates of 100, 200 and 300 kg/ha, three weeks before sowing. In Trial II, nitrogen was also added at rates of 100 kg/ha in localised (100 U Loc) mode and 3 days before sowing in generalised (100 U BS) mode.

Factor 2: irrigation. After sowing, half plots were irrigated, drop by drop, to cover evapotranspiration.

Sampling procedure: for each plot, samples of beet were taken on 5 occasions nearly every week in the beginning and on 5 occasions every two weeks at the end of the crop. The total number of samples was 10. Each sample was made of 45 to 60 beets.

In the Trial II, soil was sampled at different layers of 10 cm down to 60 cm at the sowing time, emergence, 30, 50 and 72 days after emergence. For the plots with localised nitrogen, soil was sampled both on the row (100 U Loc R) and at 10 cm outside the row where nitrogen was added (100 U Loc OR). Soil was also sampled after harvesting at depth of 120 cm.

Measurements: since 80 % emergence, at 10 stages, leaves and roots were weighted and the mass of dry matter was determined by drying at 70 °C during 48 h. The time in the growth curves was calculated, from 80% emergence, as thermal time in degree-day (°Cd) using the mean daily temperature of air and the threshold value of 3.5 °C for sugar beet (Dürr and Boiffin, 1995). Total nitrogen in leaves and roots was determined on the dry material by Dumas method ; Mineral nitrogen (ammonium and nitrate) in the 0-60 cm layers of the ground was determined 5 times beginning from the sowing date: after extraction by 1 M KCl, nitrogen was measured by colorimetric method and expressed both in kg/Ha and in mmol N/100 g water in soil. Soil water content was measured by the normalised method (NF Iso 11465).

Technlogical quality of beet after harvesting was determined by analysis of sucrose, sodium and potassium, invert sugar and alpha amino nitrogen using the standard methods (polarimetry, flame spectrophotometry emission, enzymatic method and colorimetry, respectively).

2.- RESULTS AND DISCUSSION

Strong differences were observed in early growth until 500 °Cd (base 3.5, Fig. 1). In Trial I, nitrogen treatments affected early growth. In Trial II, growth was much lower and no effect of nitrogen was observed. This could be in relation with the high nitrogen concentrations measured in trial II in the first soil layers (Fig. 2), over 7.5 mM, for all the treatments until the end of June (780 °Cd), even on the control without N-fertiliser.

The effect of nitrogen treatments on dry matter during late growth was more marked for leaves than roots (Fig. 3). The higher early growth in trial I did not improve final root production compared to trial II. No effect on root production was observed for the nitrogen localised in both irrigated and not irrigated plots (Fig. 4), probably because the nitrogen concentrations were high even when nitrogen was not localised. Nitrogen contents in roots and leaves did not differ much whatever the year and irrigation or nitrogen treatments (Fig. 5). Also, root/ leaf allocation did not differ until 500°Cd (Fig. 6). Only whole plant growth was altered. It was after 500°Cd that roots/leaves ratios changed: the more growth is decreased in relation with water and nitrogen deficiency, the more roots/leaves increased. Leaf growth was decreased most while root growth decreased far less. Yields were much higher in trial II. Irrigation had significant and contrary effects on root production and sucrose. Nitrogen had significant effects in trial I; only the control and 100BS yields were significantly lower in trial II.

CONCLUSION

These trials indicate that strong differences can be observed during early growth up to 500°Cd in relation with nitrogen and water treatments. Early growth was lower in Trial II, with no differences between treatments, as opposed to trial I. This may be in relation with water stress in Trial II even in irrigated plots, and with high soil nitrogen concentrations whatever the treatments. However nitrogen plant contents and root/leaf allocation were not altered by these differences in early growth whatever the year and treatment until root tuberisation began (after 500°Cd). Thereafter, root growth was altered far less than leaf growth when later growth conditions were unfavourable. Finally, root yields in 2001 were lower compared to 2002 although early growth was much higher. More work is necessary to better understand the relationships between early and late growth according to nitrogen and irrigation effects.

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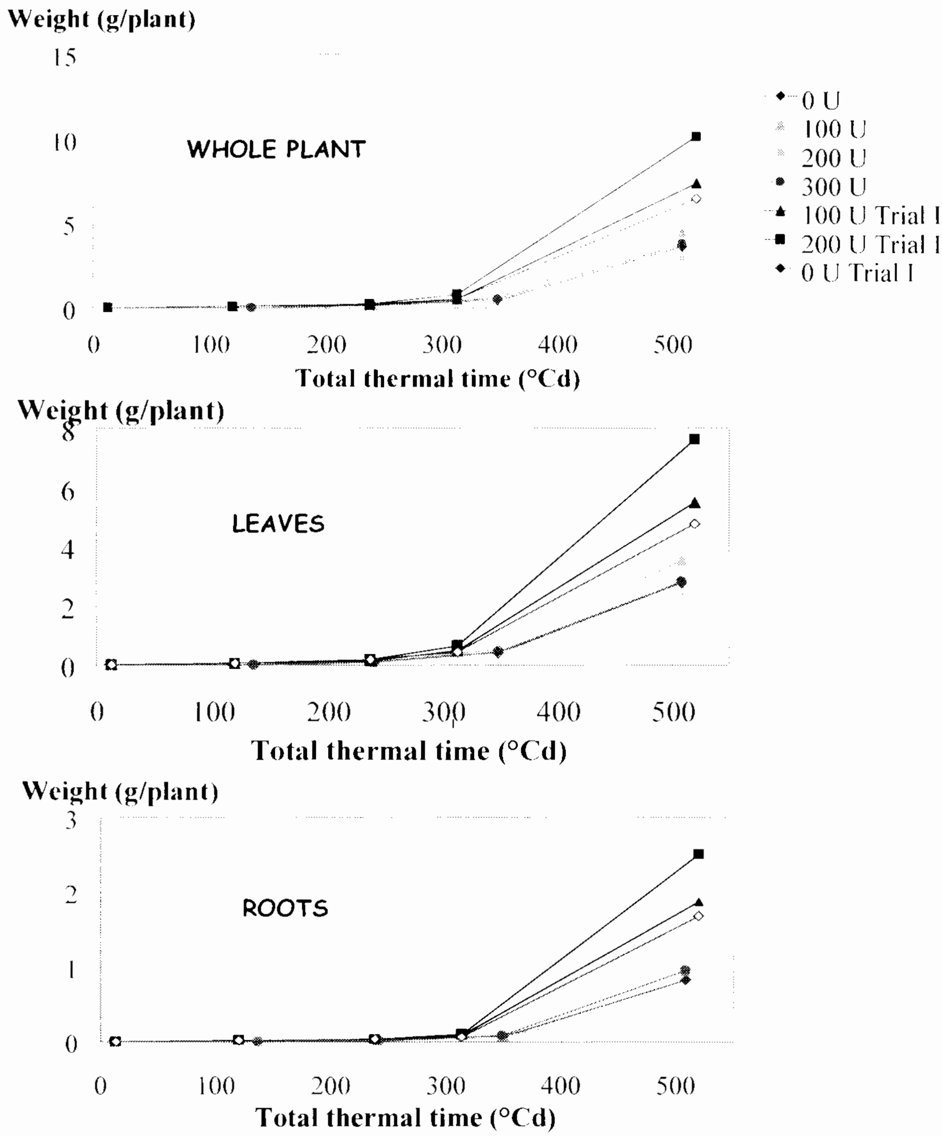
Fig.1: early growth in the irrigated plots (Trial I and II)



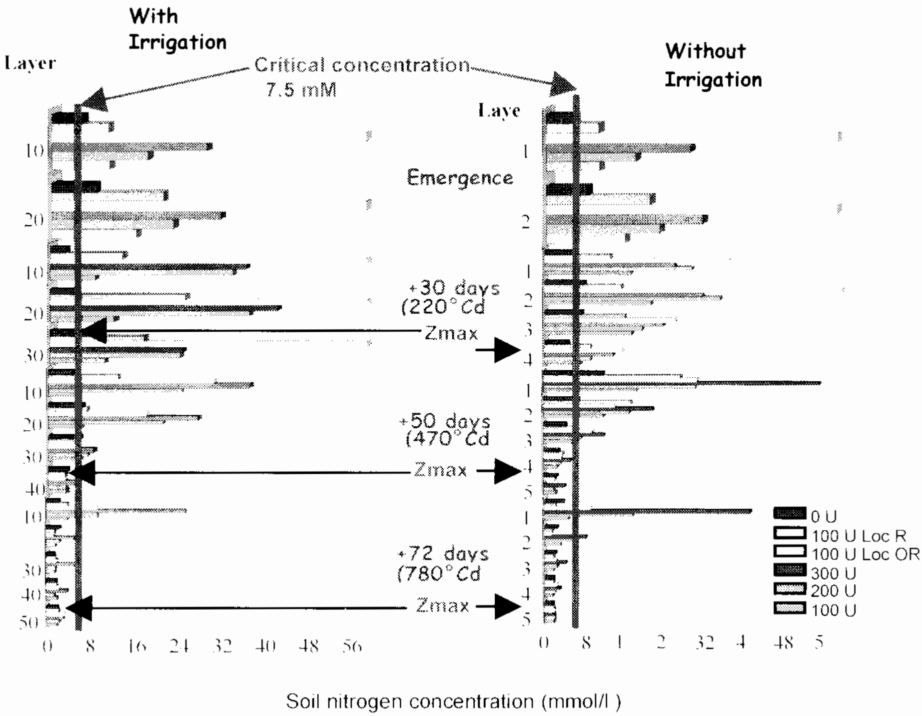


Fig. 2: soil nitrogen concentrations during early growth (Trial II)
R on the row, OR outside the row

Fig. 3: growth curves (Trial I and II)

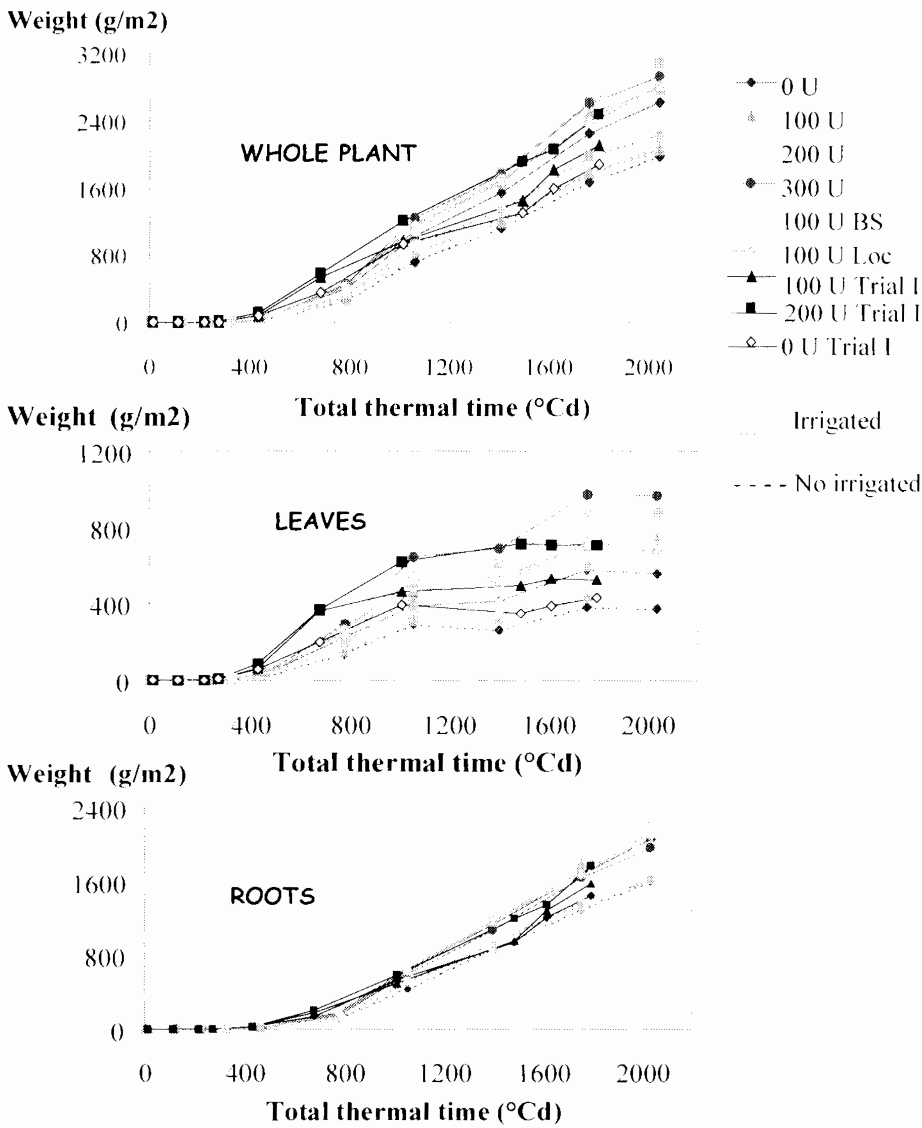


Fig. 4: 100 U nitrogen procedure effects on growth (Trial II)

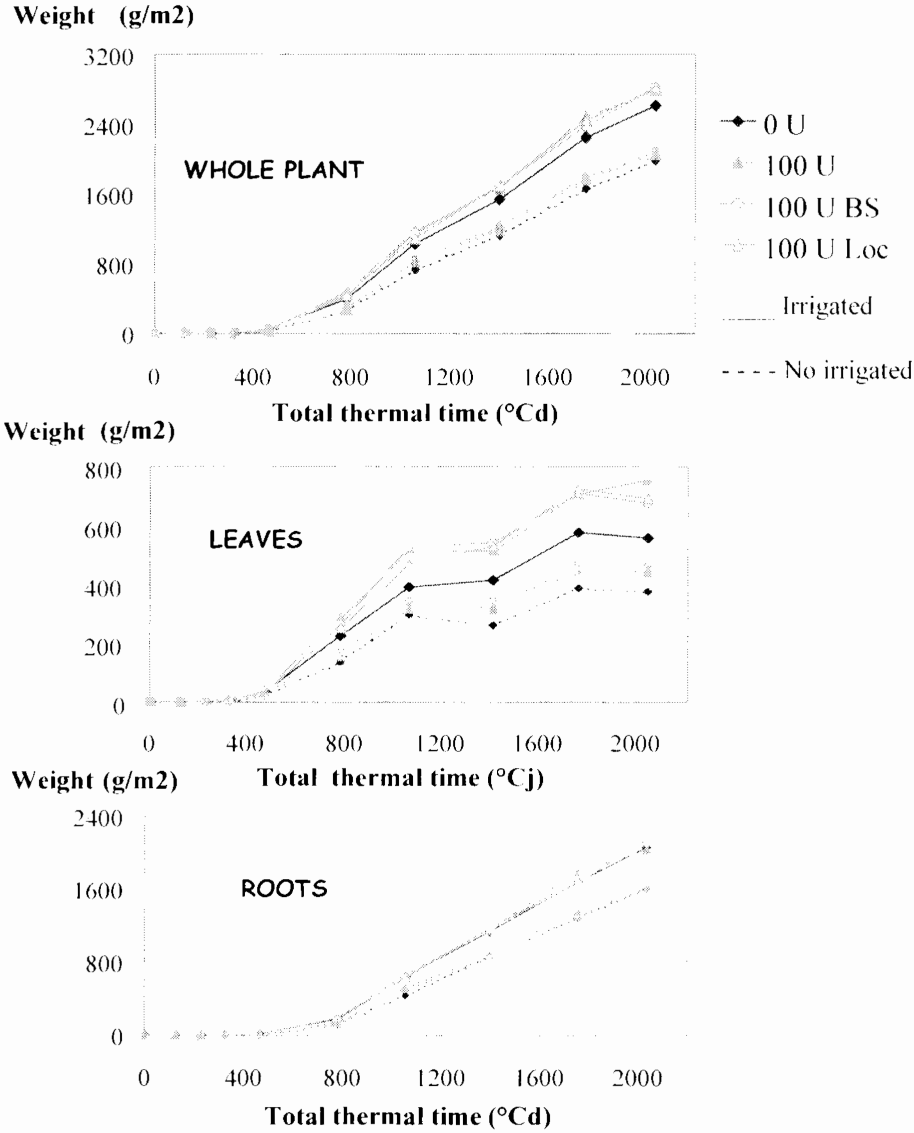


Fig. 5: nitrogen concentrations in leaves and roots (Trial I and II)

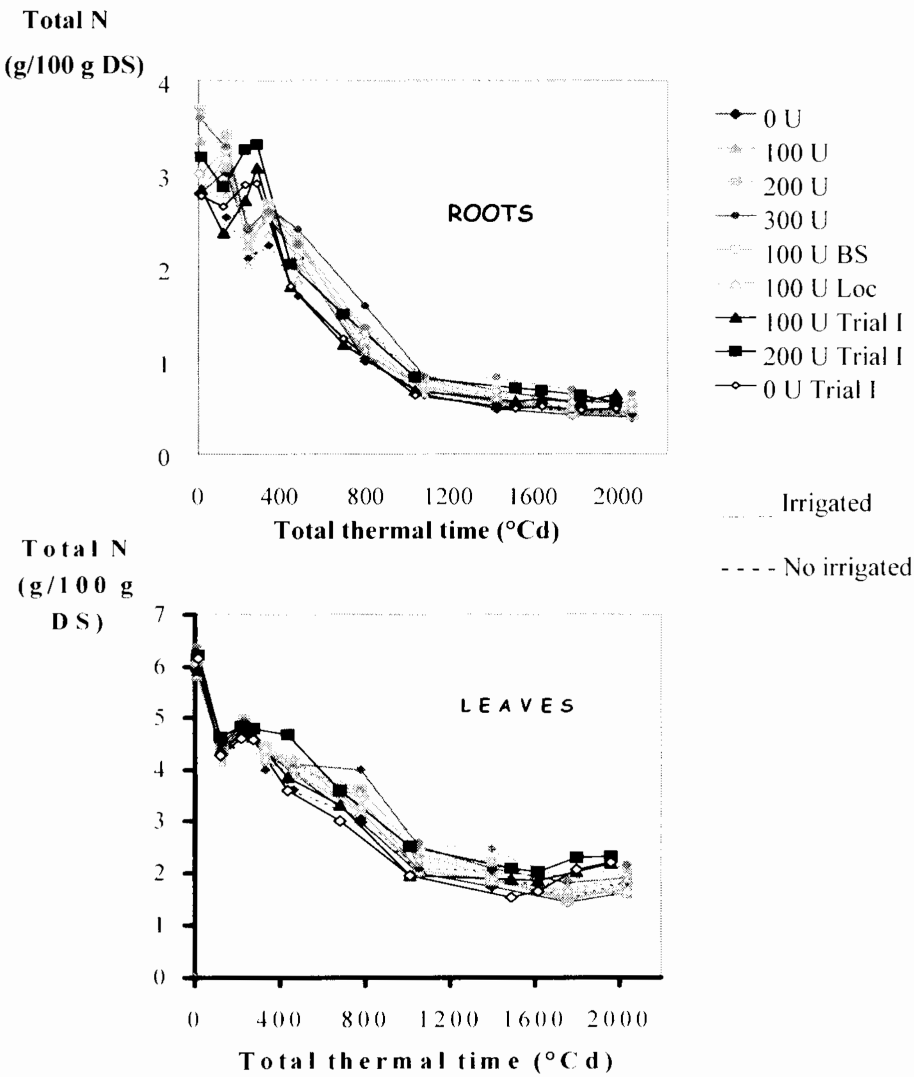


Fig.6: roots/leaves ratios (Trials I and II)