Nitrogen Leaching from Container-Grown Plants

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INTRODUCTION

Production of high quality container-grown ornamentals requires adequate levels of nutrients and water in the container medium. Water use efficiency and nutrient leaching from agricultural and horticultural crops are attracting much attention because of exhaustion of drinking water resources and pollution. In order to reduce leaching of nutrients during production of ornamentals it is important to have a balance between the concentration of applied nutrients and nutrients in the root zone, which, at the same time restricts the leaching of nutrients to a minimum and supports optimal plant growth. In outdoor production systems in Denmark, container-grown ornamentals are often supplied with a high level of fertilizer. Part of the fertilizer is often mixed into the potting medium before transplanting, and part of it is supplied with the irrigation water in a non-recirculating system.

The objective of this study was to investigate how irrigation frequency and nutrient concentration (electric conductivity, EC) in the root zone influence nitrogen leaching and plant quality of *Campanula carpatica* 'Dark Blue'.

MATERIALS AND METHODS

Campanula carpatica Jacq. 'Dark Blue' was propagated in 4 × 4-cm plugs (Vefi, Larvik, Norway) and grown in a full-fertilized peat medium in 10-cm containers from June to Oct. 1997 on outdoor benches. Fertilizer was added to the irrigation water using an AMI-5000 irrigation and fertilizer computer (DGT, Denmark) to maintain either high (EC: 2.5) or low (EC: 1.5) nutrient concentration in the root zone. The nutrient solution was supplied with a non-recirculating drip-irrigation system. Two irrigation frequencies were included. Plants were irrigated after 4 or 6 mm of evaporation. All treatments received the same total amount of irrigation water. However, plants from the 4-mm treatment were irrigated more frequently and with a smaller amount of nutrient solution per irrigation compared with the 6-mm treatment.

Leachate from each bench was collected in 25-litre tanks and analysed for NO_3 and NH_4. Plants were harvested every 2 weeks throughout the experiment and biomass accumulation of the aboveground part of the plant, plant height, and number of flowers and buds were recorded.

Nitrogen (N) balances were estimated by indexing the values of total amount of N added, N leaching, N found in growth substrate at the end of the experiment, and N uptake with total amount of N added as 100.

Plants overwintered outdoors, were transferred to a greenhouse in February 1998, and grown until flowering. During forcing, plants from all treatments received identical nutrient concentration and irrigation frequency.

RESULTS

Plant quality from June to October was quite similar regardless of nutrient concentration and irrigation frequency. There were no significant differences in plant height, biomass accumulation, production time, or number of flowers (data not shown).

Nitrogen leaching was significantly affected by both nutrient concentration and irrigation frequency. The highest nitrogen leaching was seen from plants grown with the high EC level in the root zone and irrigated with the relatively large volume of nutrient solution per irrigation (Fig. 1). Plants supplied with the low nutrient concentration and irrigated more frequently with a low irrigation volume per irrigation had the lowest accumulated nitrogen leaching (Fig. 1). The percentage of nitrogen leached was more affected by irrigation frequency than by nutrient concentration. When plants were irrigated after 6-mm evaporation (low irrigation frequency) more than 80% of the applied N was leached, compared with 60% to 70% when irrigated after 4-mm evaporation (high irrigation frequency) (Figs. 1 and 2).

Both nutrient concentration and irrigation frequency affected the number of shoots and flowers after forcing in the greenhouse (Fig. 3). Plants grown with the low EC and irrigated frequently with a low volume had a significantly higher number of shoots and flowers than plants from other treatments. The lowest number of flowers was observed in plants grown with the high nutrient concentration and a high irrigation volume per irrigation (Fig. 3).

DISCUSSION AND CONCLUSION

Although nitrogen leaching was reduced when growing plants with the low nutrient availability, nitrogen leaching was also to a large extend affected by irrigation frequency/irrigation volume. Irrigating plants with small volumes per irrigation reduced the nitrogen leached from plants grown with the high EC in the root zone by almost 70 kg ha^{-1}, indicating that nitrogen leaching and thereby the environmental pollution can be significantly reduced just by choosing the right irrigation strategy.

Plant growth and quality were apparently not affected by nutrient concentration and irrigation frequencies during the outdoor production period. However, after an outdoor overwintering and forcing to flower in the greenhouse, differences in number of shoots and flowers were found. Plants grown with the low nutrient availability and high irrigation frequency during the previous outdoor production period had a significantly higher number of shoots and flowers than plants grown at the other combinations. The increase in number of shoots and flowers in plants grown with the low nutrient availability during the outdoor production period 5 to 10 months before forcing may indicate that these plants had a more active root system since the shoots emerging during forcing are secondary shoots from the roots. A high number of secondary shoots from roots are important to growers since such shoots are used as propagation material.

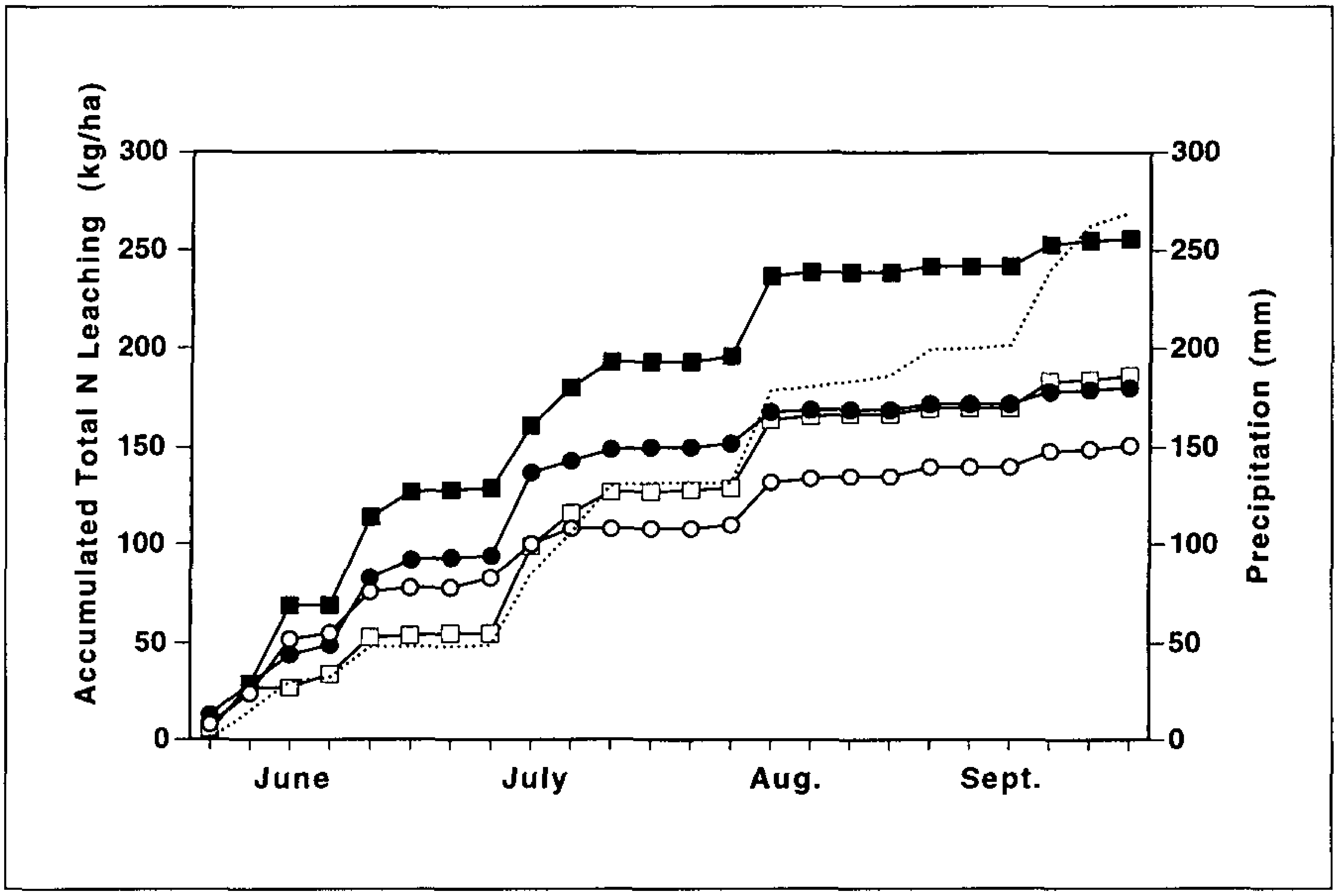

Figure 1. Accumulated total nitrogen leaching from *Campanula* fertilized with different nutrient concentrations, EC 1.5 (●,○) or 2.5 (■,□) after 4 (open symbols) or 6 mm of evaporation (closed symbols). Dotted line represents precipitation.

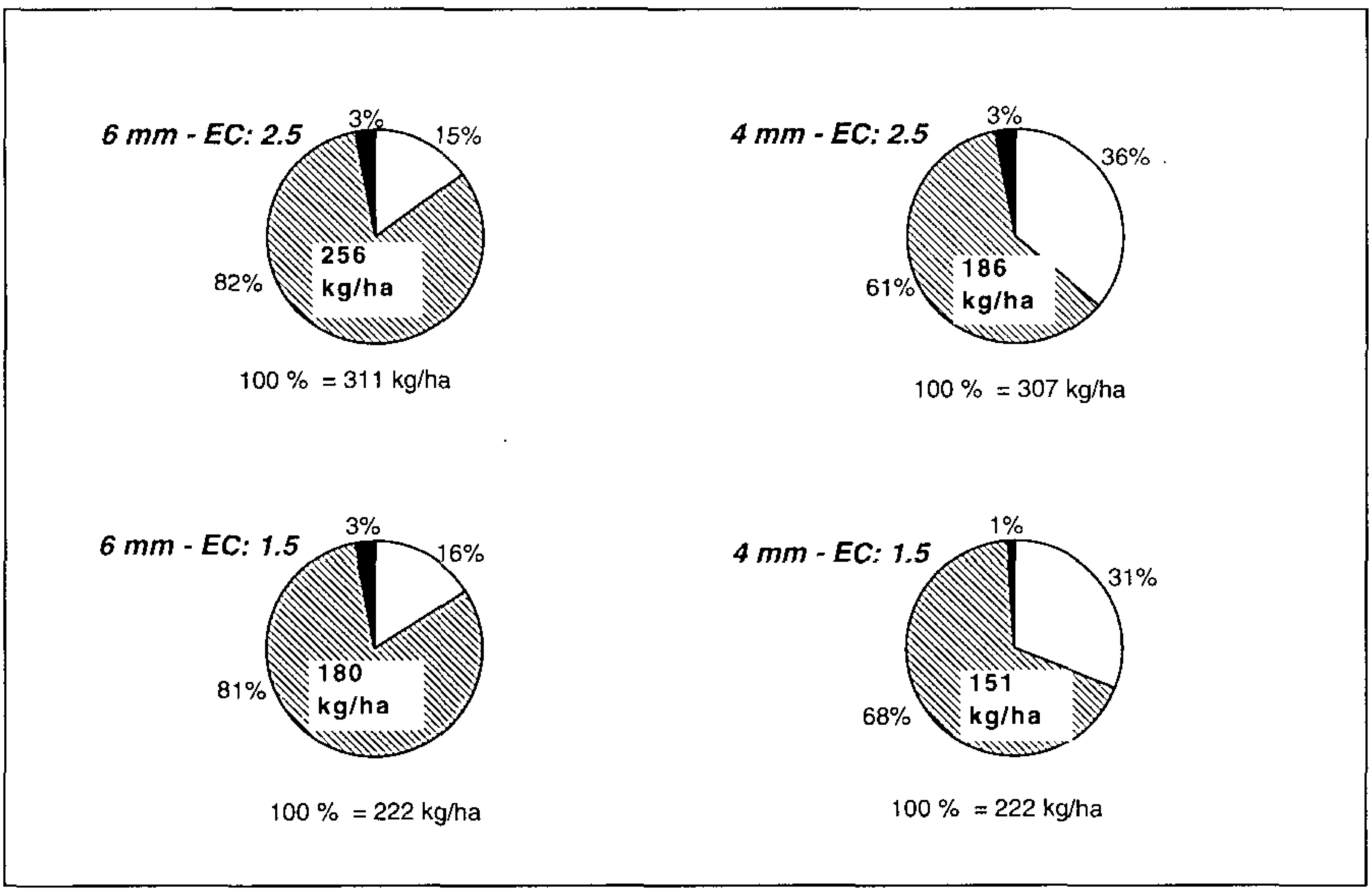

Figure 2. Nitrogen balances for *Campanula*. The figure shows the percentages of total nitrogen (N) added throughout the experiment used for N uptake (□), N leaching and not recovered (▥), and N content in the growth medium (■) at the end of the experiment. The figure below each pie chart is the total N in kg ha^{-1} added throughout the growing period.

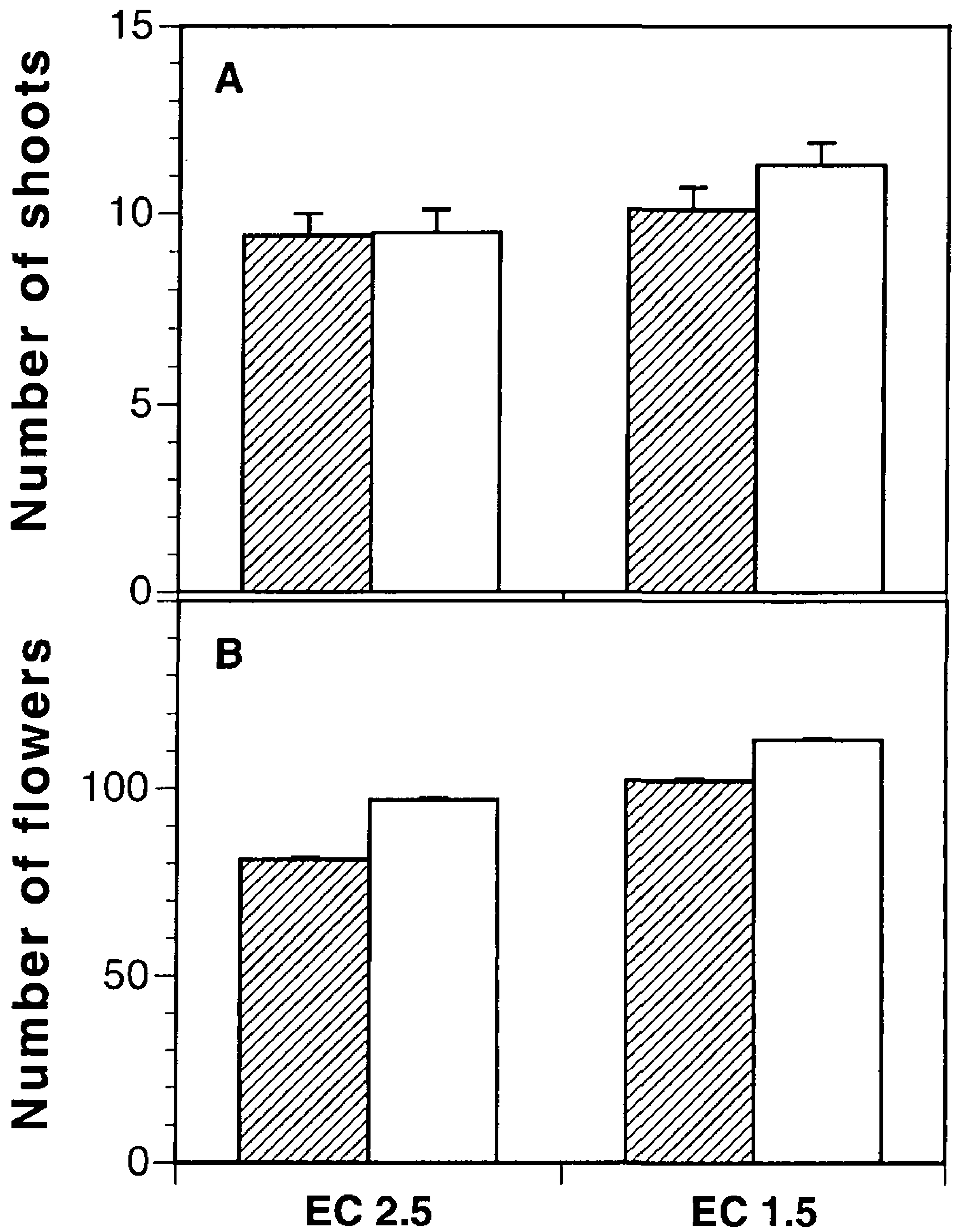

Figure 3. Number of secondary shoots (A) and number of flowers (B) in *Campanula* after greenhouse forcing. Plants were previously grown at different nutrient concentrations (1.5 or 2.5 EC) and irrigated after 4 (□) or 6 (▨) mm of evaporation. Vertical bars denote mean standard error.