The effect of cultivar, nutrient solution concentration and season on the yield and quality of NFT produced lettuce (*Lactuca sativa* L.)

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Abstract

Two series of experiments were carried out to examine the effect of nutrient solution concentration on nutrient uptake, growth and quality of Nutrient Film Technique grown lettuce at the Plant Growth Unit, Massey University. In the first study, the influence of nutrient solution concentration, ranging from 0.5 to 3.5 mS cm^{-1} and growing season, on plant nutrient uptake, growth, yield, market quality and nutritional quality of three lettuce cultivars was examined. The second study researched approaches to controlling tipburn incidence of lettuce by investigating the effect of day/night nutrient solution concentration combinations and extra calcium at 100 mg Ca l^{-1} at night with the butterhead lettuce cultivar Cortina. Here the plants were exposed to a tipburn inducing treatment of 30 ^{0}C for 4 days.

The results from these studies revealed that generally there were not large variations in nitrogen and phosphorus concentrations of the leaves across nutrient solution concentrations. Leaf potassium concentration increased with increasing nutrient solution concentration up to 2.5 mS cm^{-1}. As leaf potassium increased in concentration with increasing nutrient solution concentration, this increase mediated decreases in calcium and magnesium concentrations of the leaves. Leaf nitrogen and potassium concentrations were greater than in the root, the reverse was true for phosphorus, while calcium and magnesium levels did not differ greatly. Nitrogen and phosphorus concentrations increased from the outer to inner leaves, while potassium, calcium and magnesium decreased.

Shoot fresh weight and dry weight increased up to 1.5 mS cm^{-1} with increases in nutrient solution concentration. At higher nutrient solution concentrations dry weight levelled off, while fresh weight levelled off or decreased slowly depending on the level of stress imposed by the season. Thus fresh weight was more sensitive to stress at high nutrient solution concentrations than dry weight. With both seasons and cultivars, the order of the initial RGR was the same order as for final shoot dry weights, with the initial NAR being the important component of the initial RGR. Apart from the autumn crop, where no tipburn occurred, tipburn incidence increased with increasing nutrient solution concentration with the level of incidence increasing as environment stress

increased. Shelf life increased with increasing nutrient solution concentration, but the level of increase was not great enough to be of commercial significant.

Season, nutrient solution concentration and cultivar all affected the nutritive value. The affect depended on the nutritive quality attribute under consideration. The nutritive values obtained in this study were in the ranges reported by other workers. The summer crop had the highest ascorbic acid concentration. Where ascorbic acid concentrations were high, such as in summer or with the cultivar Impuls, then ascorbic acid concentrations decreased with increases in nutrient solution concentration. The only difference in dietary fibre occurred with the butterhead cultivar Cortina, which had the lowest dietary fibre concentration of the three cultivars. Nitrate concentration increased with nutrient solution concentration, was highest in autumn and winter, while differences between cultivars depended on the season. The nitrate concentration of lettuce produced at nutrient solution concentrations up to 1.5 mS cm^{-1} were within the permissible levels reported overseas. There were no treatment effects on protein concentration despite some reports in the literature of the effects of nitrogen level on protein content. At the lower nutrient solution concentrations, the spring and summer crops tended to have the highest soluble sugar concentrations. Generally soluble sugar concentrations decreased within increasing nutrient solution concentration up to 2.5 mS cm^{-1} and then levelled off.

When 0.5 mS cm^{-1} nutrient solution concentration was used alternately with 1.5 mS cm^{-1} during day and night, the nitrogen and potassium concentration of the leaves increased and the increases in potassium mediated decreases in calcium and magnesium concentrations of the leaves. These effects were more marked when 1.5 mS cm^{-1} was maintained during the day and 0.5 mS cm^{-1} during the night. Nutrient concentration of the innermost leaves was not affected by different nutrient solution concentration at night. Lowering the nutrient solution concentration at night to 0.5 mS cm^{-1}, when the nutrient solution during the day was maintained at 1.5 mS cm^{-1}, tended to give higher shoot fresh and dry weights, and reduced tipburn percentage. However, under extremely stressful conditions, tipburn affected almost every plant. Under these conditions 0.5 mS cm^{-1} at night still had an effect, as the number of tipburn leaves per plant and the tipburn index was reduced. Root pressure was considered to provide the benefits from the 0.5 mS cm^{-1} nutrient solution concentration at night.

Extra calcium either alone or in combination with other nutrients enhanced nitrogen and phosphorus concentration of the outer leaves and reduced potassium, calcium and magnesium concentration of the innermost leaves after tipburn induction. Thus extra calcium at night increased fresh and dry weight after tipburn induction and so increased tipburn incidence.

The important commercial outcomes of this research are as follows. The optimum nutrient solution concentration at which to grow a range of lettuce cultivars across all seasons is 1.5 mS cm^{-1}. At this nutrient solution concentration yield will be satisfactory and the level of tipburn will be minimised. At this nutrient solution concentration the nitrate concentrations were within the permissible levels reported overseas. The growers can also benefit from lowering the nutrient solution concentration at night to 0.5 mS cm^{-1}, as this treatment will increase fresh weight and reduce tipburn.

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