PLANT GROWTH, NITRATE, SOLUBLE SUGARS, AMINO-N, AND AMMONIUM RELATIONSHIPS IN LETTUCE GROWN IN NUTRIENT FILM TECHNIQUE HYDROPONIC SYSTEM [1].

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INTRODUCTION

Some experiments have been made, using Nutrient Film Technique (NFT) hydroponic systems to study how ammonium affects plant growth under different environments. Results from Cometti et alli (2001) showed a close relationship among nitrate, soluble sugars, N-amino and NH_4^+-N in plant tissues when ammonium was added continuously or intermittently to the nutrient solution. In the present study, we tested acid, base, ammonium and nitrate additions to control pH in a computerized system. We then investigated the correlations between plant size, type of pH control, and soluble sugar, nitrate, and amino-N contents, and nitrate reductase activity in the leaves and stems.

MATERIAL AND METHODS

Lettuce was germinated in phenolic foam (Floral®, Diadema, SP) and transplanted after 5 days to an NFT system as described in Cometti et alii (2000). The system was in a greenhouse and was built of PVC tubes with diameter of 100 mm as the crop canals, four 100 L reservoirs and 32 W water pumps (laundry machine type), for treatments, and four replicates composed by the canals. The plants were grown in a ½ strength Furlani solution, and pH was controlled until treatments began on day 24 with H2SO4 and NaOH (Table 1) .For the pH control, a computer based system described in Machado (2000) was used. pH set point was 5.6 ± 0.2. Plants were harvested each 7 days, starting 29 days after seeding. Free nitrate, amino acids, sugars, and ammonium were extracted from one gram of fresh tissue from the fifth leaf, stem, and root. Nitrate reductase activity (NRA) was determined in a 0.2 g fraction of fresh tissue from the same parts. All the parameters were analyzed using colorimetric methods as described in Cometti et alli (2001). The modeling was carried out in SigmaPlot® (SPSS Science, Chicago, IL). The curves were chosen according to their determination coefficients and most biologically meaningful fit.

Table 1. Treatments applied.

Treatment	Nutrient Solution*	pH Adjustment Solution	
			------ mmol L^{-1} ------
1	100% of N as NO_3^-	H_2SO_4	25
2	100% of N as NO_3^-	$(NH_4)_2SO_4$	0.5
3	5% of N as NH_4^+	KOH	50
4	5% of N as NH_4^+	$NaNO_3$	2.5

* Basic Nutrient Solution: Furlani (1997) to ½ of the ionic strength.

RESULTS AND DISCUSSION.

Nitrate content and leaf biomass showed good correlations in all four treatments (Figure 1). However, the slopes differed depending on the treatment. For example, the 5%NH_4^++KOH treatment, where the curve slope was higher. This correlation is commonly reported with or without ammonium as a nitrogen source (ULRICH & GERSPER, 1985; COMETTI et alii, 2001). Cometti et alii (2001) reported finding no correlation between nitrate content and biomass only when they used 20% of the nitrogen as ammonium in nutrient solution. These results suggest that it's possible to lower nitrate concentration without decreasing lettuce production. Soluble sugar and dry mass had a close negative correlation, which indicates that soluble sugars decrease along with time and with growth (Figure 2).

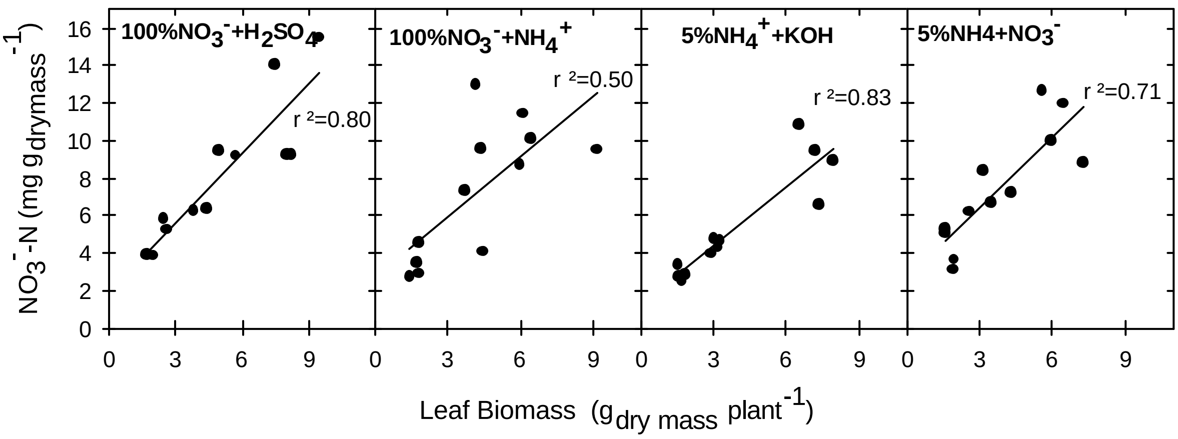

Figure 1. Correlation between Leaf Biomass and Nitrate Concentration in the Fifth Leaf in Lettuce Grown in an NFT System (Points are from Three Successive Harvests).

The higher nitrate concentration at the third harvest might also mean higher N assimilation and higher carbon sink. On the other hand, NRA showed a poor or sometimes negative correlation to dry biomass production as was found in Cometti et al. (2001) (Figure 3). NRA indicates nitrate flux through the cytoplasm (FERRARI et alii, 1973) rather than nitrate content in tissue so it can be inferred that as nitrate uptake decreases with time, NRA also decreases.

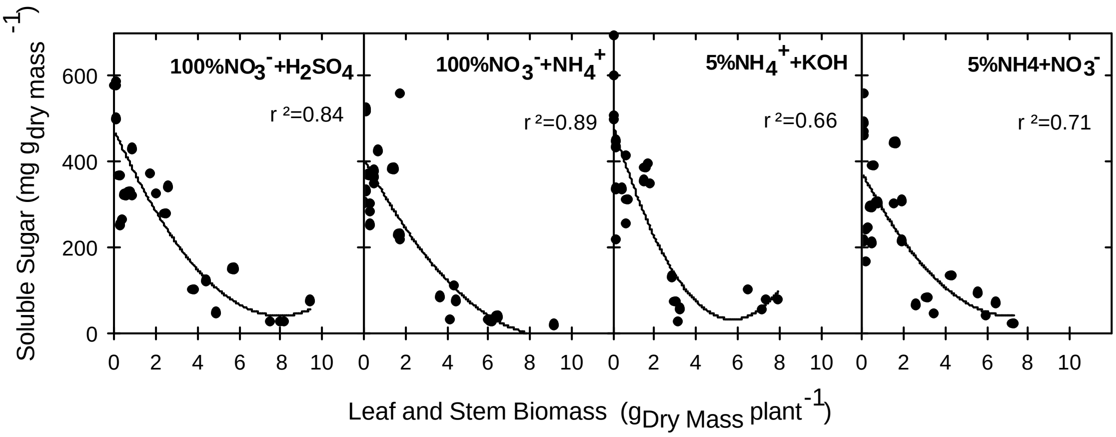

Figure 2. Correlation between Shoot Biomass and Soluble Sugars Concentration in Lettuce Grown in an NFT System (Points are from Three Successive Harvests).

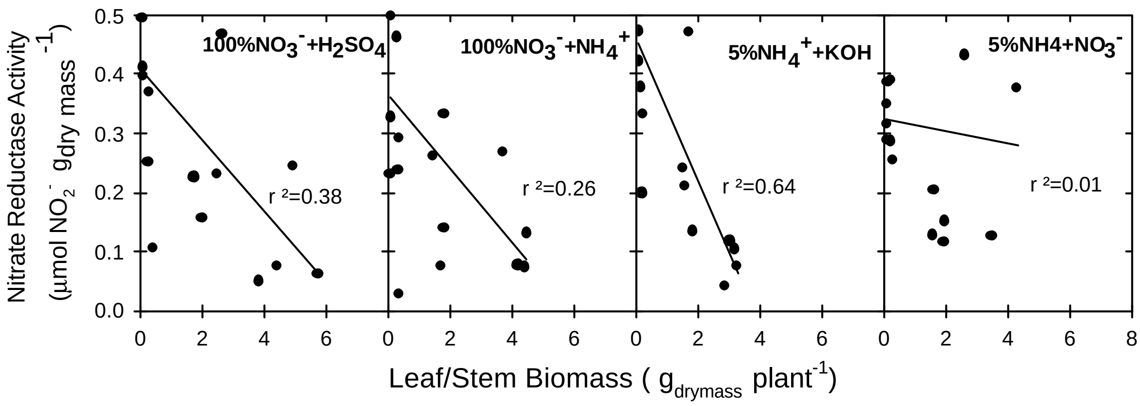

Figure 3. Correlation between Shoot Biomass and Nitrate Reductase Activity in Lettuce Grown in an NFT System (Points are from Three Successive Harvests).

Amino-N is considered a good indicator of metabolic stress. In our study, amino-N showed a positive correlation to soluble sugar contents (Figure 4) and free ammonium (Figure 5). This means that the treatments did not stress the plants especially at the last harvest when plants showed the lowest soluble sugars contents and hence low amino-N contents.

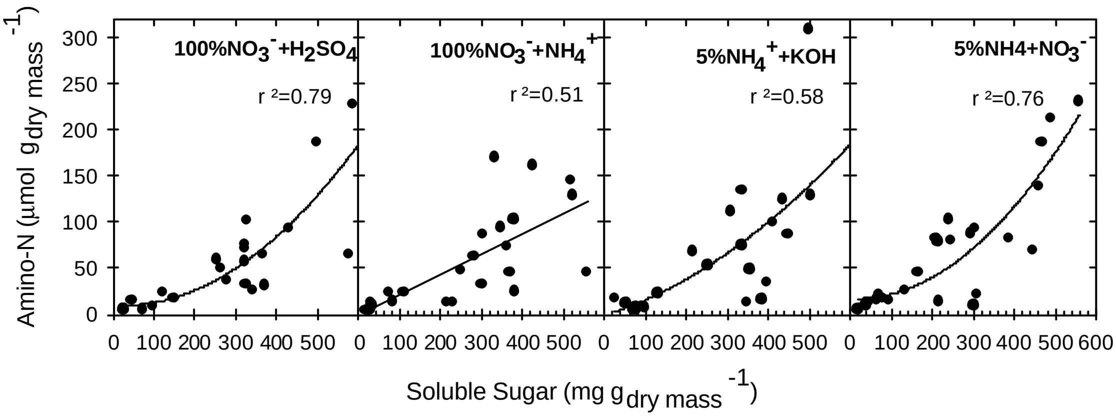

Figure 4. Correlation between Ammonium and Amino Acids Contents in Lettuce Grown in an NFT System (Points are from Three Successive Harvests).

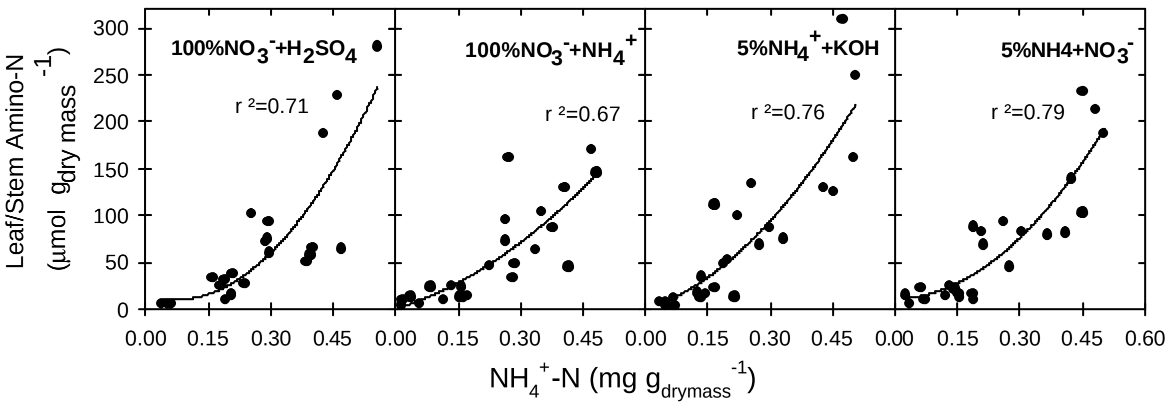

Figure 5. Correlation between Ammonium and Amino Acids Contents in Lettuce Grown in an NFT System (Points are from Three Successive Harvests).

CONCLUSION

The treatments used to control pH caused no stress to plants since equal yields, soluble sugar, nitrate, and amino-N contents, were found in all pH control treatments.

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