NITRATE, SOLUBLE SUGARS, AMINO-N, AMMONIUM, AND NITRATE REDUCTASE ACTIVITY VARYING WITH TIME IN DIFFERENT PARTS OF LETTUCE GROWN IN NUTRIENT FILM TECHNIQUE HYDROPONIC SYSTEM [1].

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INTRODUCTION

Lettuce has been grown all over Brazil using Nutrient Film Technique (NFT) hydroponic systems. Furlani nutrient solution, which is widely used today, contains about 12% of the total N as ammonium. The use of ammonium in plant nutrition is controversial due to its effect on decreasing pH. Furthermore, it has been reported that ammonium may increase or plant growth, depending on the ammonium concentration, pH control during growth (Schubert & Yan, 1996), and the frequency of the ammonium addition (Cometti et al., 2001). It is important to understand not only the effect of ammonium on final yield, but also its effect on plant nutrition. The objective of this work was to study ammonium effects on soluble sugar, amino-N, ammonium, and nitrate content of lettuce leaves in NFT.

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 al. (2000). The system was set up in a greenhouse and was built of PVC tubes with 100 mm diameter as the crop canals, four 100 L reservoirs and 32 W water pumps (laundry machine type), for main treatments, and four replicates composed by the canals. Plants were grown in ½ strength Furlani Solution, and pH was controlled using H_2SO_4 and NaOH. Treatments began 24 days after seeding (Table 1) as described in Machado (2000). pH set point was 5.6 ± 0.2. Plants were harvested every 7 days starting 29 days after seeding. Soluble nitrate, amino acids, sugars, and ammonium were extracted from 1g of fresh tissue from the fifth leaf, stem and root, analyzed by colorimetric methods and converted to dry mass basis as described in Cometti et al. (2000).

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

The results show an increasing concentration of nitrate concentration in leaves along with time, but no significant difference was observed between treatments at the end of the trial (Figure 1).

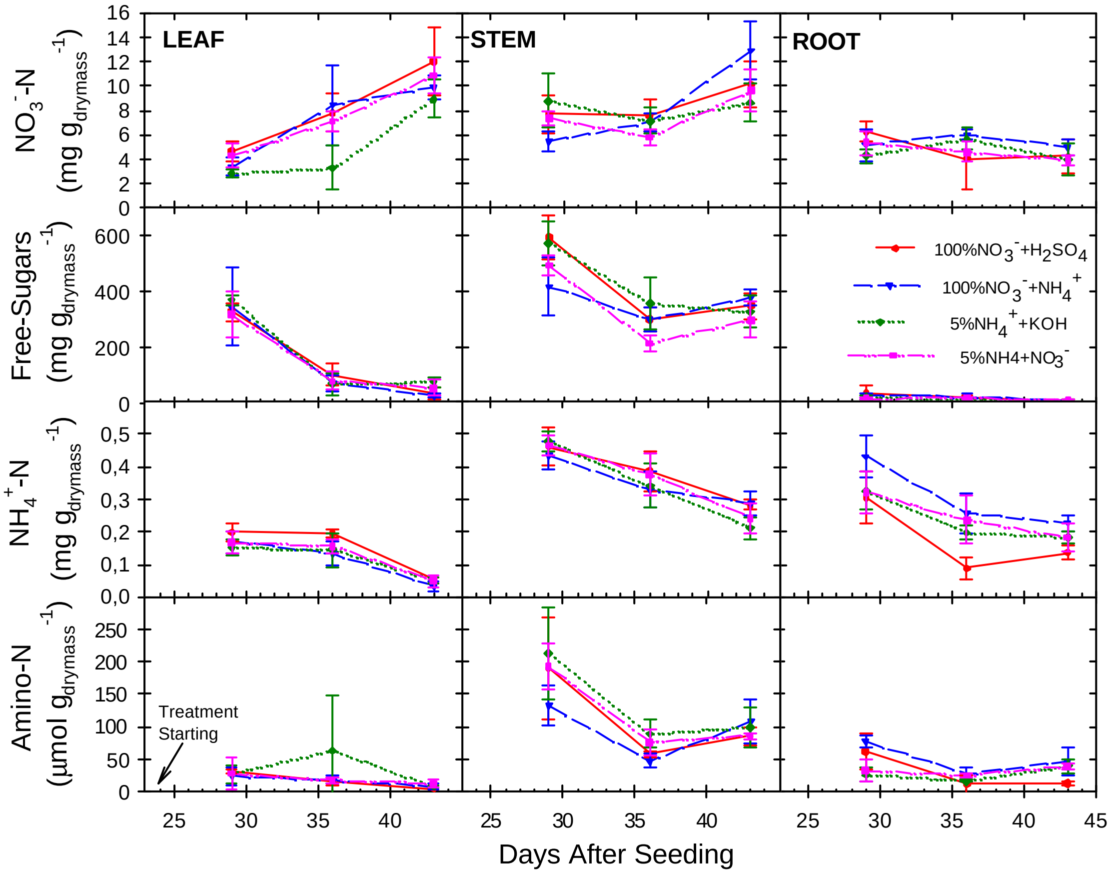

Figure 1. Nitrate, Soluble Sugar, Ammonium, and Amino-N Contents in Lettuce Grown in an NFT System (Error bars mean standard deviation of four reps.)

Nitrate content in stems and roots did not change substantially from the first to the third harvest. Stem nitrate was high throughout the trial. We believe it operates like a buffer, holding the nitrate that is taken up and maintaining it in a metabolically safe level in the leaves. Cometti et al. (2001) observed a similar effect in lettuce and Bendix et al. (1982) observed that in bahiagrass.

Treatments had no significant effect in any of the parameters, indicating that pH can be controlled with any of the four options without interfering with these plant nutrition parameters. Soluble sugars and ammonium contents dropped over time (Figure 1). This may be due to high assimilation rates during the last harvests. Comparatively, amino-N contents were low in the leaves and roots, but not in the stems. Generally, soluble sugars, ammonium and amino-N were higher in the stems, indicating a high metabolic activity. Even though the nitrate reductase activity (NRA) decreased from the first to the second harvest, it remained higher in stem than in leaves, again suggesting high stem metabolic activity (Figure 2).

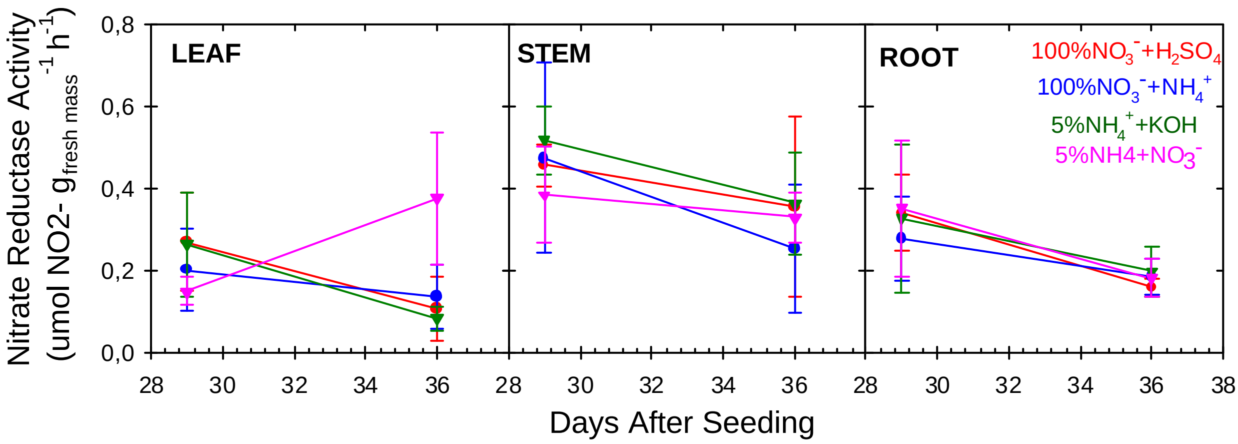

Figure 2. Nitrate Reductase Activity in Lettuce Grown in an NFT System (Error bars mean standard deviation of four reps).

The nitrate content in stem remained steady and high, indicating a poor correlation between nitrate content and NRA. It can be inferred that NRA indicates the presence of nitrate in "metabolic pool" rather than in the "substrate pool". Finally, sugar content in stem remained higher than in the other plant parts until the third harvest. Despite the high nitrate reduction activity and assimilation, soluble sugar in stem was high probably due to quick transport from the leaves.

CONCLUSION

Leaf nitrate content increased over time, reaching 10 to 12 mg $g_{dry\ mass}^{-1}$ at 43 days after seeding. The four treatments used to adjust pH showed no difference in relation to nitrate, soluble sugars, amino-N, and ammonium concentration in the tissues. The lettuce stem seems to operate as a buffer to avoid the build up of nitrate during the first plant growth phase, and so avoiding metabolic disturbances in the leaves. Stem shows high metabolic activity, high nitrate reduction activity, ammonium and amino-N content, and act as a drain for sugars coming from the leaves. Because of these features, lettuce stem likely plays a central role in the distribution of the products of plant photosynthesis and nitrogen metabolism.

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