1990 ANNUAL REPORT - ALMOND BOARD OF CALIFORNIA RESEARCH PROJECTS

Project No. 90-R4 - Root Zone Acidity and Chemistry

Project Leader: Dr. Robert J. Zasoski
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Cooperators: R. Meyer, J. Edstrom, H. Schulbach, and Nickels Trust

Objectives: (1) To determine the effects of nitrogen (N) fertilization on soil and (2) to compare the bulk and rhizosphere soil properties. This project quantifies the Al, Mn, Ca and H levels in bulk and rhizosphere soil in relation to N fertilization rate. (3) Studies of the distribution of root in relation to soil properties started in 1989.

Interpretative Summary: Our past studies have documented a low pH in the root zone induced by high levels of urea fertilization. This low pH in both the bulk soil and the soil very near the root (rhizosphere soil) can be toxic to roots. However, in the field, almond trees have not shown visual effects and yield has not been affected by the zones of low pH under the emitters. Results presented last year showed that root growth was not well related to soil acidity; however, it was not clear whether the roots grew into the acid soil or whether the soil became acid after the roots had formed. In the past year root and tree response to acidic conditions were evaluated using root ingrowth cores.

Root growth into acidified soil contained in plastic mesh cores (ingrowth cores) was evaluated at the Nickels Trust Soil Laboratory. These root ingrowth cores were constructed from polyethylene mesh. The plastic mesh (6 mm openings) was formed around either a 10 or a 15 cm I.D. PVC pipe sections 20 cm tall. The ends were overlapped and melted together with a soldering iron. Tops and bottoms were fashioned from the mesh and cemented in place with a soldering iron. The inner mesh cylinder was 16 cm tall and the outer cylinder was 20 cm tall. Smaller cylinders (10 cm in diameter) were nested in the larger cylinders and filled with moist acidified soil or untreated soil from the orchard site. Untreated moist soil was packed around the inner cores in all treatments and the entire inner and outer cores were frozen. Total soil weight for the inner and out cores was about 5.2 kg. The combined inner and outer cores were then frozen. Freezing the cores facilitates handling and placement (Henderson and Krstansky, 1989).

In the field, cores were placed with the tops about 7 cm below the surface and about 30 cm away from drip basins which had been fertilized with either ammonium sulfate or calcium nitrate.

Therefore the cores were placed in the upper 30 cm of the soil were prolific root growth would be expected. Existing roots were severed during installation and removed from an area about 10 cm around the cores. Soil from the location was used to back fill around the frozen cores. After six months the cores were removed and returned to the laboratory.

Roots in each core were removed, washed and weighed. Soil weights were obtained to calculate bulk density. Total N content of the roots were determined. Soil pH and electrical conductivity were measured on composite samples from the inner and outer cores.

The acid treatment pH 4.5 significantly ($P < 0.05$) reduced root growth in the inner cores (Figure 1 and 2). Acidification of the cores by adding an acid results in increased salt levels as well as a lower pH. The combination of these factors has reduced root growth. Table 1 contains the data for root mass in the three replications of the treatments and for the ratio of root mass in the inner and outer cores. Acidified inner cores had an average of 1.9 g of root mass compared to 4.3 g in the control cores.

The main objective of using two cores was to control for local variation and the probability of roots growing into an individual core. The coefficient of variation for the ratios are lower than those for the root mass in each core and suggests that the ratio of root mass in the outer core can be used to control for some location variation. As pointed out by Henderson and Krstansky (1989), freezing the cores facilitates handling and installation.

The cores were placed in the field so that irrigation water and fertilizer solutions had access to the entire core. Consequently, the pH and salt content of the inner and outer cores were altered over the six month period. Table 2 contains the pH and electrical conductivity data for the cores after six months. Soil pH in the outer cores was lowered presumably by nitrification of added ammonium, since the replication in the $Ca(NO_3)_2$ treatment was not as drastically affected. In all cores the salt load was relatively high. Some of this salt was the result of adding acid to acidify the soils. However, the controls also had a high level of salt. While the acidification and salinity in the cores complicates interpretation of the root growth data, this demonstrates the potential for cores to react to changes in soil chemistry and to reflect root responses to these changes.

Further studies where irrigation and fertilization impact do not interact with the cores will be necessary to fully evaluate the utility of these cores. Conceptually, the ability to control for local soil influences by comparing root growth in the inner and outer cores is appealing and will be perused his winter.

LITERATURE CITED

Henderson, G.S., and J.J. Krstansky. 1989. Fine root growth as affected by soil calcium and aluminum in a Norway spruce stand. Agron. Abst. p 304.

Table 1. Root mass in the inner and outer cores and the ratio of inner to outer core mass (I/O) in relation to the initial acid or control treatment.

	Root Mass (g) Inner	Outer	Ratio (I/O)
	CONTROL INNER CORE		
REP 1	3.2	3.5	0.91
REP 2	4.1	3.9	1.05
REP 3	5.7	5.0	1.14
MEAN	4.3	4.13	1.03
SDEV	1.26	0.78	0.115
CV	29%	18.9%	11.1%
	ACIDIC INNER CORE		
REP 1	1.5	2.5	0.60
REP 2	1.6	4.0	0.40
REP 3	2.7	4.2	0.64
MEAN	1.9	3.6	0.55
SDEV	0.67	0.93	0.129
CV	41%	26%	23%

Table 2. Final pH and EC in the inner and outer cores in relation to initial treatment and fertilizer treatment.

	pH (0.01 M KCl) Inner	Outer	EC* Inner	Outer	Fertilizer
	CONTROL INNER CORE				
REP 1	5.31	5.76	2.5	3.5	$Ca(NO_3)_2$
REP 2	4.77	3.98	3.3	3.8	$(NH_4)_2SO_4$
REP 3	3.83	4.40	5.6	5.1	$(NH_4)_2SO_4$
	ACID INNER CORE				
REP 1	4.88	5.54	4.9	4.7	$Ca(NO_3)_2$
REP 2	4.40	4.51	5.3	5.6	$(NH_4)_2SO_4$
REP 3	3.94	3.98	4.6	5.6	$(NH_4)_2SO_4$

* Electrical conductivity (dSm^{-1})

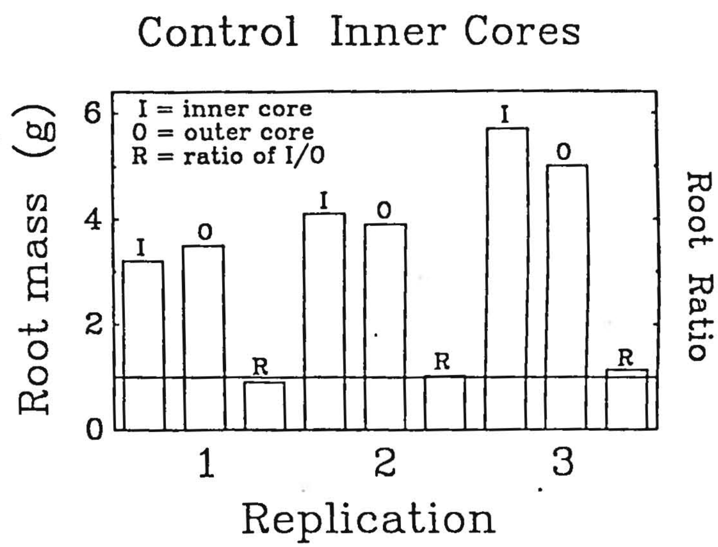

Figure 1. Root growth in control cores.

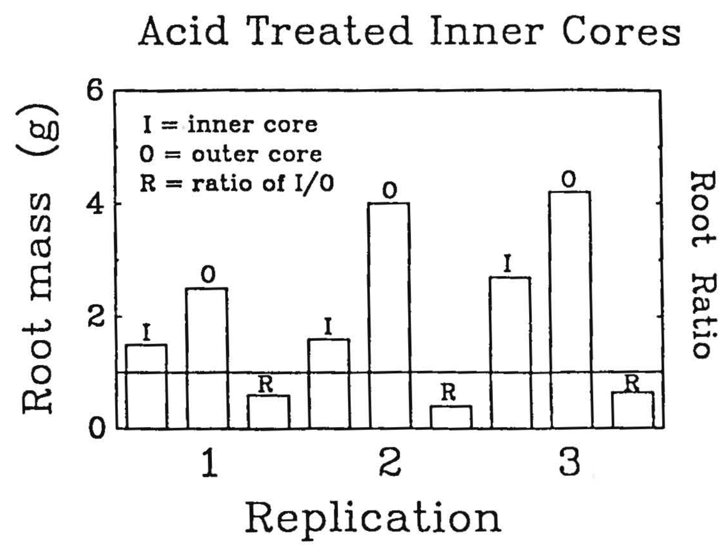

Figure 2. Root growth in acid cores.

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ALMOND BOARD

Ms. Susan P. McCloud
Research Director
Almond Board of California
P.O. Box 15920
Sacramento, CA 95852

December 28,1990

Dear Ms. McCloud:

Enclosed is a copy of the 1990 final report for Project No. 90-R4 - Root Zone Acidity and Chemistry. If you have any questions or comments, do not hesitate to call. We appreciate the support during the last year and look forward to an interesting year in 1991.

Best wishes for a productive and happy New Year.

Sincerely,

RJ Zasoski

R.J. Zasoski
Assistant Professor of Soil Science and Plant Nutrition