INTRODUCTION
Avoidance of root diseases was one of the primary motivating forces underlying the development of soilless agriculture. Although cultivation in soilless systems has resulted in a decrease in the diversity of root-infesting pathogens compared with conventional culture in soil, root diseases still occur. Most of the destructive root diseases in soilless culture have been attributed primarily to zoosporic, fungi-like species (oomycetes) in the genus Pythium and Phytophthora. Thus, knowledge of the avenues of pathogen introduction is requisite for maintaining a pathogen-free environment.

Potential and/or documented sources of pathogen introduction include the following: air, sand, soil, peat, water, and insects. Once root infection has occurred, disease management is often difficult because pathogen reproduction in the infected roots will provide a continuous (24/7) source of abundant new inoculum for rapid dispersal throughout the production system via the recirculating nutrient solution.

Disease management strategies following pathogen introduction have focused on elimination of the pathogen from the infested nutrient solution via filtration, ozonation, ultraviolet irradiation, thermal inactivation and/or the addition of specific bioicides (fungicides, etc.) to the infested nutrient solution. Unfortunately, many of these management strategies are not efficacious, not registered for use in greenhouses or on specific crops, or not cost effective at the commercial level.

OBJECTIVES
A. Pathogen introduction via insects and snails
Adult shore flies and fungus gnats have been reported to function as aerial vectors of several plant pathogenic fungi, i.e., Fusarium, Verticillium, and Thielaviopsis. However, except for a single report of the aereal transmission of Pythium aphanidermatum by adult shore flies, there is no information regarding the role of these insects as vectors of other species of Pythium or Phytophthora. Thus, the specific objectives of our research were to (i) assess the potential of fungus gnats and shore flies to ingest and excrete propagules of Phytophthora capsici, P. nicotianae, P. ramorum, Pythium aphanidermatum, P. splendens, P. sylvaticum and P. ultimum and (ii) evaluate ingestion, excretion, and transmission of Phytophthora ramorum by brown garden snails. Various life stages of these insects, as well as snails, were allowed to feed on cultures of these pathogens. Viability of propagules of these pathogens was assessed following their excretion by these pests.

B. Chemical amendments to the nutrient solution for disease control
We previously reported that N-Serve and Dwell (i.e., nitrification inhibitors), when added to the recirculating nutrient solution in hydroponic systems, resulted in a significant increase in the total bacterial and indigenous fluorescent pseudomonad populations which, either directly or indirectly, coincided with the suppression of disease caused by a root-infecting zoosporic pathogen. In our ongoing search for additional and perhaps more efficacious amendments for management of zoosporic pathogens in recirculating systems, we evaluated the efficacy of the following chemical amendments to the nutrient solution: zinc oxide, xylene, Actigard®, Neem, Perasan® and sodium salicylate.

All experiments were conducted in a greenhouse containing 18 two-sided recirculating hydroponic units (Figure 1) and used pepper as the susceptible host and Phytophthora capsici as the zoosporic pathogen (i.e., a worst case scenario).

Each hydroponic unit consisted of two troughs that were connected to a common 50 liter reservoir. Pepper seeds were sown in Rockwool cubes and grown for ca. 30 days in a growth chamber at 30°C with a 12 h photoperiod. They were then transplanted into plastic pots containing a commercial peat-based potting mix or Rockwool blocks and placed in the hydroponic units (4 plants per trough, eight plants per hydroponic unit) in the greenhouse and grown for 2-3 weeks before treatment.

Each experiment consisted of three to five treatments, each with three replications per treatment. Treatments included noninoculated units, inoculated units and inoculated units in which the nutrient solution was amended with the various chemical amendments. One plant on one side of each hydroponic unit (Figure 2, arrow) was inoculated with P. capsici. This method of inoculation permitted us to evaluate pathogen spread via the recirculating nutrient solution subsequent to pathogen colonization and reproduction on the inoculated plant.

Chemical amendments were added to the reservoirs of appropriate treatments 2 days before inoculation. The final concentration of the various chemicals in the nutrient solution was: zinc oxide (2.5 ug a.i./ml), Actigard® (10 ug a.i./ml), Neem (10 ug a.i./ml), xylene (20 ug a.i./ml), Perasan® (50 ug a.i./ml) and sodium salicylate (100 ug a.i./ml). Chemicals were reapplied at weekly intervals.

Plant mortality data was recorded daily following inoculation. Additionally, the bacterial population in the recirculating nutrient solution was estimated by dilution plating onto a nutrient agar medium at 2-day-intervals following the addition of the chemical amendments.

RESULTS: With the exception of sodium salicylate (Figures 4 and 5), none of the other chemical amendments to the nutrient solution (i.e., Neem, xylene, zinc oxide, Perasan® or Actigard®) provided either consistent or significant control of the disease. All chemical amendments, except Perasan® enhanced the total and the fluorescent bacterial population in the nutrient solution. However, the selective enhancement of the fluorescent pseudomonad population (which consisted of several biotypes) varied dramatically (0 to 87%) following each consecutive addition of sodium salicylate to the nutrient solution (Fig. 6). The fluorescent pseudomonad population may or may not have contributed to the observed sodium salicylate-mediated suppression of the disease.

CONCLUSION: This study demonstrates, for the first time, the potential use of sodium salicylate as an amendment to the recirculating nutrient solution for the control of zoosporic root-infecting pathogens. The consistent delay in both the onset and the severity of disease achieved in the extreme pathosystem we used, i.e., peppers versus P. capsici - a worst case scenario (Fig. 4 and 5), suggests that even higher levels of disease management are probable in the more common and less destructive host-pathogen combinations which occur in commercial production of crops cultivated in recirculating hydroponic systems.