NCERA-101 2010 Station Report

Cornell University
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Impact Nuggets:
Cornell University has developed a risk analysis model for hydroponic, baby-spinach production in deep-flow systems.

Cornell University has quantified the effects of environmental control on the production of a useful industrial enzyme by genetically-modified and hydroponically-grown tobacco.

Germination and plant spacing at Cornell University for baby-leaf spinach were found to provide optimum yield at a plant density near 1500 plants per square meter. Double-seeding half the cells in commercially available hydroponic floats was found to yield as much as single-seeding every cell, with significant savings of root medium.

New Facilities and Equipment:
None to report

Unique Plant Responses:
None to report

Accomplishment Summaries:
Cornell University has developed a risk analysis model to simulate the effects of *Pythium aphanidermatum* on the production of hydroponic baby-leaf spinach under varying nutrient solution temperatures. The simulation suggests that every two degree drop in the nutrient solution temperature approximately halves the frequency of Pythium outbreak within the temperature range of 18 to 24C. In addition every two day reduction of the amount of time the crop spends in a deep-flow pond approximately halves the frequency of Pythium outbreaks within a crop production range of 12 to 16 days in pond. Production strategies that relied solely on natural light failed rapidly with outbreak frequencies on the order of several per year, in contrast to significantly fewer than a single outbreak per year in the conditions with supplemental lighting, where plants reach harvest weight more rapidly.

Cornell University has nearly completed research to quantify the effects of environmental control on the production of a useful industrial enzyme, using extractions from hydroponically-grown and genetically-modified tobacco (chloroplast transform). The effect of plant spacing on biomass yield and target enzyme output indicated that maximum productivity of target enzyme, measured as mass per unit area per unit time, can be achieved within a range of final plant spacing. The best plant spacing appears to fall in the middle of the range examined, near one square foot per plant. Plants are unable to take full advantage of additional space when flowering commences, as leaf growth is curtailed. Tobacco grows very slowly in absolute terms during the first three weeks since the seed starts out so small, and for this reason harvest of seedling sized plants for biomass is also a dubious proposition.

Comparisons at Cornell University of single and double seeding were done for baby-leaf spinach production in deep-flow ponds. The object was to facilitate scaling up from bench-scale spinach

production to commercial-greenhouse-scale production. In the commercial-scale-up project, 48 standard 338-cell Speedling trays (each 13.5 inches by 26.5 inches in horizontal dimensions, 1.75 inches high) were seeded weekly, germinated for three days in a growth chamber, and placed in one of two ponds and grown for 12 to 14 days. In terms of plant growth, these experiments demonstrated no yield difference between single seeding all cells and double-seeding half the cells. This being the case, double-seeding, while maintaining the same plant density, is recommended when using 1 ¾ inch high cells of the type used in these experiments. Doing so halves the amount of medium needed. However, reusing root medium from spinach production proved not to be a viable option to save resources, for the root disease, Pythium aphanidermatum, remained viable in the recycled and heat-treated medium, leading to disease outbreaks in subsequent crops.

Impact Statements:
Cornell University has developed a risk analysis model for hydroponic baby spinach production in deep-ponds. The model considers temporal behaviors of the physical systems as well as a plant growth model, a *Pythium aphanidermatum* root disease model, and a risk model based on the Monte Carlo method.

Cornell University has quantified the effects of environmental control on the production of a useful industrial chemical by hydroponically-grown and genetically-modified tobacco. Results suggest the most important parameter to control is the rate of biomass production per unit of production area, which is a function of total light integral delivered. Spectrum and photoperiod appear to be less important.

Germination and plant spacing for baby-leaf spinach were found to be optimum at a plant density near 1500 plants per square meter. Double seeding half the cells in commercially available hydroponic floats was found to produce as well as single seeding every cell, with significant savings of root medium. However, re-using the root medium was found to promote outbreaks of root rot disease.

Published Written Works:
None to report

Scientific and Outreach Oral Presentations:
Albright, L.D. 2010. Local Food Production in a Carbon-Constrained World. Building Partnerships and Pathways to Address Engineering Grand Challenges Workshop. University of Texas, El Paso. Feb. 2010.

Other Relevant Accomplishments and Activities:
Albright, L.D., K.P. Ferentinos, I. Seginer, J.W. Ho and D. de Villiers. 2009. Systems and methods for providing optimal light-CO2 combinations. United States Patent 7,502,655.