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University of Alaska Fairbanks
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Unique Plant Responses

Yield performance was evaluated for snap beans ('Concesa', 'Gold Rush', 'Provider', 'Roma II', 'Royal Burgundy', 'Stayton') seeded directly into high tunnel and field environments on June 3, June 18 and June 30. The high tunnel was most advantageous for yield of the third planting. For example, 'Gold Rush' produced 2.7 kg/m^2 in the field and 5.7 kg/m^2 in the tunnel. The largest yield was recorded for high tunnel grown 'Provider' at 17.9 kg/m^2. 'Royal Burgundy' is a novelty purple bean that delivered 10.1 kg/m^2 in the earliest planting and 8.6 kg/m^2 in the second planting. The slender, shiny, deep green 'Concesa' beans are exceptional and despite the limited yields (1.2 to 5.1 kg/m^2) worthy of consideration for high tunnel production in regions with demand for high quality fresh market green beans.

The plastic materials K50 Clear, K50 IR/AC, KoolLite380 (Klerks Plastic Product Manufacturing, Inc., Richburg, South Carolina) and Solatrol (Visqueen GCF 925C9, British Polythene Industries PLC, Greenock, United Kingdom) were used to cover the high tunnel structures (7.3 m long by 3.7 m wide). K50 Clear and K50 IR/AC blocked radiation below 360 nm, Solatrol below 390 nm and KoolLite380 below 380 nm. Warmer temperatures were recorded during cool nights in K50 IR/AC covered tunnels compared to K50 Clear. During the warmest days, the KoolLite380 material maintained a slightly lower temperature compared to K50 Clear. Container grown long cane 'Tulameen' raspberries produced the highest yield under K50 IR/AC and lowest in the adjacent field. The K50 IR/AC yield was 487 grams compared to 391 grams per plant in the field. The KoolLite environment also supported a significantly higher yield than the field at 462 grams.

The butterhead lettuce 'Nevada' was grown in a nutrient film technique (NFT) system with 16 or 20°C solutions. The lettuce grown in the colder solution had significantly higher shoot fresh weight at 137 grams compared to 128 grams after 28 days. The root fresh weight increased with more than 2 grams using a solution of 16°C. Shoot dry weight was also higher at the lower temperature although the root dry weight was similar at 2.1 grams. The relationship between shoot dry and shoot fresh weights suggests lettuce grown with the colder solution had relatively higher leaf dry matter. The ratio between root dry and root fresh weights was calculated to 7.2 percent at 20°C compared to the 6.7 percent at 16°C. Dry weight partitioned to the roots in the lettuce grown in the 20°C solution was also larger. The percent root dry weight was 30 percent at the higher temperature and 28 percent at 16°C. Despite a similar number of leaves, larger total plant leaf area (1,922 cm^2) was observed at 16°C compared to 1,903 cm^2 at 20°C. The height and width differed approximately 2 cm between the two regimes, and the overall plant size was significantly larger in the 16°C regime. The roots were on average 39.6 cm long in the 16°C solution but the 20°C solution resulted in 10.2 cm shorter roots. The results suggest a cooler nutrient solution counters above optimum air temperature for overall growth and development of the lettuce 'Nevada'.

Accomplishment Summaries

High tunnels are usually covered with traditional polyethylene plastic materials such as K50 Clear or Tufflite IV. Under production conditions where season extension is of great

consequence, K50 IR/AC may be a better choice for local producers than traditional polyethylene plastic materials to maintain higher night temperatures as day length shortens and temperatures cool toward the end of the season. For crops sensitive to heat, the KoolLite380 material maintains a cooler environment during seasonal high temperature periods.

Geothermal resources are used for generation of electric power and heating in a collaborative University of Alaska Fairbanks project with Chena Hot Springs Resort located 60 miles northeast of Fairbanks. Two recently constructed greenhouses (4,320 ft^2) use geothermal power and heating exclusively to continuously produce tomatoes and lettuce throughout the year. The system developed here for heat and power using geothermal or other alternative energy sources is suitable for greenhouse controlled environments in communities of various sizes and locations including remote off the road regions.

Impact Statements:

Maintaining optimal greenhouse air temperatures can be difficult during periods of hot summer weather. Instead of cooling the air, lowering the temperature of the nutrient solution is an effective approach and local greenhouse strategy for continuous high rate of hydroponic lettuce production.

Greenhouse, high tunnels and other modifications of the environment can extend, improve and reduce the uncertainty of field production. In short season locations, these systems are especially valuable as a wider range of locally produced crops can be offered without competing with traditionally available produce. Putting these growing techniques into practice is therefore feasible options to improve and increase the field productivity for local market opportunities.

Controlled environments are required for year round local production in high latitude areas. Geothermal or other alternatives to fossil fuels are necessary to run these facilities. The approach developed in collaboration with Chena Hot Springs Resort to use geothermal or other alternative energy for greenhouse and controlled environment production is adaptable and suitable for rural communities of various sizes in Alaska and other remote areas.

Published written works

Okada, Y. 2007. Solution temperature and growth of lettuce in a nutrient film technique system. Senior Thesis, School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks.

Karlsson, M., H. Rader and J. Werner. 2007. Seasonal northern snap bean production using high tunnels. HortScience 42:924 (poster presentation).

Karlsson, M. and J.W. Werner. 2008. Early day length sensitivity in sunflower. HortScience 43: (in press).

Scientific and outreach oral presentations

Karlsson, M.G. 2008. Plastic film considerations for greenhouses and fields. Alaska Greenhouse and Nursery Conference. January 31, 2008. Fairbanks, Alaska.

Karlsson and Werner, 2008. Modified environments for field production. Potato and vegetable days. February 13, 2008, Palmer Alaska.