NCERA-101 Station Report March - 2010
University of Alaska Fairbanks
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Impact nugget

Research activities address emerging local needs for energy efficient greenhouse and controlled environment production. Outreach efforts provide information and training opportunities to experienced growers as well as those with limited or a recent interest in commercial greenhouse production.

New Facilities and Equipment

A retractable double-layer flat-roof high tunnel (Rough Brothers, Cincinnati, Ohio) was established during the field season of 2009. The total covered field area is 11 by 18 m (36 by 60 feet) with a post height of 3.7 m (12 feet). The tunnel is equipped with one layer of translucent material for crop production and a blackout covering for photoperiodic control. The coverings are retracted using gear motors (RW4-2, Ridder Drive Systems, The Netherlands) and controlled independently with an integrated climate controller (iGrow 1400, Link4 Corporation). The material for the roof is a knitted aluminized PLS 40 ABRI fabric (45% shade, AB Ludvig Svensson, Sweden) suitable to retain warmer temperatures during colder periods and reflect heat during hot days. To allow roll up, the transparent wall material is a polyethylene curtain (LS Solar Woven Ultra Poly, AB Ludvig Svensson, Sweden). The blackout material for the roof and walls is XLS Obscura Firebreak (AB Ludvig Svensson, Sweden). Maintaining growing conditions of twilight extended continuous light or photoperiods with several dark hours will provide insights on environmental conditions best suited for crop establishment, early season development, humidity control, flowering and fruit set, plant morphological attributes, frost protection, yields and crop quality.

Accomplishment Summaries

The geographical location demands high dependency on supplemental lighting for year round greenhouse production in Alaska. Light emitting diodes (LEDs) are compared to traditional technologies, characterized to use less electrical energy, have extended high operational output, opportunities for customized spectral energy distributions while generating limited heat in the growing environment. Panels (150W, 300W, 600W) with red LEDs (peak 665 nm) supplemented with 10 percent blue LEDs (peak 456 nm) were compared to high-pressure sodium (HPS) and metal halide (MH) lamps. *Rudbeckia hirta* 'Toto' (black-eyed Susan) was grown 100 cm below the light sources. PAR (400 to 700 nm) varied from 65 $\mu mol \cdot m^{-2}s^{-1}$ under the 150W LED panel to 130 under the 300W panel, and 300 $\mu mol \cdot m^{-2}s^{-1}$ under the 600W LED array. In comparison, PAR was 200 $\mu mol \cdot m^{-2}s^{-1}$ in the growing environments of HPS and MH. After 21 days, at least 50 percent of the plants had developed visible flower buds (2 mm) under HPS, MH, and the 300W LEDs. All plants in the 600W LED environment already had visible buds at 21 days. Early development and growth in respect to height and leaf number were comparable to HPS when the LEDs provided at least 300 $\mu mol \cdot m^{-2}s^{-1}$.

Panels (300 W) of red (665 nm) and blue LEDs (456 nm), white LEDs, and 40 percent red (660 nm), 40 percent orange-red (630 nm) and 20 percent blue (460 nm) LEDs, along with HPS, MH and 5T fluorescent lamps were tested. PAR (400 to 700 nm) at plant height was approximately 150 $\mu mol \cdot m^{-2}s^{-1}$ for all lamp types. An LI-6400 photosynthesis system (LI-COR, Lincoln, NE) with a clear top leaf chamber was used to measure net photosynthetic rate (Pn) of the *R. hirta* 'Toto' plants grown in the various environments since seedling stage. Measurements were made on exposed single leaves at 400 ppm CO_2 immediately prior to first open flower. Pn was in the range of 3.5 to 4.0 μmol $CO_2 \cdot m^{-2}s^{-1}$ independent of the lamp type, suggesting PAR to be more important for the rate of Pn than the spectral energy distribution.

Impact Statement

The demand for information to expand and improve local production systems is increasing with the concerns for a continuous and affordable high quality food supply. Knowledge developed in this project is applicable to local climates and is disseminated through various channels. Communications on greenhouse opportunities in relation to local energy and food supplies are ongoing with individuals and groups in numerous locations within the state including Anchor Point, Anchorage, Aniak, Barrow, Bethel, Chena Hot Springs, Cordova Delta Junction, Dillingham, Eagle River, Fairbanks, Ft. Yukon, Galena, Glenallen, Haines, Healy, Homer, Iguigig, Juneau, Kaltag, Kantishna, Kenai, Kenny Lake, Ketchikan, Kodiak, North Pole, Nulato, Manley Hot Springs, Nome, Palmer, Pt. Hope, Seward, Sitka, Skagway, Soldotna, Talkeetna, Tok, Valdez and Wasilla. Through partnerships with local greenhouses at Chena Hot Springs Resort (CHSR) and Pike's in Fairbanks, training and apprenticeship opportunities are available for students and interested individuals of all ages and backgrounds. Current production approach, environmental controls, scheduling and management of the CHSR and other production greenhouses are continuously evaluated and adjusted as information becomes available. Presentations are frequently provided at local, regional, national and international meetings, conferences and workshops on crop production in greenhouses, high tunnels and under field conditions. Daily educational programs on greenhouse operation and management are conducted year round at CHSR. Each guided tour has a minimum of 15 participants from local populations, residents from various parts of Alaska, and visitors from all over the world. The August 2009 Energy Fair at CHSR was attended by 2,000 people of diverse educational, financial and demographic backgrounds. Most attendees viewed the greenhouse production during educational tours throughout the day. At Pike's, techniques suitable for northern greenhouse production are used and demonstrated to local and visiting individuals and groups during the summer months. Formal and self-guided tours attract at least 50 daily visitors during June, July, August and September. Pamphlets describing the greenhouse operations at CHSR and Pike's are widely distributed to support the educational programs.

Published Written Works

Karlsson, M. and J. Werner. 2010. High tunnel covering materials for northern field production. Acta Horticulturae (in press).

Karlsson, M. and K. Calhoun. 2010. Fruit and berry crop trials program for rural communities in Interior Alaska. The Sustainable Agriculture Conference and Organic Grower School. March 17-19. (poster presentation).

Karlsson, M. and J. Werner. 2009. Hydroponic greenhouse lettuce production in subarctic conditions using geothermal heat and power. Acta Horticulturae 843:275-281.

Karlsson, M. and J. Werner. 2009. Snap bean yield and photosynthesis during twilight extended field conditions. HortScience 44: 1127. (poster presentation)

Karlsson, M. and J. Werner. 2009. High tunnel covering materials for Northern field production. International Symposium on High Technology for Greenhouse Systems. GreenSys2009 Quebec City, Canada, P129, p. 156, GreenSys2009 Scientific Program. (poster presentation)

Karlsson, M. and J. Werner. 2009. Growing under the midnight sun. SNRAS/AFES Misc. Pub. No. MP 2009-06.

Karlsson, M. and J. Werner. 2009. Growing fresh vegetables: midnight sunlight and the earth's warmth. SNRAS/AFES Misc. Pub. No. MP 2009-10.

Werner, J., Y. Okada and M. Karlsson. 2010. Using light emitting diodes in high latitude greenhouse production. Acta Horticulturae (in press).

Werner, J. and M. Karlsson. 2010. Retractable flat roof high tunnels for managing crop production under extreme high latitude day lengths. Greenhouse 2010: Environmentally sound greenhouse production for people. 28th International Horticultural Congress, Lisbon, August 2010. (in press).

Werner, J., Y. Okada and M. Karlsson. 2009. Using light emitting diodes in high latitude greenhouse production, 18P12, p. 115. Sixth International Symposium on Light in Horticulture, Tsukuba, Japan. (poster presentation)

Scientific and Outreach Oral Presentations

Karlsson, M. 2010. High tunnels, hoop houses and retractable roofs for improved field production. Alaska Greenhouse and Nursery Conference, Juneau, Alaska. February 25.

Karlsson, M. 2010. Are LEDs the future of greenhouse lighting? Alaska Greenhouse and Nursery Conference, Juneau, Alaska. February 26.

Karlsson, M. 2009. Research update for statewide Ag/Hort personnel. Cooperative Extension Service. Fairbanks, December 17.

Karlsson, M. 2009. Greenhouse technologies. North of 60° Agriculture Conference. Government of Yukon. White Horse, Canada, November 7.

Karlsson, M, 2009. Energy for Alaska greenhouse production. North of 60° Agriculture Conference. Government of Yukon. White Horse, Canada. November 6.

Karlsson, M. 2009. Geothermal agriculture and food security. Alaska Geothermal Conference. Risks, Barriers, and Opportunities: Geothermal projects in Alaska. Chena Hot Springs Resort. April 30.

Werner, J. 2009. Geothermal greenhouse production. Natural Resources Council at Chena Hot Springs Resort. September 19.

Werner, J. 2009. Using greenhouses as a production system. Energy Fair, Chena Hot Springs Resort, August 22.

Werner, J. and M. Karlsson. 2009. Field and high tunnel production. Workshop for teachers of "Ag in the classroom". Fairbanks, June 2.

Werner, J. 2009. Managing hydroponic production for success in Alaska. Fifth Annual Sustainable Agriculture Conference and Organic Grower School. March 17.

Other Relevant Accomplishments and Activities.

We have developed partnerships with Chena Hot Springs Resort and Pike's Waterfront Greenhouse. These associations offer opportunities for more effective information dissemination to the public, out-of-town and out-of-state visitors, and commercial producers. These greenhouse operations also offer training and summer job opportunities for high school and college level students.