High Tunnels in the Great Plains
Flower-based Production Systems
University of Nebraska - Lincoln

Laurie Hodges, Beth Barry, & Heather Bittinger

Cut Flowers & High Tunnels for Season Extension

Cut flowers are the highest value crops that can be grown in a high tunnel. Many states are actively researching specialty cut flowers to supplement or replace other agricultural crops (e.g. tobacco in Maryland and Kentucky, vegetables in Florida, dairy in Wisconsin) and make farming profitable. Limitations include intensive production techniques with high labor demands to meet the stringent quality demands of the floral industry. Both local and national markets are limited for any one product and can be highly competitive. Increasingly foreign production is the low-cost producer. However, interest in "garden" flowers (such as sunflowers) for floral designs and an industry driven by "something different" provide opportunity for motivated growers willing to market their products and seek out innovative buyers. The main competitive advantages for a local grower are freshness and service. For certain crops, local production provides significantly higher quality and a local supplier can have floral products that don't ship well or are characteristic of the local area. High value niche markets are easy to saturate and require producers to spend significant time on market development and maintenance. Yet many find the personal connection with buyers the most satisfying aspect of specialty crop production.

- Six tunnels were constructed and intensive microclimate monitoring systems installed during 2002. Manure was added to all tunnels in winter 2002-03. Crops were first planted in 2003. Due to poor drainage and aeration problems, all beds were amended with peatmoss in 2003-04. Selected beds in the east/west facing tunnels (#1,3,5) are being double-dug and amended with alfalfa hay in 2004-2005. Soil condition has been a major limiting factor for quality production.

- Anil Jayaprakash [UNL MS degree 2005, Horticulture & Biometry (dual degree)]developed a predictive model to predict high tunnel soil temperatures based on the outside air temperature. Although the air temperature in these single-layer poly tunnels drops below freezing during the winter, the soil temperature at 4" depth remains above freezing. We verified a grower belief that high tunnel production is shifted two zones warmer in terms of plant material appropriate for cut flowers. Lincoln is in cold hardiness zone 5b with high tunnel air temperatures comparable to zone 7b. For more on high tunnels, see www.hightunnels.org

- We have grown spinach, onions, broccoli, green peas, sweet peas, *Celosia* spp., *Asclepia* spp.(milkweed), *Myosotis* sp. & *Cynoglossum* sp. (forget-me-not), *Calendula* (pot-marigold), *Dianthus* (sweet william), ornamental peppers, and ornamental brassicas in the tunnels. Data is being entered and analyzed. he ornamental brassicas will be harvested for the November floral market. The large shrub is *Hibiscus sabdariffa* (Roselle), a tropical plant. The pods have many uses including herbal teas, juice, and as a decorative floral stem. It will bloom in late September.

- A model of the economics of triple cropping grape hyacinths (*Muscari* sp.), sweet peas (*Lathyrus* sp.), and hyacinth bean (*Dolichos lablab*) in a high tunnel based on 2004 data is available at http://hort.unl.edu/hodges/extension.

- *Dicentra spectabilis* (Bleeding heart) is being researched for local production as a forced crop in high tunnels. It does not ship well, is not readily available, and has market appeal from February 14 through June. Field-grown bleeding hearts would be available to florists in May. Ingrid Mallberg [UNL MS degree 2005, Horticulture] found distinct differences between the white and red forms in growth and vase-life. The stem length and number of stems were best for the red form under 63% shade in the greenhouse while the white form was best without any shade. Vase life was best with floral preservative, averaging 18 days for the white-flowered form and about 15 days for the red-flowered form. Research on the effect of plant growth regulators on stem length did not lead to any useful procedures.

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Integrated Pest Management

Pest management is especially important for cut flower crops because they have such high quality standards. Essentially no insect damage is tolerated. In the protection of high tunnels or greenhouses, insects can multiply rapidly. Although there are many chemicals available for insect control in greenhouse crops, small-scale growers often have difficulty knowing about them, purchasing small quantities, and correctly applying the pesticides. Also, a growing number of such producers are interested in organic production of high value crops. While we use a few conventional pesticides for specific problems or situations, since 2004 we are emphasizing the use of beneficial insects – both predators and parasites – to manage insect pests. Certain pests such as bean leaf beetles, sunflower head clipping weevil, sunflower stem borer, and harlequin bugs do not have any effective parasites or predators. In 2005 we have used Pyganic, an OMRI approved pyrethrim insecticide, and Sevin (carbaryl) for these pests. Cabbage worms and loopers are controlled with Dipel, an OMRI approved formulation of *Bacillus thurengiensis*. We are using an OMRI approved fungicide, potassium bicarbonate (Mil-stop) for control of powdery mildew. Weed control is a combination of hand weeding, a thick layer of alfalfa hay as mulch, and glyphosate (Roundup). Generally, I have been very pleased with biological control. It is much easier, quicker, and less hazardous than using conventional insecticides. Our costs have been roughly comparable to that of using conventional products.

Whitefly parasite: *Encarsia formosa* Nile Delta. Whitefly is a major problem for us in ornamental peppers and calendula. It also infests other plants. *Encarsia formosa*, a small parasitic wasp, is attracted to whiteflies by a volatile chemical found in the whitefly honeydew. It rarely will be found on plants that are not infested with whiteflies. *Encarsia formosa* lays it's eggs in the whitefly larvae, each female parasitizing 50 to 100 whitefly larvae, with a life cycle of about 25 to 35 days. An infected egg will be black. The most recent release of *Encarsia* eggs was on August 31.When using beneficial insects, avoid using any systemic sprays. M-Pede and Safer's Insecticidal Soap are effective whitefly insecticides with low toxicity to *Encarsia.*

Aphid parasite: *Aphidius*. *Aphidius* is another small wasp that hunts for aphids throughout the crop. It lays an egg in the aphid, which, when hatched, feeds on the aphid, glueing it to the leaf and wrapping it in a cocoon. A parasitized aphid egg is papery brown or silver and swollen. It may be mistaken for a "fat brown or silver aphid. When mature, the wasp cuts a hole in the dead aphid and emerges to repeat the cycle. *Aphidius* wasps were released on August 31. If you look closely you may find some aphid mummies. Check the underside of leaves for the swollen aphids. Generally two applications are made, two weeks apart.

Aphid predator: Ladybeetle. Ladybeetles eat not only aphids, but also mites, scales, mealybugs, and many other soft-bodied insects. The ladybeetle larvae consume many more insects than the adults. We have effectively controlled milkweed aphids (distinctly bright orange) which appear in mid-July each year by a single release of ladybeetles.

Aphid predator: Green Lacewing (*Chrysopa carnea*). Lacewing larvae feed voraciously on any soft-bodied insect or insect egg. The larvae are light tan with large jaws clearly visible to the naked eye. They are best known for attacking aphids, each one eating to 100 aphids per day and killing more by just puncturing the aphid with its jaw. They will feed on immature whiteflies. Each lacewing larvae feeds for about three weeks and then pupates before emerging as a adult in about one week. The adult does not feed on aphids but lays about 100 eggs which then repeat the 4 to 6 week cycle. Two releases are recommended to get overlapping generations.

Spidermite predator: Phytoseiulus persimilis. Spidermites feed on the underside of leaves toward the top of plants. Severe infestations will infest all leaves and flowers. Phytoseiulus is a predatory mite that seeks out

spidermites. Repeated application of Phytoseiulus every couple of weeks ensure overlapping generations. Spidermites multiply at a weekly rate of about 2.7 whereas the predatory mite multiplies at a rate of about 4.6 at 68 F. By releasing Phytoseiulus, not only are spidermites actively hunted and consumed, over time they become outnumbered by the predator.

Thrips: Predatory mite (*Amblyseuis cucumeris*). Thrips are extremely small insects that feed on plant juices by scraping the leaves. They tend to hide in flower buds and where leaves emerge or are tightly clasping the stem. Getting an insecticide to contact thrips hidden in these locations is the challenge. In our experience, thrips are a particular problem in Dutch bulb crops and sweet peas. *Amblyseuis cucumeris* is a predatory mite that seeks out thrips where they hide. The adult lives about three weeks. In the absence of sufficient prey, it can survive on pollen. They do not overwinter well or survive well in the field so releases are necessary each year in the high tunnels.

Soil insect predator: Predatory nematode (Guardian, a Steinernematid species). Guardian is a brand name for a specific sub-strain of a predatory, insect-eating nematode. It feeds on many insects that spend some part of their life cycle in the growing media or soil. This includes thrips, spidermite eggs, cutworms, corn borer larvae, and fungus gnats. It does not attack other nematodes. Once the nematode locates and enters a host, it will be killed. The nematode reproduces within the killed host and the offspring will exit in search of more host insects; repeating the cycle. It requires moist, not soaking wet, soil to survive and tends to gather in the root zone of plants.

For suppliers of biological controls, see NebFact 182, Retail Suppliers of Beneficial Organisms, available at county extension offices or on the Internet at http://ianrpubs.unl.edu/insects/nf182.htm

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Integrated Pest Management
Insect Movement between Field & High Tunnel
Laurie Hodges, Charles & Karen Messenger, Beth Barry, Heather Bittinger

Some growers report that crops in the field can be infested by certain pests while the same crops being grown in near-by high tunnels are not infested. Further, they have noticed that, when an infested area or earlier crop is disced under, the pests move to younger plantings whereas if the host plants are left in the field, there is less infestation in the new planting. Normally, growers are encouraged to disc a crop as soon as possible after the last harvest to reduce the inoculum of plant pathogens and destroy insect eggs, larvae, and insect habitat.

This is preliminary study to obtain data related to the types of insects in the area during the growing season and changes during the growing season inside and outside the high tunnels and the effect on mowing on these movements.

The yellow sticky cards are placed at set locations 24 hours before mowing and removed 24 hours after mowing. This usually occurs on Tuesday and Wednesdays. The number and types of insects on the traps, and the location on either the front or the back of the trap, are recorded as well as the time and date the trap was set out and before or after mowing.

We now have a large amount of data to analyze and interpret this winter. This is part of a regional project on integrated pest management in high tunnels in Nebraska, Missouri, and Kansas.

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Background: A high tunnel can be defined as a plastic enclosure designed to grow or temporarily protect plants. They have evolved from protected cropping systems dating back thousands of years: cold-and-hot-frames, winter gardens, orangeries, conservatories and glasshouses in different forms, and plastic-clad plant enclosures of all sizes ranging from low tunnels, walk-in tunnels, to these large plastic houses called high tunnels.

The nursery industry uses high tunnels to protect perennials and shrubs through the winter. High tunnels also are often used to extend the growing season for high value crops. Profitability for small -scale intensive farms relies on selection and timing of diverse crops to optimize use of these structures. Temperature conditions within the tunnels depend on manual manipulation of sidewalls for ventilation. The basic structures are seen here. Many growers will provide supplemental heat and/or a second layer of polyethylene plastic to form an insulating air layer (double-walled poly) to maintain temperatures above freezing to force certain cool-season crops. The regional cooperators decided our initial three-state project (Kansas, Nebraska, Missouri) would be simple, inexpensive, and not involve these inputs.

Structure: Stuppy Polar Cub model, modified with 5 ft sidewalls (vs standard 3 ft). A 20 x 97 ft structure was cut in half for statistical purposes. We also specified the heavier gauge tubing due to the wind pressures in Nebraska (and are thankful for it!). Because we are on a heavy clay soil, we did not cement the posts. This is recommended in lighter soils. The structure, available from several manufacturers, will probably cost roughly $2,000 with another $500-$800 in plastic, wood, and miscellaneous parts for the covering, end-walls, doors, etc. For details, contact Stuppy Manufacturing at www.stuppy.com or 800-733-5025. Our website, www.hightunnels.org, includes a section on construction (including self-made structures), suppliers, various cropping systems, a listserve for communication among growers and others working with high tunnels and many links to suppliers and publications. There are many different ways to construct the sidewalls, and doors, the means to roll up the sidewalls. The higher sidewalls facilitate harvesting and crop maintenance but their primary advantage has been in reducing heat accumulation during the summer. The entire structure is sealed during the winter to retain heat in the soil accumulated through solar gain and released during the night. Our high tunnel air temperatures in the winter generally equal the outside air temperature with a 2 hour lag. Soil never reaches freezing at 4 inches due to heat accumulated during the day being slowly released at night. Access is needed during the winter to irrigate Dutch bulbs and other crops, which we begin harvesting in late March.

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T-bar roll-up

Crank style roll-up

Heavy-duty ratchet type crank for long sidewall

Some assembly required. . . . .

Push up & tie sidewall

Make sure posts are square & level & uniform height

Use of bucket to push posts into ground to level& uniform height

Time spent here is well-spent

A simple rig to hold post square & vertical