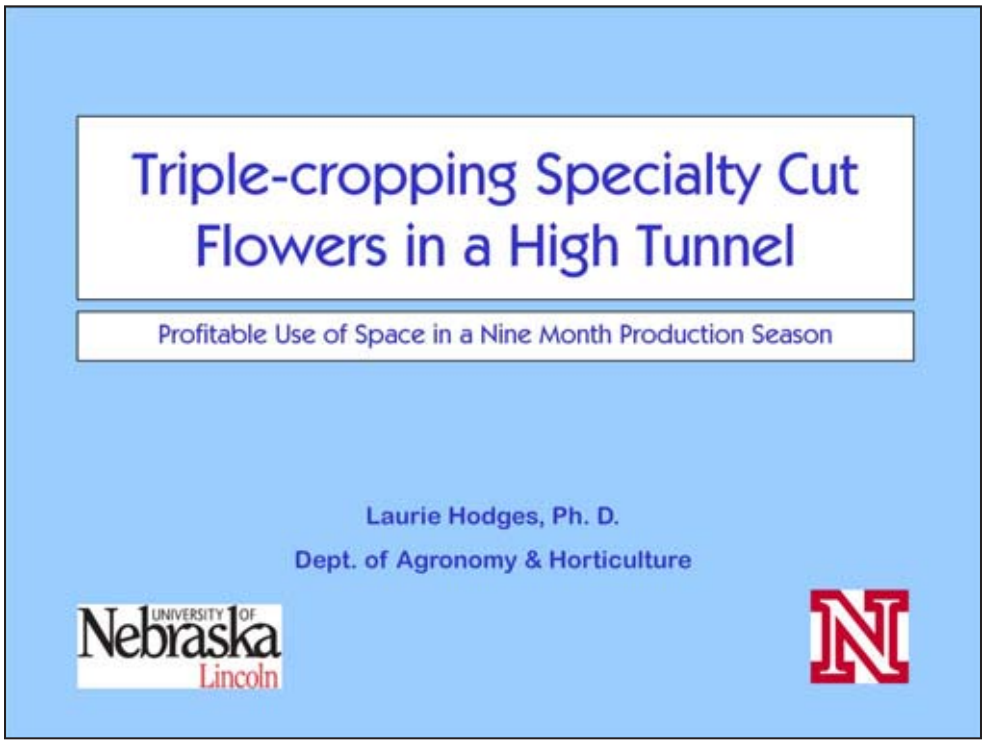
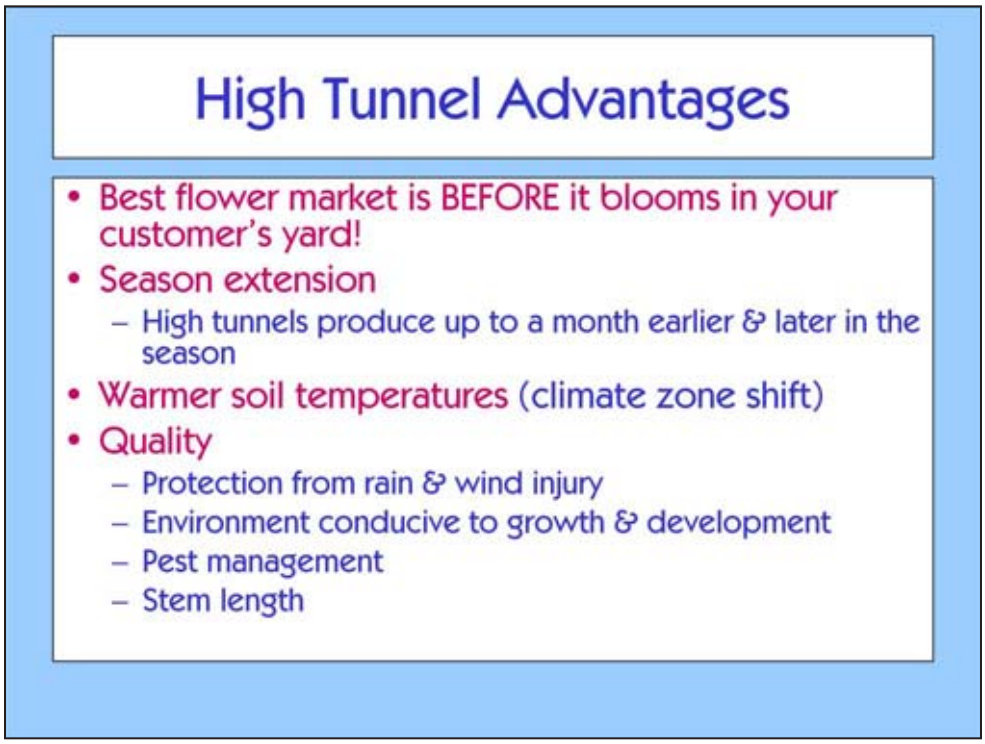


Hello. My name is Laurie Hodges, Horticulture Extension Specialist at the University of Nebraska. I want to share with you some results we've had growing specialty cut flowers in high tunnels here in Lincoln Nebraska. You can progress through the slides at your own pace, go backward or forward as you wish. This gives you time to look closely at the pictures or text.

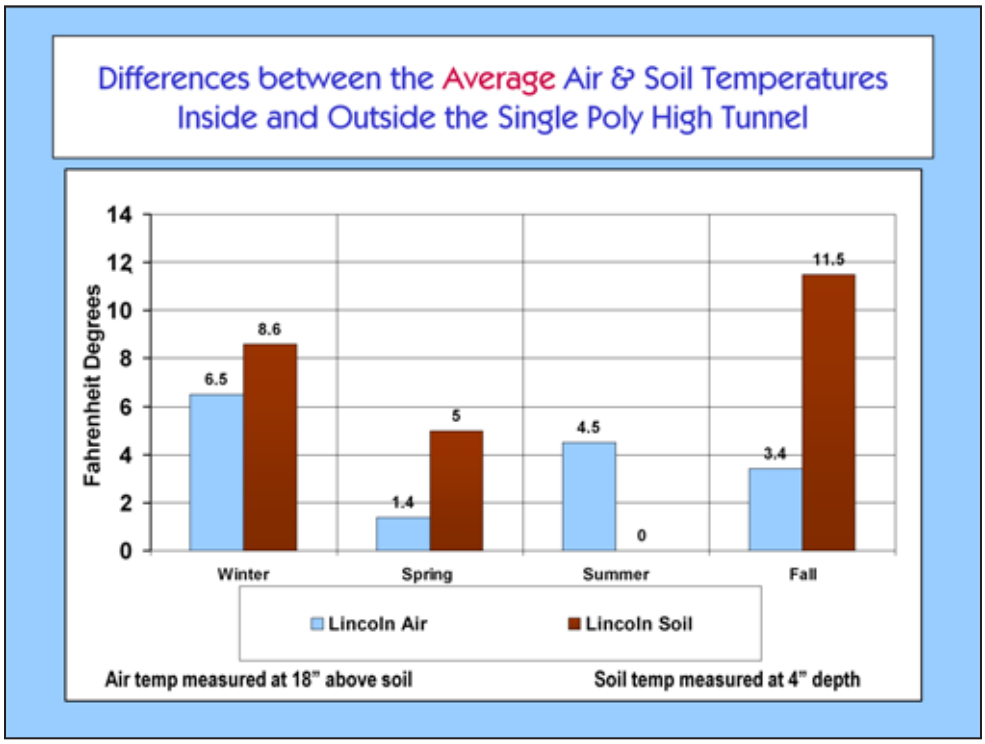


Growing plants in high tunnels has many advantages for the commercial specialty cut flower grower. We know that the best flower market is BEFORE it blooms in your customer's yard! High tunnels allow you to provide your customer with high quality crops earlier and later in the season, in fact, as much as a month earlier and later.

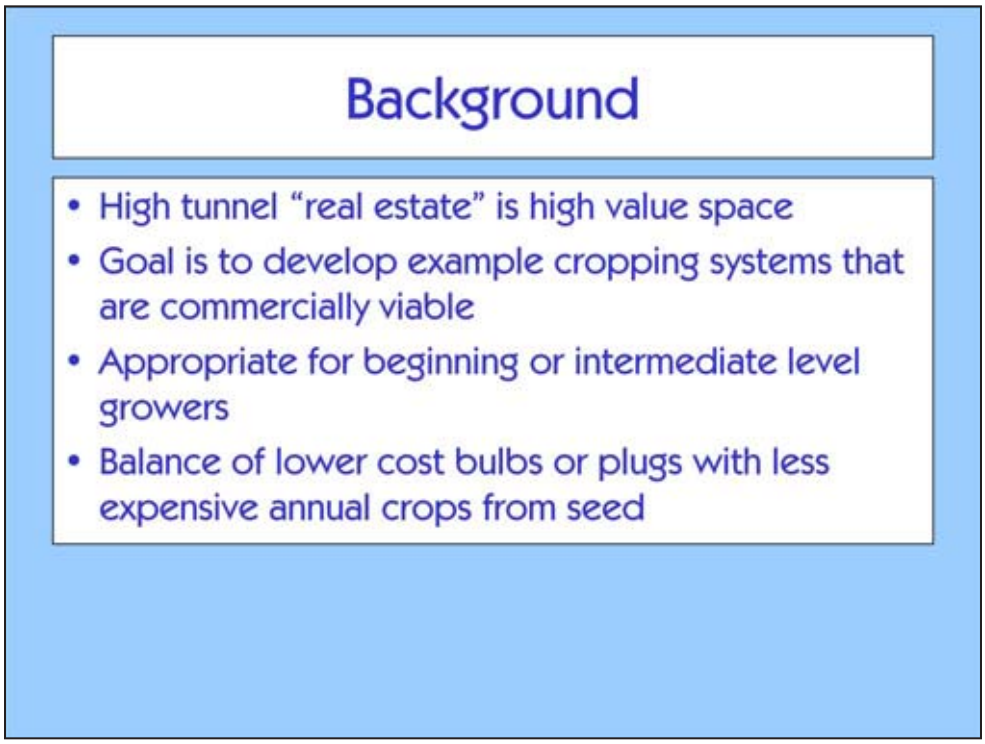
This is possible because the tunnels accumulate solar radiation in the form of heat during the day, some of which is stored in the soil and released slowly during the night or during inclement weather. In a single-walled poly high tunnel, air temperatures quickly equilibrates with the outside air. We found, however, that soil temperatures four inches below the surface in our tunnels, never went below freezing during the winter of 2003 to 2004. This warmer soil temperature creates conditions typical of more southern regions. For example, Lincoln is in the USDA hardiness zone 5a. However, in 2004 winter in Lincoln was warmer than normal, in fact, we were the equivalent of zone 6a. We found that the high tunnel effectively shifted our growing conditions to those typical of hardiness zone 7b during the winter of 2003-4.

Beyond season extension, the quality of crops grown in high tunnels is often higher than field grown corps.

The crops are protected from rain and wind injury and have an environment that is conducive to growth & development. Pest management, especially biological control practices, often are easier in the partially enclosed high tunnel environment. And many growers have documented longer stems from high tunnel crops.

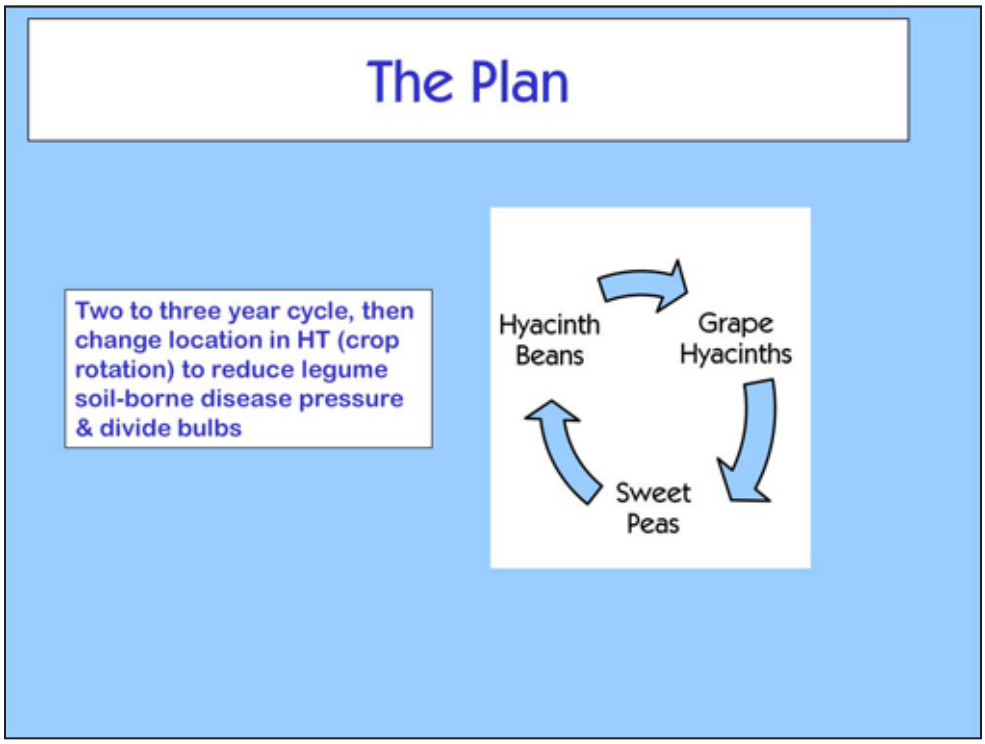


This slide show how a high tunnel affects soil and air temperatures. Our crops were in a single-wall polyethylene covered high tunnel with 4 ft roll-up sides. The sidewalls were manipulated to optimize conditions for crop growth, including reducing wind stress, a big factor here in Nebraska. The higher average soil temperatures during the winter, spring, and fall allow for good root growth, soil microbial activity, and nutrient availability. In the spring we try to keep the air temperatures cool and in the fall, we want to delay chilling injury or crop freezing. Soil heat accumulated during the daylight hours (solar gain) is released at night.



The idea behind this project was to develop some examples of crops and cropping systems that would be commercially viable, i.e. profitable, and that would be appropriate for beginning and intermediate level growers using a simple, single-wall polyethylene, unheated high tunnel in the Central States.

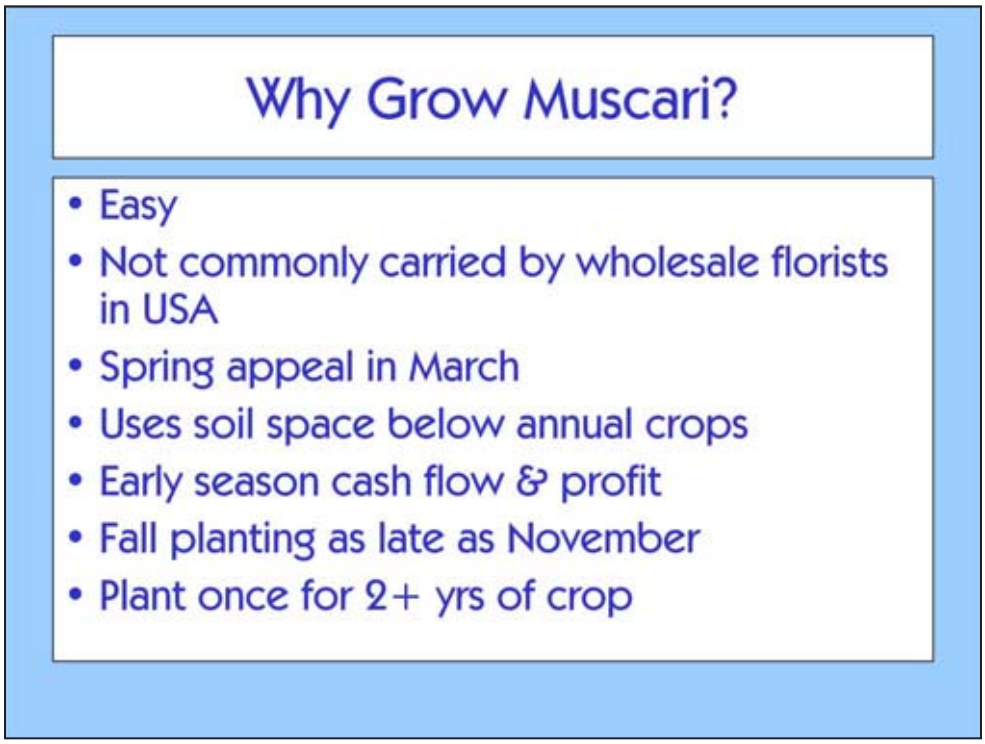
Many beginning growers hear from others about growing a wide range of high-value cut flowers such as lilies, ranunculus, anemone, calla lilies, etc. Some of the crops experienced growers and florists are most excited about tend to be more expensive to produce and handle. The small-scale grower, having just invested $3,000 or more in a basic high tunnel, may be a hesitant to work with bulbs that can cost a dollar or more each and are ordered in minimum numbers of 500 or 1000, not being sure of their market, their growing ability, or problems that may occur in scheduling production.



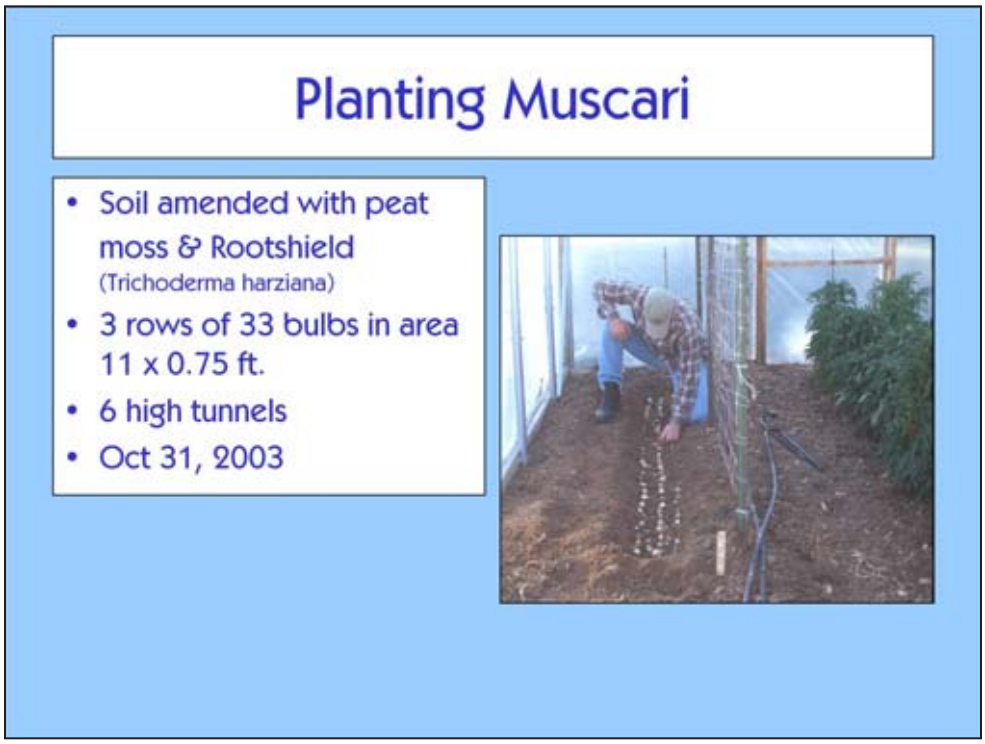
This is a schematic of the cropping plan for two to 3 years, after which the trellis will be moved to a new location in the high tunnel, the muscari dug and divided, perhaps selling the surplus, and then replanted adjacent to the trellis in it's new location for another two year cycle. It is important to rotate the planting area within the high tunnel. Since this scheme has two sequential legume crops, Sweet peas and Hyacinth beans, it is likely that the soil-borne disease pressure will build up unless rotation is practiced. Without crop rotation, an expensive fungicide drench might be required.

Growing Muscari (Grape Hyacinths) in High Tunnels

Grape Hyacinths, Muscari armeniacum, is the first crop we harvested



Why did we select Muscari as a crop? It is easy to grow and not commonly carried by wholesale florists, although it is available in the trade for those willing to seek it out. It is a bright, cheerful blue flower that makes people think of Spring. It works well in bouquets and small vase arrangements. Growing grape hyacinths in high tunnels can provide early season cash flow and profit. Because the flower bud is formed in the bulb before the bulbs go dormant, they can be planted as late as November if the high tunnel space is occupied by a fall-blooming crop. After the bulbs go dormant in June, other annual crops can be planted in the same area. This is a crop that can be planted once and harvested for more than one season, reducing labor.



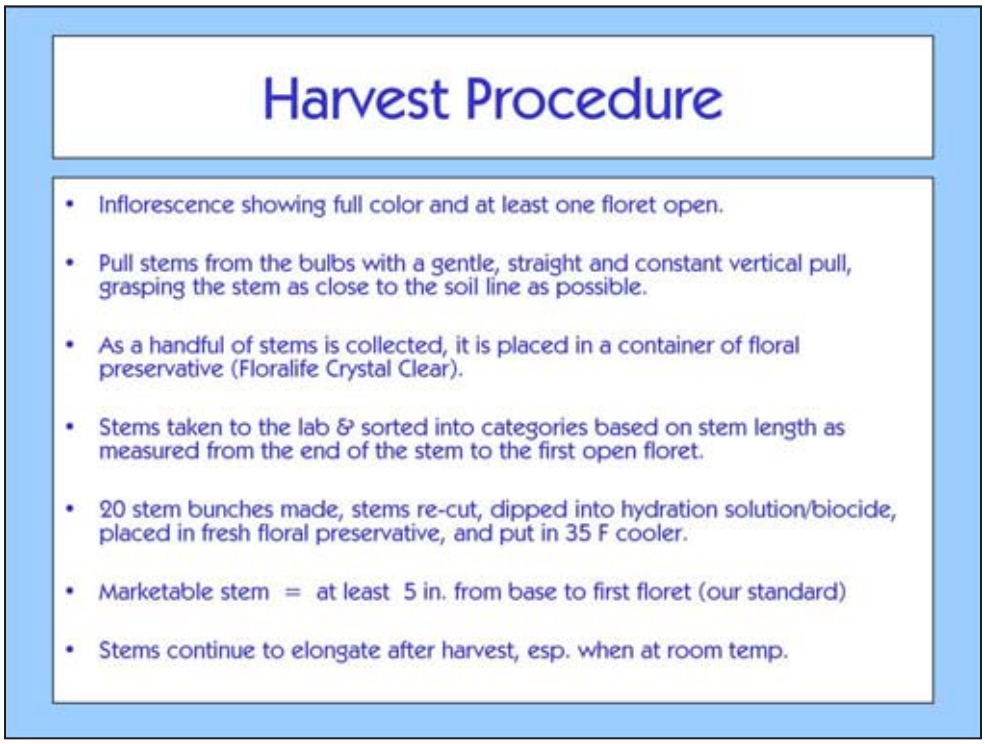
Muscari bulbs were planted in each of 6 high tunnels, planted to the open or sidewall side of the sweet pea trellis on October 31, 2003. The peat moss & Rootshield™ amended soil was moved to one side and the bulbs placed about 2" apart in 3 rows of 33 bulbs each for a total of 99 bulbs per house. After bulbs were placed in all 6 high tunnels, then soil was moved back on top of the bulbs to a final depth of approximately 4 inches. The area was watered well with a hose to settled the soil. The muscari bulbs took up a band about 8 inches wide x 11 ft. Total plot area is 11 ft x 3 ft. Bulbs were untreated The sidewalls were ***closed*** for the duration of the winter (Late November through most of March).

It took about 15 to 20 minutes to excavate the area in one high tunnel, plant the 99 bulbs in three rows of 33 bulbs and then pull the soil back over the bulbs.

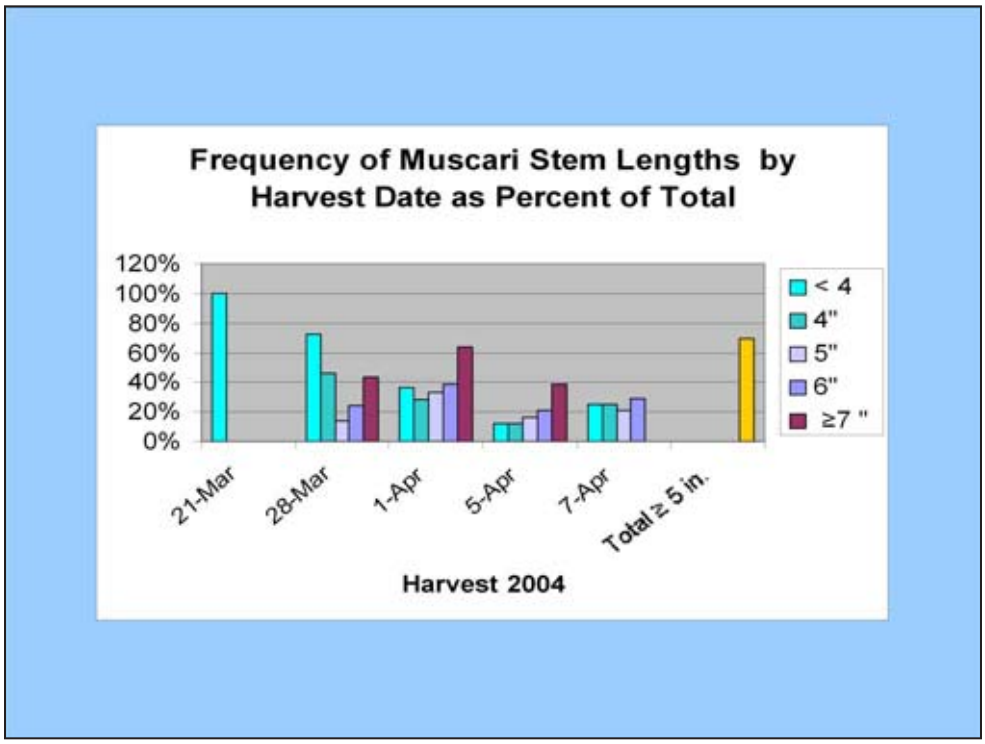
Crop Timing - Muscari

	2003-2004	2004-2005
Planted Bulbs	Oct 21	Carried over
High Tunnel Walls Sealed	Nov 26	January 28
Wiggle Wire Removed	March 9	March 12
First buds	March 10	March 23
First Harvest	March 21	April 1
Last Harvest	April 8 (18 days)	April 12 (12 days)

This was our experience in 2003 to 2004. Bulbs were planted October 31. We sealed the side-walls and end walls shortly after Thanksgiving, opening the end-wall door for ventilation or sprinkler irrigation as needed. Nebraska weather is quite variable, and even more so during the spring and fall. By March 9, days were warm enough that we needed to fully ventilate by raising the sidewalls so the wiggle-wire was removed and the sidewalls manipulated to reduce daytime heat build up and yet attempt to maintain temperatures above freezing at night through the soil releasing the soil heat accumulated during the day. The first buds were observed March 10 with the first harvest on March 21 and the last harvest on April 8, for an 18 day harvest period.

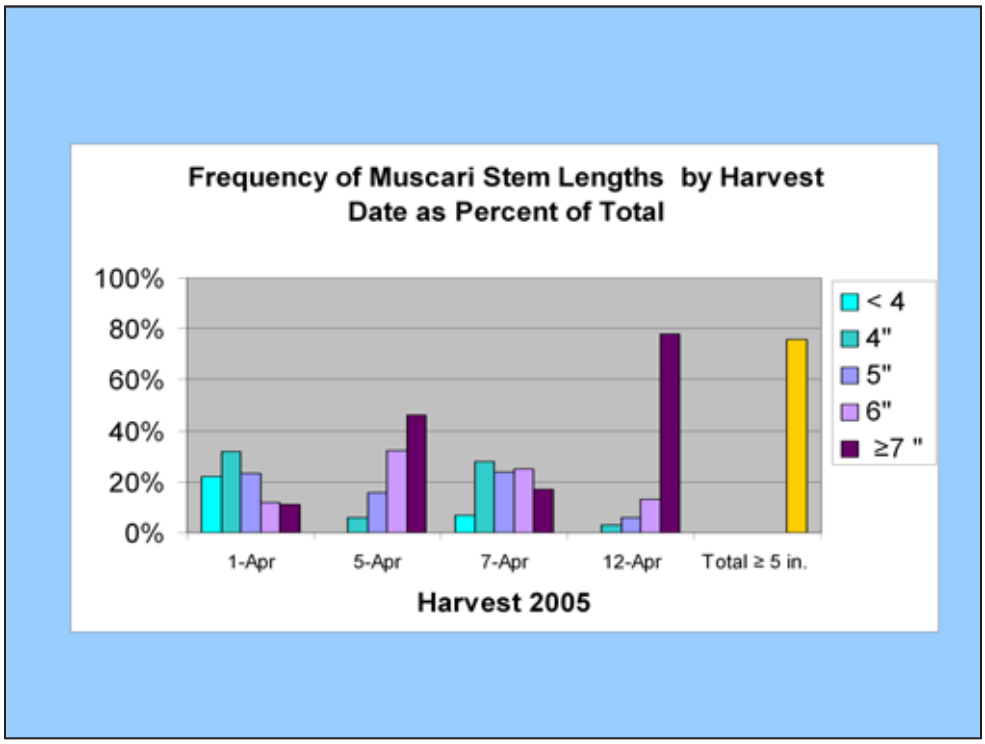


Muscari are harvested when the first florets open and the inflorescence is showing color. Stems are pulled from the bulb with a gentle, persistent upward motion. A few stems break, but it is really quite easy to do. As a handful of stems was collected, they were placed in a Mason jar containing floral preservative. Back in the lab, stems were sorted by length, measured from the end of the stem to the first open floret. Sizes were grouped into 20 stem bunches, stems recut, dipped into a hydrating solution, and then place in fresh floral preservative and put into a 35 F cooler. We considered a marketable stem one that was at least 5 inches long at harvest. It is important to remember that the stems will continue to elongate after harvest, not so much in the cold room but several inches when placed at room temperature. Be sure to let your florists know this so that they consider it when using the stems in designs. They should treat muscari similar to how they handle tulips.

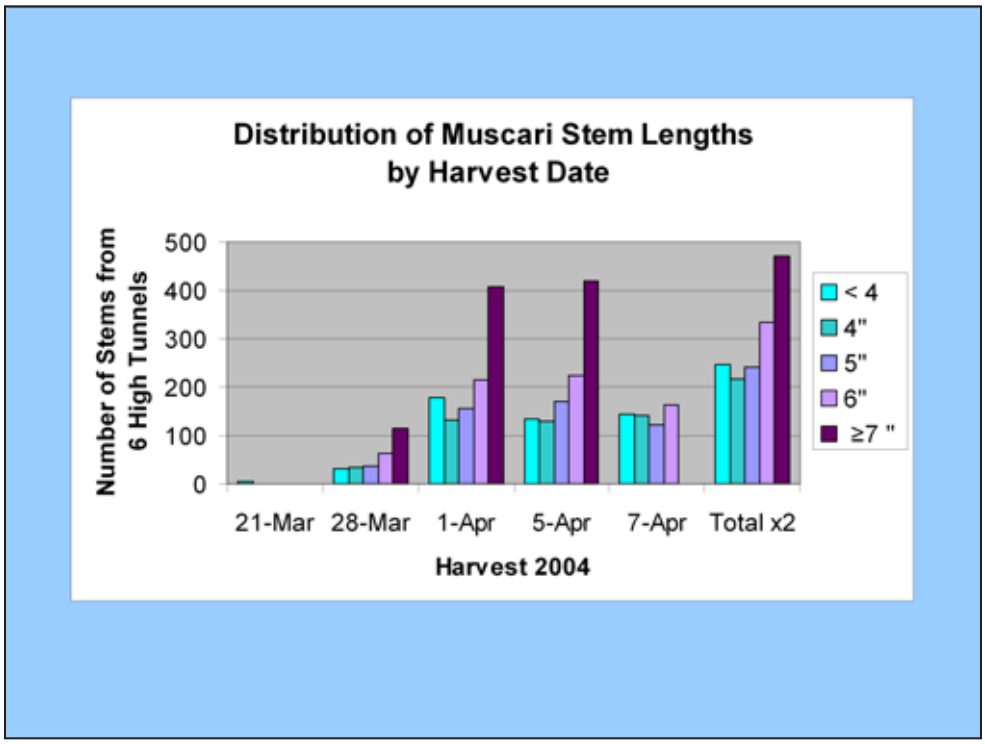


As a percent of total stems harvested, 7% of the stems were 8 inches or longer and 36% were more than 7 inches long.

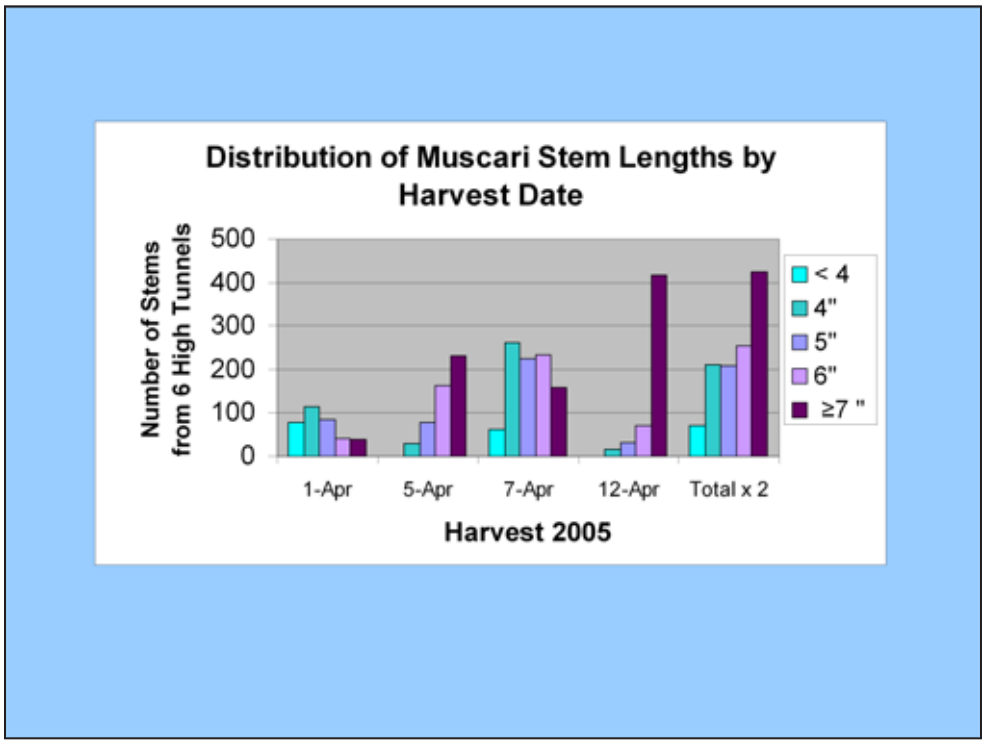
Perhaps I was overly eager to begin harvest as the stems, measured from the base of the stem to the first floret, were less than 5 inches long for the first harvest. By the second harvest we were getting stem lengths of more than 7 inches.



In 2005, I held back harvesting until the first of April and only had 21% with stems < 4" long and 46% were marketable at 5 inches or more. Four days later on April 5, the percent of marketable stems reached 94% and 46% were 7" or more in length. Then we harvested again on April 7 and there were fewer long stems with 66% marketable . The final harvest on April 12 with 97% marketable and 78% with stems at 7 inches or more from the base to the first flower.



This graph is similar to the last one but shows the total number of stems harvested in each size category at each harvest date and then the total. We had quite a few stems more than 7 inches long (dark purple bar) during the second week of harvest (the first week of April). I was surprised at how many we had with good stem length – as many as 63%!

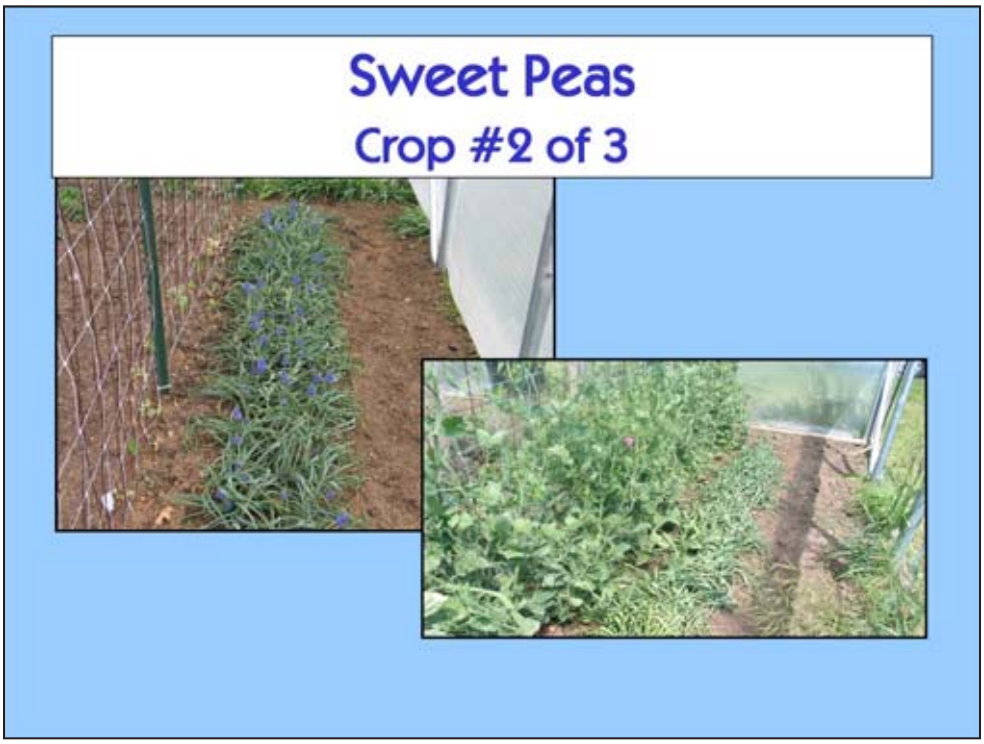


We harvested fewer total stems in the second yea, a total of 2340 with 1775 at least 5 inches long. 75% were marketable.

Muscari Budget

	2004	2005
Total number marketable (≥ 5 inches to base of flower)	2164	1775
Percent Marketable	69%	76%
Number of 20 stem bunches	108.2	88.8
Number of bunches per high tunnel	18.0	14.8
Value per HT@$7 per bu	$126.23	$103.54
Value per linear foot	$11.48	$9.41
Value per sq. ft actual bed space (8.25 sq. ft.)	$15.30	$12.55
Value per sq. ft. based on 33 sq. ft. bed space	$3.83	$3.14
Marketable stems per bulb	3.6	3.0
Marketable stems per high tunnel	360.7	295.8
Total stems per bulb	5.3	3.9
Total stems per high tunnel (99 bulbs planted)	521.2	389.8

If the entire 33 sq ft plot area was filled with muscari and all marketable stems were sold, the two-year average return would be $459.53 rather than the two-year average price of $114.89, which was produced on 8.25 sq. ft of actual bed space.

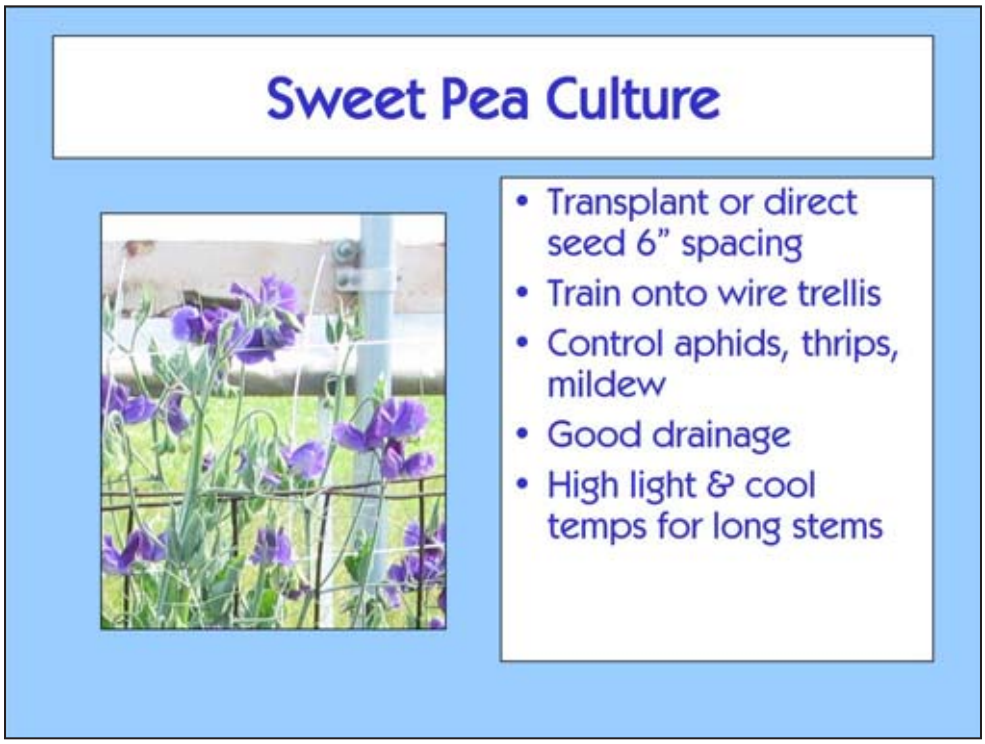


Sweet peas were the next crop we harvested in this scheme. The photo on the right was taken in early April, when the muscari were still in production. Muscari are finished below sweet peas on May 28, 2004 in high tunnels as first flowering occurs.

These are the sweet pea cultivars we planted. Mammoth series of cultivars is reported to have good heat tolerance for a sweet pea. Winter Elegance series has good cold tolerance. Cupani was selected because it is reported to be the original sweet pea, noted for its fragrance. However, it flowered much later than the other cultivars and the temperatures were getting much too hot for sweet peas. The data for Cupani was not included in what I'll show you. It is a lovely color and very fragrant with a very different plant type than the other sweet peas.

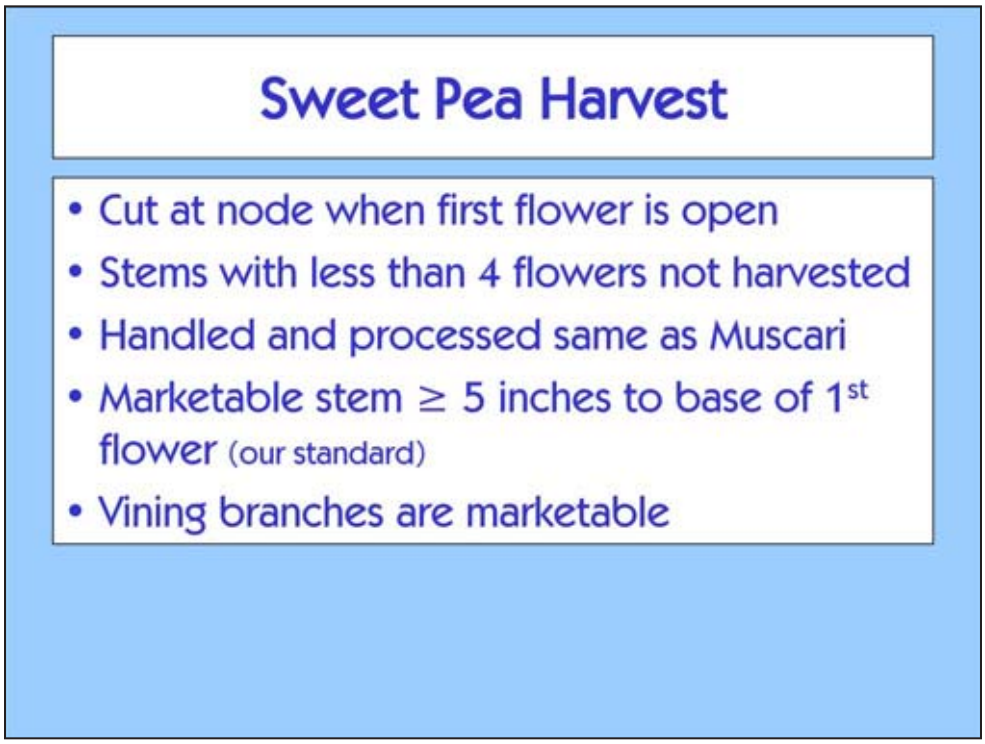
These are the sweet pea cultivars we planted. Mammoth Navy Blue and Mammoth Deep Rose were planted again in 2005. But I switched to some different cultivars that are mostly what are called Spencer type sweet peas for their color and fragrance. We had very poor germination and difficulty getting a good stand in 2005.

Navy Blue sweet peas in High Tunnel #3, June 6, 2004.

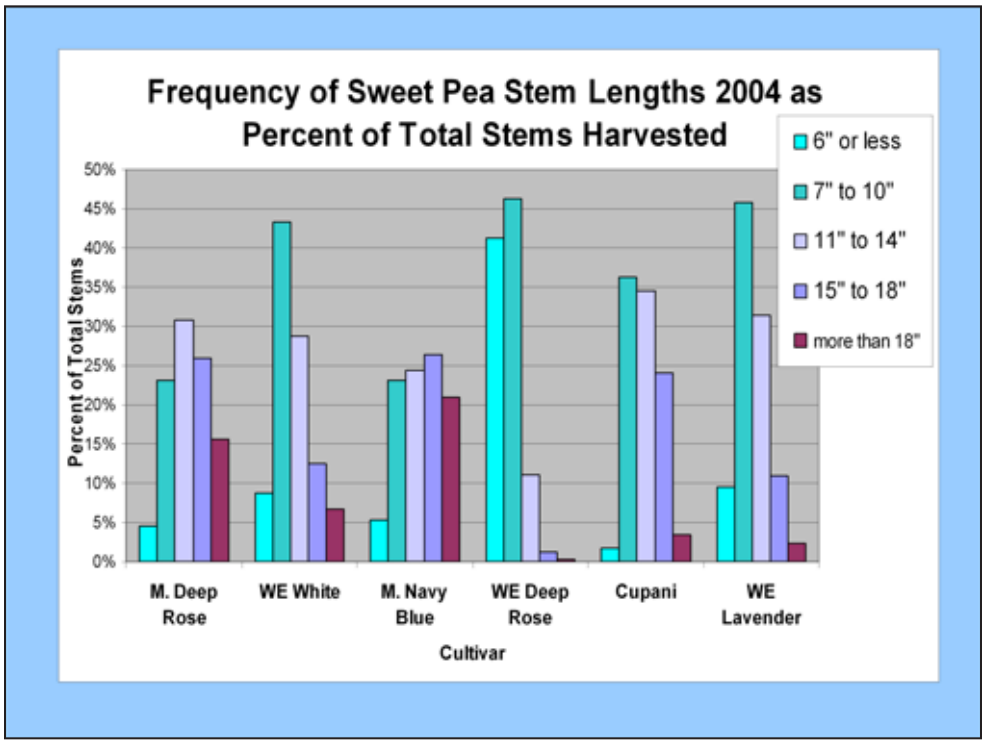


Sweet peas can be either direct seeded or transplanted, six inches apart, and trained onto a wire trellis. They white nylon trellis is not strong enough to support the weight of sweet peas. Aphids, thrips, and mildew are common problems with sweet peas. They prefer good drainage and moderately high nutrient availability. For long stems, the plants should grow under high light and cool temperatures.

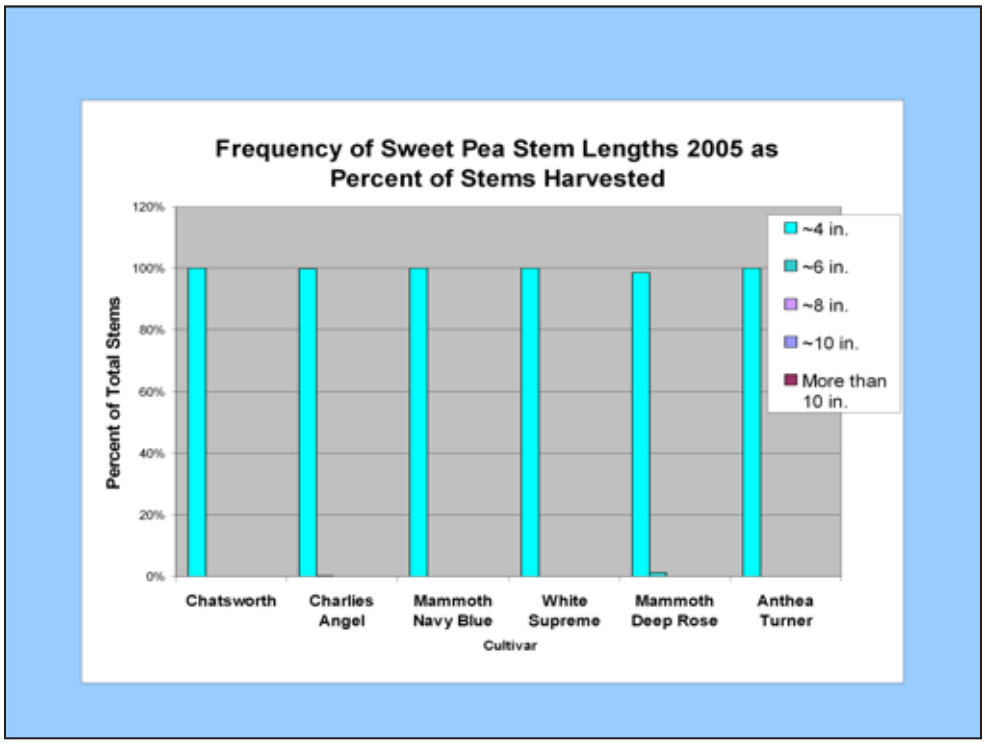
This was our schedule of events with the sweet pea crop. We transplanted rooted seedlings on March 8. There was a severe cold snap that night and the plants froze back. I was not sure how well they would recover, and so I went in on March 18 and direct seeded to get a uniform stand. Plants were thinned to get 22 plants in the 11 foot long trellis. Aprils were a problem in mid-May. I applied both a predatory mite and then used an insecticidal oil. Our first harvest was on May 11 and we quit on June 17 as conditions were no longer good for sweet peas quality.



Sweet peas are harvested at the node when the first flower is open, using a small knife or clippers. We decided not the harvest stems with less than 4 flowers. I considered a marketable any stem with at least 4 flowers and at least 5 inches long from the cut end to the base of the first flower. Many growers market sweet peas on the vine for the same price as a single stem. We sold a few of these veining branches.



Long stems are desirable. Sweet peas are not known for long stems. Again, we took a conservative approach that is hopefully more consistent, and measured from the cut end of the petiole to the first flower on the base of the inflorescence. So in this chart, we see that the Mammoth Series had a larger proportion of the stems more than 14” in length than the Winter Elegance Series although all cultivars produced at least 25% of their stems in the longest two length categories.



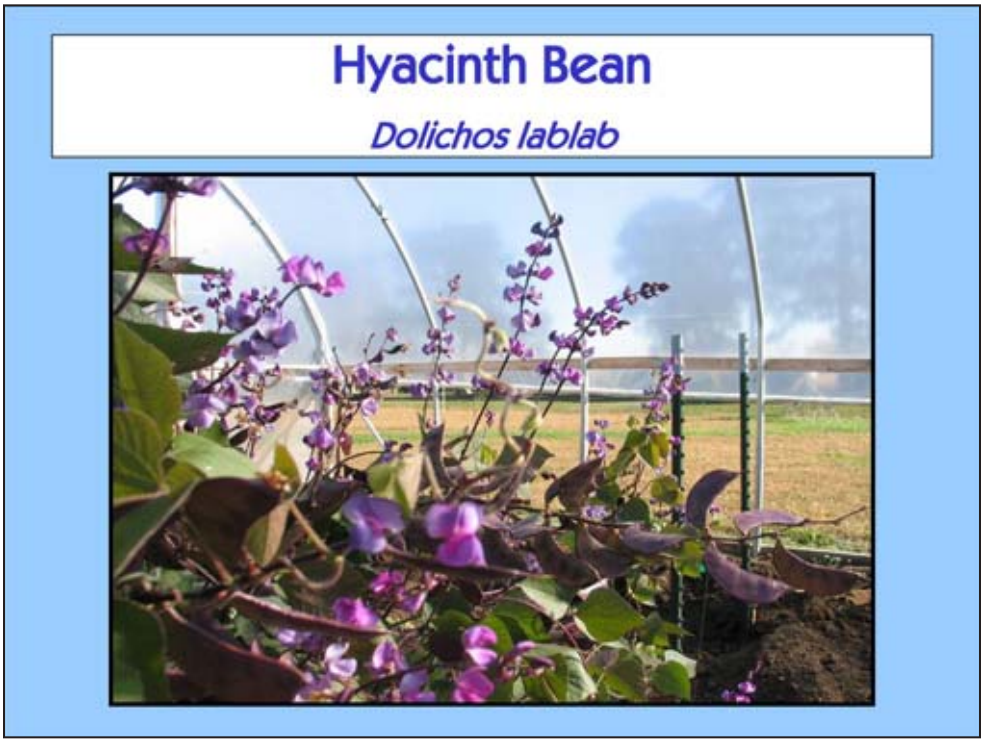
From our Spring 2005 crops, we had very short stems, probably because they were planted so late and experienced hot weather more than those in 2004. The one thing I'll say is that the new varieties were very fragrant, much more fragrant that Mammoth series. I will probably try them again, being sure to get them in the high tunnels early in the season and also may go back to transplants, or may over plant to ensure a good stand. Consistent soil moisture and fertility also affect flower stem length.

Sweet Pea Budget

	2004	2005*
marketable stems per tunnel	823	673
# of 20 stem bunches per trellis	41	34
Trellis length ft	11	11
Number of bunches per linear ft	3.74	3.06
Value per linear ft @$4 per bunch	$14.97	$12.24
Value per linear ft trellis @ $8 per bunch	$29.92	$24.47
Value per sq ft based on 33 sq ft trellis space & $8 per bunch	$9.94	$8.16
Marketable stems per plant	37	31

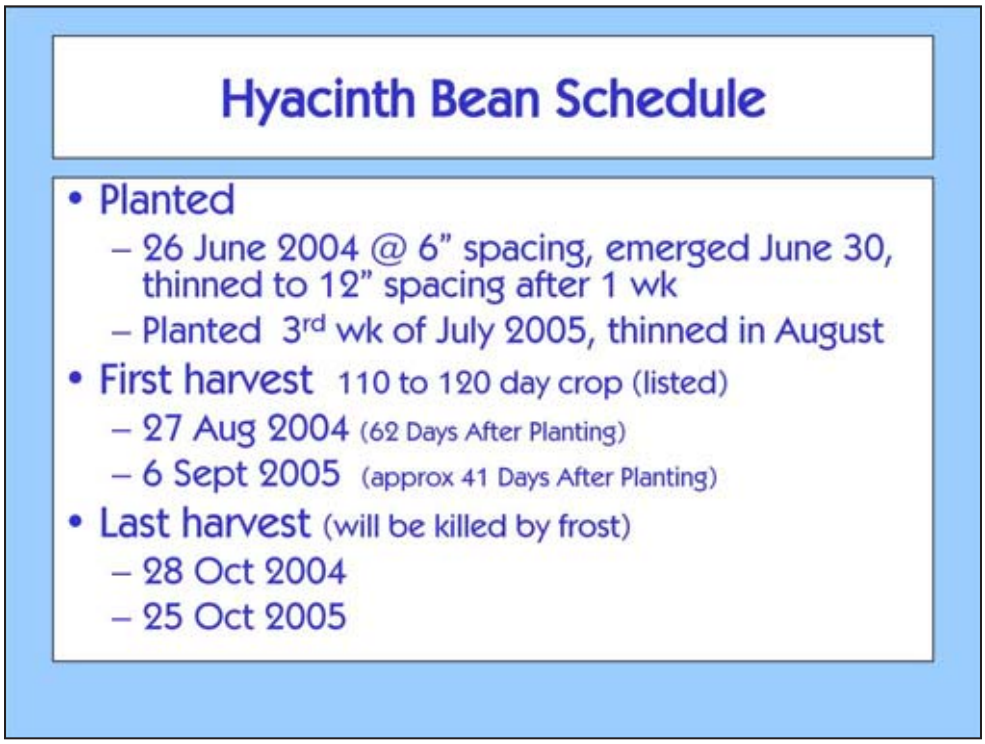
* Extrapolated data to uniform stand counts & all stems marketable

A marketable stem needed to be at least 6 inches from the base of the cut stem to the first flower. We averaged 37 marketable stems per plant. When bunched in 20 stem bunches, we averaged 3.7 bunches per linear foot of trellis space. Although I set my price based on the San Francisco Wholesale Market Report at $4 per 20 stem bunch, many cut flower growers selling direct to florists charge double this or $8 for 20 stems or $4 for 10 stems.



The final crop was Hyacinth Bean, a vigorous vine with dark purple stems and pods with lighter lavender flowers.

The pods are very attractive, glossy dark purple.



Here is the crop schedule. Our seed cost us 27 cents each. Seed costs for this crop vary widely among vendors so you may want to shop around. Spaced 12" apart along the trellis, we crowded the plants closer than the recommended spacing, although the crop is reported to yield more stems is a less dense planting. It is a very vigorous tropical vine. We can't imagine wanting more stems as you'll see soon.

It prefers full sun but did well in the high tunnels. Although the crop is listed as taking 110 days, it is sensitive to photoperiod and flowers under short days, conditions we have in Lincoln Nebraska by mid-August. We harvested from August 27 to the end of October. We opened the sidewalls at night on purpose the last week of October to get more color in our ornamental cabbages. Plus, we were tired of the hyacinth beans after two months. When the air temperature in the high tunnels dropped below freezing, the hyacinth beans died.

The description for post-harvest handling is what we do as standard treatment. Although we did not do any experiments for different post-harvest procedures, according to researchers at the University of Kentucky hyacinth beans may do well without the use of floral preservatives. Vase life for young flowering stems is about 7 days. Once pods begin to form, it is best just to let those stems go on to develop pods.

With no pricing guidelines for this crop, we just selected a bunch size and price that seemed appropriate, although one grower reports receiving 70 cents per stem.

Since this crop is growing and maturing during the summer, we did have some damage to the leaves by bean leaf beetles, and cucumber beetles damaged some flowers. We controlled these insects with carbaryl (Sevin) insecticide.

Hyacinth Bean Budget
Two Year Average

	Flowers	Pods	Flowers & Pods
Avg stem length (in)	15.1	13.7	28.8
Total count stems	1189.6	239.0	1428.6
Total count marketable stems	1042.6	191.0	1233.6
Number of 10 stem bunches per trellis	104.2	19.1	123.3
Trellis length ft	11	11	11
Bunches per linear ft	9.5	1.7	11.2
Value per linear ft @$3.50 per bu	$33.14	$6.08	$39.22
Value per sq ft based on 33 sq ft trellis space & $3.50 per bunch	$11.05	$2.03	$13.08
Marketable stems per plant	81.3	14.3	95.6

Here is the data from two years of growing Hyacinth Beans in the high tunnels as part of a triple cropping scheme. We measured stem lengths from the cut end to the base of the first flower on the raceme, not the total stem length. Total stem lengths were in the 15 to 28 inch range. As you can see, we averaged close to 100 marketable stems per plant, which is a pretty good return for a 27 cent seed! The gross return per square foot was about $13.00 for this crop alone.

So, here are the three crops we grew in a space 3 ft wide by 11 feet long. Are we making any money?

Gross Returns - Two Year Average

Marketable Yields	Value per linear ft	Value per sq. ft of total bed	Marketable stems per plant
Muscari @ $7.00 per 20 stem bunch	$10.45	$3.49	3.3
Sweet peas @ $8.00 per 20 stem bunch	$27.27	$9.09	34.0
Hyacinth Bean @ $3.50 per 10 stem bunch	$39.22	$13.08	95.6
Total	$76.94	$25.66	
Gross returns per 11 ft trellis x 3 ft wide bed (33 sq. ft) or 1/8 of our productive tunnel space			$846.44

I always hesitate to put up potential returns for horticultural crops. Anyone who has worked in horticulture very long understands that there can be a big difference between gross returns and actual net profit. These figures are based on the assumption that all marketable stems would be sold at the price given. Prices are reasonable expectations and have been confirmed with other growers who do sell these crops; however, the price you will be able to receive may vary considerably. For example, in Lincoln Nebraska, the sweet peas sold for $4 a bunch, not the $8 that many growers receive for a bunch. $4/bu is the San Francisco Wholesale market price. Several growers report selling sweet peas at $8/bunch to the florist. The number of stems per bunch also varies. So everything you see regarding time or money in these high value crops, needs to be adjusted to reflect your specific experience and situation, remember the tight link between supply and demand, especially with perishable crops. This is a good example, though, of why many growers say they can pay for their high tunnels the first year from crop sales.

Thank you for your interest in this presentation and the research projects here at the University of Nebraska. If you have questions or comments, I can be contacted by e-mail to LHodges1@unl.edu.

Sources
Sweet Peas

Chatsworth	Thompson & Morgan
Charlie's Angel	Unwins
White Supreme	Thompson & Morgan
Mammoth Deep Rose	Germania Seed Co.
Mammoth Navy Blue	Germania Seed Co.
Anthea Turner	Thompson & Morgan
Winter Elegance White	Germania Seed Co.
Winter Elegance Deep Rose	Germania Seed Co.
Winter Elegance Lavender	Germania Seed Co.
Winter Elegance White Imp.	Germania Seed Co.
Cupani	Thompson & Morgan

Sources

Muscari armeniacum (Grape hyacinth)	Langeveld Bulb Co.
Dolichos lablab (Hyacinth bean)	Johnny's Selected Seeds
Beneficial Insects	Hydro-Gardens

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