The Vegetable and Small Fruit Gazette

Vol. 7, No. 4- April 2003

Horticulture Department
The Pennsylvania State University

In this Issue:

Tip for the Month: "The greatest service which can be rendered any country is to add a useful plant to its culture" - Thomas Jefferson

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Comments from the Editor

Bill Lamont, Department of Horticulture

With snow on the ground I am not sure that winter is over-maybe. The 2003 growing season is underway and we hope that it will be a favorable one and also a profitable one for farmers. I really appreciate the two excellent articles that Lee Young from the Washington County Extension Office developed for the April issue on **"The Pennsylvania Simply Sweet® Onion Moves Forward"** and **"Pest Management Considerations When Planting Vine Crops"** and I look forward to receiving George Perry's article that will appear in the May issue and also want to encourage my colleagues from other departments to contributed articles throughout the year. If you have an event that you would like to advertise, please send it to me. As always, the

Vegetable and Small Fruit Gazette Team encourages your feedback so that we can better serve your needs and address your concerns.

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Schedule for Agent Articles

Bill Lamont, Department of Horticulture

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The Pennsylvania Simply Sweet® Onion Moves Forward

Lee Young, Penn State Cooperative Extension, Washington County

Recent developments in the branded Pennsylvania Simply Sweet® Onion project have increased the awareness and interest of our state's vegetable growers in this unique opportunity. This article seeks to answer some of the frequently asked questions about this onion.

What is the Pennsylvania Simply Sweet® Onion? The Pennsylvania Simply Sweet® Onion is a branded onion, licensed through the Pennsylvania Vegetable Growers Association. This is a sweet Spanish-type onion that was originally tested at Penn State University and in Washington County from 1998-2001. Since then, it has been marketed locally as a branded onion in Washington County, Harrisburg and Philadelphia retail stores. The onion is produced in Pennsylvania under a set of production and grading standards that result in a very high quality,

large, sweet, non-pungent onion. It is marketed in August and September, during a period of low competition from other branded sweet onions grown in other states or other countries.

Who can grow, market and sell Pennsylvania Simply Sweet® Onions? Anyone in Pennsylvania can produce and sell sweet Spanish onions. However, in order to use the trademarked name "Pennsylvania Simply Sweet®" on or to describe their onions, growers and handlers must be licensed by the Pennsylvania Growers Association Simply Sweet Onion Committee. Growers and handlers can apply for a license, and if granted, must follow strict guidelines on production, grading, drying, and packaging the product. Onions sold under the Pennsylvania Simply Sweet® name must meet minimum soluble solids (sugars) and maximum pungency standards as established by the Simply Sweet Onion Committee. The deadline for license applications for 2003 is April 1.

What is the PVGA Simply Sweet Onion Committee? The Pennsylvania Vegetable Growers Association established the Simply Sweet Onion Committee in February, 2003, to develop onions as a major profitable crop for all qualified Pennsylvania growers. It is the committee's responsibility to make all decisions relative to the "Pennsylvania Simply Sweet®" onion trademark and its administration. The committee is currently made up of four growers, one handler, one PVGA representative, and one representative from Penn State University. The committee has met several times since its inception to develop a licensing agreement, a licensing application, and to work through the many other details involved in launching this new marketing and licensing program.

Is there a licensing fee? Growers or handlers who are granted a license in 2003 will be required to pay an annual fee to the PVGA Simply Sweet Onion Committee of $100 plus 20 cents per 40 lb. box of onions sold. In addition, growers will be required to pay for pungency and soluble solids tests on their onions, as well as pay to have a soil sulfur analysis performed. Part of the funds raised through the licensing fees will be used to enforce the proper use of the trademarked name, "Pennsylvania Simply Sweet®".

Where can I get more information? Questions concerning license applications and licensing agreements should be sent to the PVGA Simply Sweet Onion Committee, c/o Bill Troxell, PVGA, RR1 Box 947, Richfield, PA 17086. For general information and recommendations on growing sweet Spanish onions, see your local Cooperative Extension horticulture agent, or contact Dr. Mike Orzolek, Department of Horticulture, Penn State University, 814-863-2251.

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Sources of Colored Plastic Mulch

Michael Orzolek, Department of Horticulture

Use of plasticulture production systems for horticultural crops has increased dramatically in the last 5 years. One common question we receive from many growers is where can I purchase plastic mulch and what colors are available?? This is a current list of polyethylene manufactures and the colors they produce.

Clarke Ag Plastics - P.O. Box 238, Greenwood, VA 22943. Ph: 540/456-4578 Fx: 540/456-6403. Low density, highly reflective (metalized) silver/black or clear - smooth or embossed
Website: http://www.cstone.net/~agmulch/about.html

Climagro Mulch Film, 3235 Sartelon,St-Laurent,Quebec H4R 1E9. Toll free: (800) 561-8029
Fax: (514) 332-0406. PST Thermal green, white/silver on black and black. All films are embossed.
Website: http://www.climagro.com/

Integrated Packaging Americas, 3115 35th Avenue, Suite 201, Greeley, CO 80634. Phone: 970-339-5103. E-mail: kseese@ipstretch.com black, clear and silver.

Ken-Bar, Inc., 25 Walkers Brook Drive, Reading, MA 01867-0704 Toll free: 800/336-8882. All films are high density, embossed polyethylene. Black, silver/black, white/black, SRM-olive (IRT-Green), SRM red and black paper mulch. Website; http://www.ken-bar.com/

Mulch Film. Com - John Weiswasser. Phone: 610/909-7594. All colors are offered as embossed or taffeta films. Black, reflective white, IRT green, IRT brown, co-extruded white/black, blue, red, clear, co-extruded 20"black strip on Super Brite aluminum.
Website: http://www.mulchfilm.com/

Pliant Corp., 1515 Woodfield Rd. Suite 600, Schaumburg, IL 60173. Phone: 866/878-6188.
All films are embossed. Black, black/white. white, clear, blue, thermic olive, and olive green.
Website: http://www.pliantcorp.com/

Reflectek Foils Inc., 1075 Brush Hill Lane, Lake Zurich, IL 60047 Toll free: 888-439-6121. Metalized UV reflective - silver/black, silver/white, black and white. Both embossed and smooth film offered. Website: http://www.repelgro.com

Rochelle Plastic Film, P. O. Box 606, Rochelle, IL 61068. Phone: 815/562-7848. Offer either high density or low density embossed films. Black and IRT green.

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Diamondback Moth

Shelby Fleischer, Department of Entomology

The diamondback moth (DBM) tends to be the smallest of three lepidopteran larva that infest crucifer crops in Pennsylvania (the other two species are the imported cabbageworm, and the cabbage looper). On a per larva basis, the diamondback moth causes less damage than the other two species, however, populations can be high enough to cause severe damage.

DBM overwinters as an adult in warmer climates. It probably overwinters in most years in the warmest parts of Pennsylvania, but may not overwinter in the cooler parts. Adults are weak fliers, but populations are known to migrate long distances and annually reinvade areas well into Canada. Immigration also occurs as eggs or other life stages on transplants, including immigration of insecticide-resistant strains. Care should be taken to ensure clean transplants. Adults initiate activity at dusk, and continue well into the night. New adults, which emerge from pupa in the morning, mate as early as the evening of the first day of emergence. Adults feed only on water drops or dew and are short-lived (12 to 16 days). In side view, adult wing-tips turn upward; in top-view, there is a weak pattern of diamonds down the back. Egg-laying starts soon after mating, and lasts for abut 10 days. Eggs are laid before midnight. About 250-300 eggs are deposited per female. Eggs are flat ovals, laid singly or in small cluster, typically in concavities of leaf surfaces. Eggs hatch in 4-8 days. Larvae go through 4 instars: the range of days per instar is 3-7; 2-7; 2-8, and 2-10 for the 1st - 4th instar. Larvae wriggle, move backwards, and spin down silk threads when disturbed. Larva can also be recognized by a body that is tapered on both ends, and a pair of prolegs at the tail end that forms a distinctive 'V'-shape. Crop damage is caused by larval feeding. First instars mine leaf tissue, thereafter feeding occurs on the undersurface of the leaf, resulting in a windowpane from the remnants of the top leaf surface. The windowpane will dry, crack and fall out over time. Pupation lasts 5-15 days in a loose silk cocoon. Total development from egg to pupal stage ranges from 17-51 days, and averages 25-30 days.

DBM is a specialist on both cultivated and wild plants in the crucifer family, but does have preferences within this plant family. Cultivated areas hold the largest populations, but weedy mustards, yellow rocket, etc., can help maintain populations. The plant chemicals that are common in this plant family are used by DBM as movement arrestants, feeding stimulants, and egg-laying stimulants. Mustards and collards are preferred egg-laying sites and are sometimes used to concentrate populations, or to help bring populations into a test plot. It may be feasible to use these in a trap crop practice. Intercropping may influence host-seeking or egg-laying behavior. Some literature reviews suggest that intercropping tests have not been consistent; others suggest that crops like white mustard (*Brassica hirta*) or rape (*B. juncea*) can be quite trap crops - an example planting would be a band of trap crop every 15-20 rows of cabbage. DBM oviposited in the trap crop, and parasitism rates can be high in those crops. Host plant resistance occurs on glossy-leaf cabbages (cabbages without the waxy bloom, so leaves are green).

DBM is notable among our pests in just how much populations can suffer large amounts of mortality from natural enemies when those natural enemies are in the farmscape. Parasitoids have repeatedly been extremely important for keeping populations of this insect in check. In fact, DBM was not considered a pest until widespread use of broad spectrum insecticides were in use. This probably killed off the parasitoids, while the DBM developed pesticide resistance - and DBM is one of our best at developing insecticide resistance. Parasitoid populations may be influenced by intercropping or other methods of providing nectar resources in the farmscape. Adult parasitoids live longer when provisioned with nectar. The larval parasitoids appear to be the most important, particularly *Diadegma insulare*, although there are many larval parasitoid species. Egg parasitoids have been used in a repeated mass-release method.

Rainfall is a useful mortality factor. Rainfall, and sprinkler irrigation, kills young larvae. Drip or furrow-irrigated crops tend to have higher populations.

Row covers, when placed on the crop prior to immigration of any life stage, are an effective control.

The sex pheromone used by females to call in males is known and available commercially for monitoring. It is a good management practice to put several DBM pheromone traps in each field, to help you know when moths are flying. At a higher concentration and distribution, scientists are experimenting with the sex pheromone to disrupt mating, with some notable success in Japan and Florida. However, pheromone disruption tests are difficult to conduct, and may be difficult economical if you still have to spray for other pest species. Results from Florida show dramatic reduction in sprays for DBM (from ~13-15 sprays down to 3 sprays) when plots are greater than 16 acres in size. It is unclear what the results would be in areas that do not have the type of pressure to warrant large numbers of sprays.

In addition to monitoring with a pheromone-baited trap, monitoring for larva or feeding damage, and limiting sprays to when thresholds are exceeded, consistently reduces the amount of insecticide applications. Thresholds tend to be very low for seedling establishment, rise considerably while there is vigorous vegetative growth, and then are reduced again when the marketable part of the crop (e.g., broccoli florets, cupping stage of cabbage) is growing. Counting from 40-50 plants is needed to give a good estimate of larval density. In Texas, 0.3 larvae per plant (1 larva per 3 plants) are tolerated; in Florida the threshold is 1 feeding hole per plant. The Commercial Vegetable Production Guide suggests a threshold of 20% infest cabbage plants prior to heading, then drops the threshold to 5% when heads begin to form.

Recently, spray options have become much more selective. In addition to one newer carbamate (Avaunt), and one systemic organophosphate (several formulations of acephate), the 2003 Commercial Vegetable Production Guide recommends these newer, selective biorational materials for control of diamondback moth, including 3 microbial metabolites:

- SpinTor; or Entrust. Both use the same active ingredient. The Entrust formulation can be used on certified organic farms.
- *Bacillus thuringiensis* (Bt). The *kurstaki* strain was the standard for many years, but DBM developed resistance to Bt *kurstaki* in some parts of the world. The *aizaiwai* strain is designed to avoid this problem. Some formulations contain both strains. All Bt formulations meet organic certification. Higher rates may be needed.
- Proclaim, a semi-synthetic microbial metabolite.

It is possible that the newer formulations will be more compatible with the biological control that can be very effective at limiting the severity of DBM.

References:
Talekar, N. S. and A. M. Shelton. 1993. Biology, ecology and management of diamondback moth. Ann. Rev. Entomology v. 38. Available at www.nysaes.cornell.edu/ent/dbm/review.html

Capinera, J. L. 2001. Handbook of vegetable pests. Academic Press.

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Pest Management Considerations When Planting Vine Crops

Lee Young, Penn State Cooperative Extension, Washington County

Vine crops, including cucumbers, pumpkins, squash, melons and gourds, can be among the most profitable fresh market vegetable crops produced in Pennsylvania. This group of crops, however, is susceptible to a wide array of pests, including insects, diseases, weeds and wildlife, which can eat into profits in a serious way.

Some of the most important pest management decisions are made at planting time. Here is a checklist of pest management considerations to think about when planting vine crops.

Site Selection. Probably the most important pest management decision for vine crops lies in choosing the field. Many pest problems can be minimized or even avoided altogether by proper site selection. Choosing a site with minimal, or at least manageable, weed pressure, may save hours of hoeing and cultivating, and gallons of herbicide, later in the season. It is especially important to clean up perennial weeds such as yellow nutsedge, Canada thistle, and quack grass BEFORE planting vine crops, since these can be very difficult to control in the crop. If you are direct-seeding vine crops, you will minimize the risk of seed maggot damage by avoiding planting into a field with a lot of fresh organic matter (manure, crop or weed debris) mixed into the soil surface. Selecting fields with good water drainage, as well as good air movement, will help keep many root and foliar diseases at bay. If you are growing in an area of heavy deer populations, fencing may be necessary to keep your vine crop protected. Similarly, groundhogs

love vine many crops, and taking measures to control them along field edges at planting time can be more effective than waiting until they have established permanent residency in the pumpkin patch.

Rotation. Rotate vine crops with non-hosts of insect and disease pests. Following vine crops with more vine crops is only asking for trouble with diseases that are either soil-borne or carry over in crop debris through the winter. But be aware that other vegetable crops can carry diseases that attack vine crops as well. A dramatic example of this is the highly destructive Phytophthora disease of vine crops, which can cause damping off, foliar blight, root and crown rot, and fruit rots in squash, cucumber, and pumpkin. This disease also infects tomatoes, peppers and eggplants, so these crops are not good options for rotation with vine crops. Vine crops usually do well following either sweet corn or field corn, unless these crops have had high populations of corn rootworm. If so, problems with western corn rootworm adults, one of three cucumber beetles that feed on vine crops, may arise later in the season.

Variety and Seed Selection. Plant breeders have made great progress over the last decade in breeding disease resistance into the different vine crops. Take a close look at the descriptions of the varieties you are growing, and ask yourself if you could be improving your disease management by growing varieties with resistance to a broader array of pathogens, or to specific diseases that are common on your farm. Disease resistance is especially important in managing viral diseases, where few other control options exist. These viral diseases are often spread very quickly by aphids, but trying to control the spread of the virus by controlling the aphids with insecticides often is ineffective.

Always use high-quality, certified, disease-free seed when growing vine crops. Many of the foliar fungal diseases of vine crops can be transmitted by seed, and early infections can be devastating to a crop. Check the germination on the seed, as the more vigorous the seed and seedling, the less loss there will be due to damping-off and other seedling diseases. Commercial seeds will be treated with the appropriate fungicides and possibly also an insecticide to provide further protection to the growing seedling.

Weed Control. The use of plastic mulch, raised beds and trickle irrigation can go a long way toward controlling weeds in vine crops. If you are growing without plastic mulch, there are a number of pre-emerge herbicides that can be used for weed control. Curbit can be used pre-emerge on cucumbers, melons, squash and pumpkins for control of annual grasses and some broadleaf weeds, including carpetweed and pigweed. Curbit will not control lambsquarters, bindweed, ragweed or mustard. Command controls annual grasses and many broadleaf weeds such as lambsquarters and velvetleaf. Strategy, a jug mix of the active ingredients in Curbit and Command, is now available for vine crops. Alanap will provide fair to good control of pigweed and purslane, and fair control of galinsoga, lambsquarters and ragweed. Prefar will control annual grasses, and must be incorporated after application. A new herbicide, Sandea, is available this year through a 24(c) Special Local Needs label. Sandea can be applied pre-emerge in cantaloupe and cucumber, and post-emerge on those as well as on pumpkins and winter squash. Used pre-emerge, Sandea controls nutsedge, pigweed, lambsquarters,

mustards, ragweed, Pennsylvania smartweed, velvetleaf and galinsoga.

Insect Control. The most common early-season insect pests of vine crops in Pennsylvania are striped cucumber beetle. These insects are attracted to vine crops by "smell", and feed on the leaves, cotyledons and stems. If small plants are not protected, cucumber beetles can eat them right down to almost nothing. In situations of heavy infestation early in the season, stands can be decimated in a matter of several days. For small plantings of vine crops, floating row covers can provide sufficient protection from cucumber beetles. A number of foliar insecticides are labeled for beetle control, but growers must be vigilant about scouting their fields frequently during the early stages of crop growth. A systemic insecticide such as Admire, applied at planting or shortly after, will provide good control of cucumber beetles for a number of weeks, long enough to allow the crop to grow out of that early susceptible stage.

For more information on herbicide and insecticide labels and rates, see the sections on pumpkins and winter squash, cucumbers, summer squash, and melons in the 2003 Pennsylvania Commercial Vegetable Production Recommendations.

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High Tunnel Production of Tomato and Peppers

Michael Orzolek and William J. Lamont, Department of Horticulture

High tunnels are designed to reduce environmental extremes during the early spring and late fall growing season. The tunnels themselves are generally 14' to 30' in width (17' and 21' are the most common widths in commercial use) and 94' to 100' in length. While high tunnels are not greenhouses (no heat or automatic ventilation), the greenhouse principle is the basis for the function and design of a high tunnel. Metal bows approximately 1.5" to 1.75" in diameter are used as the support frame for the polyethylene covering. The bows are spaced 4' apart and are connected to metal posts that are driven 2 feet into the ground. The end walls generally have minimal framing and should be easily removed to facilitate ventilation and use of power tillage equipment. The high tunnel frame is covered with a 6-mil, high tunnel grade clear polyethylene film that is left on during the entire year. Snow removal from the top of the tunnels is only necessary during heavy snowfalls, especially wet snows. However, it is recommended that snow be removed from the sides of the tunnels as needed to reduce/eliminate outside water intrusion into the tunnel and collapse of the tunnel sidewalls. Taking the time to square and level the tunnel(s) site prior to construction will make subsequent steps much easier. Ventilation is accomplished by rolling up the sides of the tunnel to the batten boards, approximately 4.0 to 5.0 feet in height on each side of the tunnel. Once the tunnel is covered and ready for use, installation of plastic mulch and drip irrigation tubing can be accomplished using a small raised bed/mulch applicator available from Reddick Fumigants, Williamston, North Carolina, Nolt's Produce Supplies, Leola, Pennsylvania or Kennco Mfg., Ruskin, Florida. The use of black

polyethylene mulch on raised beds is not recommended when transplanting crops in mid-July to early September do to considerable heat buildup under the plastic and on the surface of the plastic. It is recommended that a high opaque white or metallized silver mulch which promotes cooler soil and surface temperatures be used during that time frame.

The keys to successful production in high tunnels for Horticultural crops are crop scheduling and ventilation. When planting crops in the spring in high tunnels, it is generally recommended that you transplant the vegetable crop about 2 weeks earlier compared to your earliest planting date in the field on bare ground. If unusually cold night temperatures are experienced several days to weeks after planting the vegetable crop in the high tunnel, a portable propane heater that burns cleanly can be placed in the high tunnel until more seasonal temperatures return to the location. The most critical component of the system is ventilation (high tunnels are placed in the field perpendicular to prevailing wind direction). Maintaining optimum growing conditions inside the high tunnel without having extreme fluctuations in temperature will guarantee early, high yielding and high quality horticultural crops. Checking high tunnel internal temperature several times a day will help insure crop yields and profitability.

Perhaps the most common application of high tunnels to vegetable production is the use of the structures to extend the cropping period for warm-season vegetable crops such as tomato, pepper, eggplant, cucumbers, and summer squash. Research conducted at the Penn State High Tunnel Research and Education Facility (PSHTR&EF), Rock Springs, has continued to demonstrate that warm-season crops can be successfully transplanted into high tunnels about 4-6 weeks ahead of field planted crops. In most regions of Pennsylvania, this means that growers can establish warm season high tunnel crops during April, rather than May. However, there is considerable variation in acceptable planting dates as a result of geographic location within the state. The inherent differences in regional micro-climate across Pennsylvania suggest that it is important that growers be conservative in setting out early plantings. Even if plants survive colder temperatures, certain physiological disorders can result from transplant stress that can significantly impact vegetable yield and quality. Two examples are "buttoning" in broccoli and cauliflower and "cat-facing" in tomato. Both of these physiological disorders result from temperature stress following transplanting. When selecting a transplant date, it is therefore important to bear in mind that survival does not necessarily equal success.

Select both tomato and pepper varieties that if possible have a determinant or compact growth habit since placing plants in high tunnels that are not well ventilated can be infected with powdery mildew. Smaller plants will enable greater air movement through the high tunnel; removing both heat and moisture (lowering relative humidity) from the tunnel. Both tomato and pepper plants are produced more efficiently on raised beds with plastic mulch and drip irrigation. Because of the width and height of high tunnels, a smaller, modified plastic mulch layer was designed (mentioned above) for use in high tunnels. These mulch layers will make a 3-4'' high bed, 18 inches wide from 36 inch wide plastic. The beds are spaced on 44-inch centers; thus a 17' wide high tunnel can

accommodate 4 beds while a 21' wide high tunnel can accommodate 5 beds. The drip tape is generally placed 2 inches deep and depending on crop being grown either placed in the center or one side of the bed. For tomato, the tape is placed on one side of the bed and a single row of tomato plants are established in the middle of the bed. For pepper, the tape is placed in the middle of the bed and two rows of pepper plants are established on either side of the drip irrigation tape approximately 12 inches apart.

For either tomato or pepper, a vigorous growing active transplant is placed in the holes in the plastic mulch on each bed. Before transplanting either tomato or pepper transplants into the plastic covered raised beds be sure that the soil in the bed is at 80% water holding capacity; if not, it is recommended that the drip irrigation system be run for 2 hours after transplanting. For tomato, the in-row-spacing would be 18 inches between plants and for peppers the spacing could be 18 to 24 inches in the row with 2 rows per bed. In terms of fertility, several materials are available for use in high tunnels; graded fertilizers, compost, or animal manures. The graded fertilizer (40 to 60% of actual crop needs) should be broadcast and then incorporated in the top 4 to 6 inches of soil before making the raised beds. Both compost and manures should be used judiciously applying only small amounts (about an 1.0 inch in depth) on the floor of the high tunnel. Any additional nutrients can be injected in the drip irrigation tape during the growing season depending on crop need as determined by tissue sampling at 2 to 4 week intervals.
After transplanting tomatoes, it is recommended that the plants be staked using the Florida weave system. Generally, the plants would be tied approximately three times during the growing cycle. It is also recommended that the plants be pruned at two different times prior to early fruit set. If the sides of the high tunnel are rolled up during flower development, the wind will act as a pollinator resulting in fruit set; no additional pollination methods will be required. Recommend scouting for pest problems within 7 days of transplanting the tomato plants, especially scouting for thrips, aphids and whiteflies. If populations of any of these insect pests exceed threshold levels, introduce appropriate predators at recommended rates. The only disease that has been a problem in high tunnel tomato production is powdery mildew. Use of resistant varieties or application of labeled fungicides will control mildew problems.

After transplanting peppers, it is recommended that stakes be placed on the shoulders on both sides of the raised bed at 8 feet intervals to help prevent pepper plants from lodging. Recommend scouting for pest problems within 7 days of transplanting the pepper plants, especially looking for thrips, aphids and whiteflies. If populations of any of these insect pests exceed threshold levels, introduce appropriate predators at recommended rates.

Tips For Successful Tomato And Pepper Production With High Tunnels

1. Use raised beds (3 4" high) when applying the plastic mulch to insure better water and nutrient management in the high tunnel.
2. When applying plastic mulch in the high tunnel, make sure soil is at least 85% of water-holding capacity.

3. Wait at least 2 to 3 days after laying plastic mulch in the high tunnel before transplanting pepper/tomato plants through the plastic to allow for increased soil temperatures.
4. Use actively growing, insect-free tomato and pepper transplants that are between and 5 to 7 weeks old for tomato and 6 and 10 weeks old for pepper.
5. After transplanting pepper/tomato plants through plastic mulch, monitor soil moisture level underneath the plastic mulch with a tensiometer or irrometer and maintain moisture level by use of drip irrigation system.
6. Monitor tomato/pepper plants for aphid, thrips and whitefly populations since they can rapidly reproduce and vector viruses to young pepper/tomato transplants and reduce total marketable fruit yield.
7. Remove row cover or low tunnel when female flowers appear on the crown set of pepper/tomato plants.
8. Fertigate with low levels of nitrogen (5 to 7 lbs/A) throughout the growing season.
9. Apply one pound per acre Boron pre-bloom stage either through the drip irrigation system or as a tank-mix with fungicide spray.

High Tunnel and Plasticulture related websites:
http://plasticulture.cas.psu.edu - The Penn State Center for Plasticulture
http://www.plasticulture.org - American Society for Plasticulture

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Bug vs. Bug - Managing Plant Diseases with Biofungicides

Cathy Thomas, Integrated Pest Management Program
Pennsylvania Department of Agriculture

There are beneficial insects for all of the major greenhouse pests including, aphids, caterpillars, fungus gnats, mealybugs, scales, shoreflies, spider mites, thrips and whiteflies. Using bumblebees for pollination is an effective alternative and can completely replace manual pollination. In addition to saving on labor, bumblebee pollination has many advantages. These advantages include: (1) bumblebees are active at low temperatures (41°F), windy and cloudy conditions, (2) effective in greenhouses, high tunnels and in open air, (3) bumble bee pollination results in higher yields and large, high quality fruit in crops such as tomatoes, peppers and strawberries. Bumblebee hives are shipped to growers in completely maintenance-free hives. The housing is made of solid, recyclable cardboard with a moisture resistant coating.

This a partial list of sources for distributors of biological pest controls and bumblebees.

Crop King, http://www.cropking.com
phone: (330) 769-2002 fax: (330) 769-2616

Green Spot, http://www.greenmethods.com
(603) 942-8925, FAX (603) 942-8932

Hydrogardens. http://www.hydro-gardens.com
(888) 693-0578, FAX (800) 694-6362

International Technology Services, http://www.bugsandbees.com
Ph. (800) 375-1684, FAX (303) 661-9543

IPM Laboratories, Inc. http://www.ipmlabs.com
Ph. (315) 497-2063, FAX (315) 497-3129

Koppert Biological Systems, http://www.koppert.nl
(800) 928-8827

An electronic database of suppliers of beneficial organisms with information on IPM may be accessed through the California Department of Pesticide Regulation homepage at http://www.cdpr.ca.gov/docs/ipminov/bensuppl.htm

Or request a written copy:
California Department of Pesticide Regulation
Environmental Monitoring and Pest Management Branch
1020 N. Street, Room 161
Sacramento, CA 95814-5604
(916) 445-4300

For another comprehensive listing of biocontrol suppliers and information visit this website: http://www.anbp.org. This is the site of The Association of Natural Biocontrol Producers (ANBP), a professional association representing the biological pest management industry. ANBP membership includes producers, distributors, and in addition, users of natural enemies and researchers.

Keep these points in mind when ordering and using biological controls and bumblebees.

- Most biocontrol distributors require that your order be placed by Wednesday or Thursday for shipment the following week.
- Beneficials and bumblebees are usually shipped overnight delivery to ensure healthy products. Check with your distributor for shipping charges to your area.
- The company you are working with should guarantee live, healthy products. Notify them immediately if you feel the quality is poor and you need replacement.

Consider these steps before initiating a biocontrol program. Managing pests with biological controls requires thought, careful planning and the realization that every crop cycle may prevent a unique situation.

- **Start Small** - As with any new technology, start small. Learn the system in one greenhouse and expand as you gain confidence and knowledge.
- **Pesticide Residues** - Discontinue using insecticides with residual activity at least one to two months prior to introducing beneficial insects and bumblebees. Pesticide residues

on plants, and greenhouse coverings can be deadly to biocontrol agents. Consult suppliers for information on specific products if you want to be certain about the compatibility of a compound that has been applied. These websites will provide specific information on the side effects of many compounds.
http://www.koppert.nl/e0110.shtml
http://www.biobest.be

- **Good Sanitation** - Weed management is critical to the success of a biocontrol program both before and during crop production. Weeds serve as reservoirs for pests and diseases and may upset the predator-prey balance you are trying to establish in the crop. It is also critical to maintain a weed free zone around the outside perimeter of the greenhouse for the same reason. Using a herbicide will have pests scrambling for another food supply, which will probably be your crop - remove weeds and destroy!
- **Clean Transplants** - In many cases, serious pest and disease problems that plague growers throughout the growing season result from the purchase of infested transplants. Selection of a reputable transplant grower ensures a quality transplant. Inspect what you are buying!
  If you are growing your own transplants, the area used for transplant production should follow strict sanitation procedures.
- **Pest Identification** - Accurately identify the pest you are trying to control with a natural enemy. Inform the biocontrol supplier of the pest species in your crop so they can recommend the most effective product for the pest and crop situation.
- **Start Early** - Begin introductions of biocontrol agents when pest populations are at low levels. This can be determined by weekly crop inspection. For example, high populations of pests such as whiteflies reduce the effectiveness of the natural enemy *Encarsia formosa* through honeydew secretions. The sticky honeydew will interfere with the parasitoid's walking and searching speed and may even cause them to become trapped and die.

Scouting Program

A weekly scouting program is essential for a successful IPM program. Early detection and treatment of pests is critical in high value greenhouse vegetable crops. Designate one employee (2 people for larger operations) who will be trained to monitor for pests and evaluate the effectiveness of the biocontrols. Only through crop monitoring can you determine if further introductions of biocontrols (or any other controls) are required.

- Use flagging tape to designate hot spots for biocontrol placement.
- Monitor at least 1% of the plant population in addition to plants at vents and doors.
- Record data weekly from sticky cards and plant inspection. Keep this data for future reference.

Use sticky cards as a guide, and do not depend on them to determine if the biocontrols are working. Counts may be misleading, especially in the warmer months when there is migration of pests, especially whiteflies, from outside. Yellow and blue sticky cards can be purchased through a greenhouse supply company and from many of the biocontrol distributors.

Cathy Thomas
Integrated Pest Management Program

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That's a Berry Good Question!!

Kathy Demchak, Department of Horticulture

Q. I'd like to buy an accurate thermometer for monitoring temperatures in my field during frost protection season. Are any available that are more accurate than typical store-bought thermometers, and affordable enough for field use by growers? (Ken Bupp, Penn-Vermont Farm, Bucks Co.)

A. I thought the answer would be easy. In fact, I thought once I found the right model, I'd just buy one myself. However, the conclusion that I came to was that I'd stay with my min-max thermometers, but make sure that I calibrated them. Here's a bit of a review of thermometer types and information to keep in mind when buying a thermometer.

First, don't confuse resolution with accuracy. Resolution tells you how fine the divisions are to which the thermometer can be read. Accuracy tells you how far off from correct the device could be. For example, a certain digital thermometer may give you a resolution of 0.1 degrees, but have an accuracy of + or - 2 degrees. So, you may think you're getting very correct results if you get a thermometer with fine resolution, but instead you may just be being very exact about being off by a couple of degrees! Accuracy is the important figure for knowing whether you're correct.
The liquid-in-glass thermometers, generally $20 or less, that you buy in a store, or from a grower supply catalog, can vary in their readings. However, they usually vary less than dial thermometers, and are a good value. Just be sure to calibrate them. Even most typical scientific liquid-in-glass lab thermometers, with accuracy traceable to NIST (National Institute of Standards and Technology) standards, are only accurate to + or - 1 degree C (+ or - 1.8 degrees F). You can calibrate them by immersing them in a water and crushed ice slurry, which you know will be at 32 degrees F. Be sure to allow enough time for the thermometer to equilibrate fully, even if need to keep adding ice to the mixture to keep the temperature at 32 F. Also, make sure that the thermometer is fully immersed, keeping in mind that the bulb is probably at the top of the thermometer, not at the bottom as with others. It can also be laid horizontally in the ice slurry.
Sometimes you'll see a notation that a thermometer is accurate to a certain percentage within its range. That means that if, for example, it's listed as accurate to within 0.5% in its range of -60 to 140 degrees, it would be accurate to within 0.5% of this 200 degree

range, or, to within plus or minus 1 degree of any temperature read between -60 and 140 degrees.

Thermocouple thermometers are generally capable of measuring a wide range of temperatures, and have a very good percentage accuracy, such as being within plus or minus 0.05% of the temperatures in their ranges. Normally this would be wonderful, but because they may be capable of reading ranges of hundreds of degrees, the accuracy in terms of degrees may not be much different than that of a liquid-in-glass thermometer. So, calibration in an ice-water bath is still needed before use, though they can be calibrated directly. The thermouple probes themselves are quite cheap, but by the time you also buy the device that produces the readable output, you'll likely spend around $200 or more.

Thermistor thermometers are probably the best option for accuracy, as they are designed to read a relatively narrow temperature range, and have a good % accuracy, so that there are models that will be accurate to within plus or minus 0.5 degrees F, costing between $60 and $100. Calibration is still recommended.

One last note - the number display on digital thermometers, regardless of what type they are, is not meant to withstand below freezing temperatures, so the display could 'black out' when you need it the most! So, you can't leave thermometers with digital displays in the field during frost events, and possibly not even on the truck seat all night. Thanks to technical support at Hanna Instruments, Inc. for a most enlightening discussion on this topic.

Got a question? Chances are that someone else has the same question, but isn't asking! Send your question to Kathy Demchak, at 102 Tyson Bldg., University Park, PA 16802, or via email to kdemchak@psu.edu. You will be credited with the question, or can remain anonymous, as you wish.

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PSU Small Fruit Web Site On-Line

Kathy Demchak, Department of Horticulture

A Web site containing Extension information for small fruit production is now available as part of PSU's Department of Horticulture site at http://hortweb.cas.psu.edu/extension/smallfruits. While it's not at 100% at this moment (for example, judging from this site, you'd think we have no idea how to spell the word "commercial"), we hope that it will be by the time that you have a chance to visit. You'll be able to link to publications that contain small fruit info from Penn State and surrounding states, and link to PA county Extension offices and many small fruit grower organizations. You'll also be able to get an update on PSU's small fruit research projects, and visit many valuable Web sites containing information on pesticide issues

and updates, and sustainable and organic practices. You can also visit other Penn State sites such as Ag Publications and the Agricultural Analytical Services Lab, and link to some of the best other small fruit Web sites from other Universities. Happy Surfing!

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Potato Musings

Bill Lamont, Department of Horticulture

Potato Seed Piece Size and Placement Affects Yield

Bill Lamont, Department of Horticulture

Given that we will be planting potatoes in the not so distant future, I thought it would be appropriate to re-visit this topic. When we plant we hope to have a good potato seedpiece that is spaced equally in the row and the proper distance between rows. If we miss getting things right-seed size and placement-it will negatively impact yield and quality of our crop.

A 100 percent stand of potatoes planted 12 inches apart in the row and in rows spaced 3 feet apart we would have 14,520 plants per acre. We routinely do this figuring with vegetable transplants. If set a yield goal of 320 cwt. per acre and every plant produced exactly the same amount (let just say that this is true for illustration), then each plant would contribute about 2.2 pounds to the total yield. If 10 percent of the plants were missing, you might then think that the yield would be reduced by 10 percent. However, this doesn't happen because plants on both sides of the missing one compensate by producing more yield because of less competition. Additionally, several successively missing plants may result in more yield reduction than an equal number of sporadically missing ones. Nonetheless, the bottom line is missing plants reduce yield. Thus, if you had a 100 percent stand in the field, applied sufficient fertilizer, maintained the correct amount of moisture, prevented any disease and insect problems from reducing your yield, then you would see what the potential maximum yield would be for a given variety at that spacing on that acre for that year.

Achieving as close to a 100 percent stand as possible begins before planting. You first need to obtain a uniform seed piece size profile. Evenly sized seed pieces will generally plant more uniformly. You cannot determine seed piece size profile by only knowing the average size. Two seed lots with the same average seed piece size could likely have considerably different seed size profiles. You should not only have an average seed piece size of 1.5 to 2.5 ounces, you should also have at least 72 percent of the seed pieces in the 1.5 to 2.5 ounce size categories.
The seed piece size profile is determined by individually weighing approximately 100 seed pieces and placing them in size categories of less than 1 ounce, 1.0-1.5 ounces, 1.5-2.0 ounces, 2.0-2.5 ounces, 2.5-3.0 ounces, 3.0-3.5 ounces, 3.5-4.0 ounces, and greater than 4.0 ounces. Calculate the percentage in each size range by dividing the number of seed pieces in each size category by the total number of seed pieces and

then multiplying by 100.

Just as missing plants can reduce yield, non-uniformly placed seed pieces may also cause a yield reduction. A significant factor contributing to missing or misplaced seed pieces is operating the planter too fast. Recognizing there is not single best planting speed for all planters, you will need to determine the best speed for your planter.

Evaluating seed piece placement accuracy will take some time to do correctly. You should uncover seed pieces in about 25 feet of row behind each planter unit, which allows you to measure the accuracy of the entire planter.

After exposing the seed pieces, measure the distance to the nearest inch from the center to center of each seed piece. Consider a seed piece accurately placed if it is within 3 inches of your desired spacing. For example, if you want a 12-inch spacing, then all seed pieces placed 9 to 15 inches would be accurately planted. After measuring the distance between each seed piece, record whether the space is too close, accurate, or too wide in comparison to your target spacing. Then calculate the percentage of spaces in each category.

For example, let's say you want an average seed piece spacing of 12 inches. You uncover 22 seed pieces in one row finding 3 spaces less than 9 inches (too close), 16 spaces at 9 to 15 (accurate), and 2 spaces more than 15 inches (too wide). Note that you are accounting for the spaces between the seed pieces rather than the seed pieces themselves so you are measuring 21spaces-one less than the number of seed pieces uncovered. Your seed piece placement accuracy is 16 divided by 21 x 100 = 76 percent. This would be done for every row.
You should also calculate your average seed piece spacing. You may be surprised to find the average seed piece spacing is not what you intended. Determine average seed piece spacing by measuring the total distance between the first and last seed piece in each row and dividing by the number of spaces. In our example, let's say the distance between the first and last of the 22 seed pieces uncovered was 276 inches. The average seed piece spacing for that one row would be 276 divided 21 = 13.1. In our example, the desired spacing was 12 inches so the spacing is too wide. To get an overall average, add the total distances for all rows and divide by the total number of spaces.

Planting a potato crop correctly will most likely result in high yields, and additionally, a uniformly planted crop will likely improve tuber size and quality at harvest.

Source: Taken from Bill Bohl, Extension Educator from Idaho's newsletter.

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Upcoming Meetings

Bill Lamont, Department of Horticulture

Local

May 16, 2003. High Tunnel Workshop from 9 AM to 4 PM at the Penn State High Tunnel Research and Education Facility, Horticulture Farm, Rock Springs, PA. Registration is $15 and will include a light lunch. For further information and program content contact: Lisa White (814) 692-4635 or e-mail ldw112@psu.edu.

Regional

National

August 16-19, 2003. 31st American Society for Plasticulture Congress. The Crown Plaza, Grand Rapids, MI. Contact: Pat Heuser (814) 238-7045 or http://www.plasticulture.org

International

World Potato Conference. Kunming, China. See www.potatocongress.org

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