S3M2 Vegetable Notes Articles on Winter Production and Storage

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WINTER SPROUTING BROCCOLI: A CROP TO CONSIDER?

In England, sprouting broccoli is a traditional heirloom crop that has shown a recent rise in popularity. The crop is sometimes referred to as 'asparagus broccoli', due to the tender long sweet shoots produced in very early spring. Sprouting broccoli is unlike the broccoli typically grown in the U.S. because it produces many small shoots, rather than a single head. In addition, many varieties require a cold treatment, or vernalization, before making sprouts. In England, sprouting broccoli is planted in late summer, and plants grow very slowly during the fall and winter months. When temperatures start climbing in February, they start to grow again and produce prolific amounts of small purple or white florets on long bright green leafy stems. The shoots are harvested from March to May, when other fresh local vegetables are in short supply and high demand. Unlike broccoli rabe or apini, the shoots are mild-flavored, even sweeter than typical broccoli.

Growing in High Tunnels

New England winters are more severe than those in England. However, to cope with a short growing season, many farmers and gardeners have already created warmer climate zones by constructing low-cost, unheated greenhouses (called high tunnels) or cold frames. We have shown in Durham, NH that sprouting broccoli can survive the winter in high tunnels to produce early spring crops. In New England, many high tunnels are used to produce tomato crops during the summer growing season. Winter sprouting broccoli can be used to provide a source of income from these tunnels when they would otherwise be unoccupied and when little other local produce is available. It would also serve as a rotation crop that could help reduce soil-borne diseases in the next tomato crop.

Varieties, Availability & Yields

Most sprouting broccoli varieties are purple, but some are green or white, like cauliflower. Currently, seeds of these varieties are available from only a handful of companies (High Mowing Seeds, Thompson & Morgan, Bountiful Gardens, and Territorial). In three years of experiments with different varieties, we have had yields in the range of 0.25 lbs of sprouts per plant. It appears that the white-sprouted varieties, in general, have higher yields than the purple varieties.

Yields

In our 30'x60' tunnel, we harvested 136 lbs of sprouts over the entire season in 2008. However, our experimental layout did not use space efficiently. At our spacing (2.25 sq.ft. per plant), a 30x60 tunnel could house 800 plants, yielding over 200 pounds. Higher yields may be possible with optimum spacing and timing.

Marketing

This crop will not be familiar to consumers, and it will require education about the crop and how to prepare it. It can be used in any way that broccoli or asparagus is used. It may be helpful to refer to it as 'asparagus broccoli' or another creative name for marketing purposes. In our experience, trial consumers and chefs have been ecstatic about the crop once it is introduced to them and they then seek it out. Restaurants or specialty markets may be the best market for the crop since the harvest season is before most farm stands and markets open for the season.

Production Information

From 2007-2010, we grew several varieties of winter sprouting broccoli in unheated tunnels in Durham, NH. Important step: Inside the tunnels, plants were covered with an additional layer of 1.25 oz spunbonded polyester rowcover during the coldest part of the winter (late Nov-early Mar). After establishment, the plants were not watered, fertilized, or otherwise managed during the winter. Winter temperatures were below 0F for several days; in 2009 the crop survived a low temperature of -18F.

Fertility

Compost and aged manure was added at a rate corresponding to approximately 50 lbs N/acre prior to planting. Spring sidedressing may be beneficial for later varieties.

Planting date

Based on our results, seeding from late Aug-early Sept and transplanting in late Sept-early Oct appears best in terms of plant survival and yield. Plants that are either too small or too large when winter arrives and temperature plummet are less likely to survive.

Spacing

We used raised beds with 3' between row-centers. Plants were planted in staggered double rows, with 9" between each plant in a row. This corresponded to 2.25 square feet per plant. More trials are needed to determine the optimum spacing.

Harvest period

In early March, it is important to remove rowcovers from covered plants to prevent over-heating and to let light in as the plants start to grow. The earliest varieties can be harvested in early March and the latest varieties will go until late April-early May, depending upon the spring weather patterns. For most varieties, harvests last for 1-3 weeks.

Pests
Because the crop is grown outside the main production season, common Brassica pests (cabbage loopers, imported cabbageworm, etc.) are not present during harvest. In 2007, our plants became infested with aphids during harvest (March-April). Despite heavy infestation, aphids remained on lower leaves and did not affect the sprouts. We managed the aphids by removing the heavily infested outer leaves and introducing ladybugs (Hippodamina convergens) to reduce aphid populations. With additional questions about this crop and/or our results, please contact

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ONIONS: HARVEST AND CURING TIPS FOR BEST QUALITY

As onions mature, their dry matter content and pungency increase, with a resulting increase in storage potential. Onions are ready for harvest when at least half the leaves are dead. Tops are beginning to fall in many fields. Pull the bulbs by hand or use equipment such as a potato digger or undercutter to cut the roots and lift the bulbs. If you wait until all the leaves are dead and dry, it's likely that the outer skins will be loose rather than firm, which may not hurt the keeping quality but the onions will not look as nice. However, pulling too green will make it difficult to cure them well. Harvest when the weather is dry; harvesting after a rainfall or when the increases susceptibility to post-harvest disease.

For optimum storage quality, onions must be cured soon after harvest. Optimum conditions are 68-86°F and 70% relative humidity for at least 12 to 24 h. Curing decreases the incidence of neck rot, reduces water loss during storage, prevents microbial infection, and is desirable for development of good scale color. Curing can be done in the field, preferably when the weather is warm and dry. If it rains, let them dry fully before handling – don't handle the bulbs when they are wet. A greenhouse or hoophouse also provides good conditions for curing. Temperatures in the 80's will enhance the bronze color in the skins. Sunshine is good as long as it is not too hot. Extremely hot sun with temperatures in the 90's can produce sunscald. Onions curing on a sandy soil will get hot quicker than those lying on a heavier soil. In a greenhouse, temperatures should be held below 85 degrees F, which will probably require leaving everything wide open. Using a black shade curtain over the house can help. Curing is complete when the neck is completely dry and tight. If the neck remains open it allows entry of pathogens such as Botrytis neck rot.

The next step is topping. Mechanical onion toppers are essential for larger plantings, and for the needs of a small diversified farm they are probably best obtained second-hand. Check your favorite used equipment dealers! Onions can also be topped by hand using clippers. Handle gently to avoid bruising. Defective onions (i.e. sprouted, insect damaged, sunscalded, green, bruised) should be discarded. Grade for size according to your markets.

To ensure maximum storage, onions must be promptly stored after curing. Get them out of the sun; exposure to light after curing will induce greening of the outer scales. The optimum temperature for long-term storage of onions is 32°F with 65-70% relative humidity, but it is important to bring them down to this temperature slowly. In fact, holding onions in a barn or garage so that they cool along with the average outdoor temperature in late summer and fall works quite well. Avoid cooling bulbs to well below the average daily temperature, because they will draw moisture from the warmer air, which can lead to disease. If you are selling them within a couple of months, keeping them in an un-insulated barn is fine. To hold longer, an insulated storage room will be needed.

Harvest Tips for Best Quality

1) Be sure onions are well dried and necks tight (i.e. the tissue does not slide when you roll your neck between your fingers) before topping. Bacterial diseases and Botrytis Neck rot can move through green tissue into the bulbs. These diseases do not move in dry tissue.
2) Leave 2-3 inches of neck on the bulb. This increases the distance from the cut surface to the bulb for these pathogens to travel.
3) Minimize mechanical injury during harvest & topping. Reduce drops to 6" and pad sharp surfaces. Bruises provide direct entry points for diseases to get started.
4) Grade out damaged onions before putting them into storage. Damaged bulbs give off moisture, which is favorable for development of diseases in storage.

- John Howell, Andrew Cavanagh, & Ruth Hazzard. Resources: CSU Extension and the University of Saskatchewan.

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POSTHARVEST PRACTICES IN PRODUCE PRODUCTION

Harvested produce continues to be physiologically active but no longer has the whole plant to support the activities of metabolism, moisture uptake, temperature control, etc. To be successful in the marketplace, it is critical to preserve as much of the fresh value of the product as possible. That is the purpose of exercising proper postharvest preservation practices. One of the conditions that occurs quickly after harvest that accelerates change in quality is the build-up of heat in the produce. This is a natural result of the process of respiration in the plant. Accelerating physiological processes consume sugar, reducing product quality, and generating more heat. As heat builds up, more respiration occurs, stimulating more generation of heat. If that cycle of heat-build-up can be arrested, the preservation of quality in the harvested product becomes much easier. Cooling the produce is the answer.

Many growers concerned about the cost of post-harvest technology take advantage of nature and the opportunities it provides to minimize the challenge of preserving produce quality. One way they can do this is to harvest when the produce is naturally coolest. This occurs just before sunrise. Assembling harvest crews early to be ready just as morning light becomes adequate accomplishes a couple of worthy goals. The product is cool at harvest, and the harvest crew is enjoying work under better conditions than later in the day. The longer produce sits in distribution channels, however, the more likely a grower needs to use more energy-intensive systems for preserving quality. Growers can benefit enormously from studying postharvest issues and capitalizing on tools for postharvest preservation. This is a key to developing a reputation for quality. An excellent resource for growers to learn more about postharvest technology is a publication from the University of California at Davis: Small Scale Postharvest Handling Practices: A Manual for Horticultural Crops, available online at http://ucce.ucdavis.edu/files/datastore/234-1450.pdf .

- *Bill Shoemaker, Purdue; reprinted from August 11, 2010 PestMinder Volume 17, Issue 15*

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PUMPKIN AND WINTER SQUASH HARVEST AND STORAGE

Winter squash and pumpkin fruit sitting in the field face a daunting list of diseases and insects – not to mention possible passing hurricanes -- that could threaten fruit quality. Early harvest and careful storage is often preferable to leaving fruit in the field. This is especially true if you know that your pumpkins or squash are in fields that are infected with Phytophthora blight.

Since the pumpkin market lasts from Labor Day to Halloween, pumpkins may need to be held for several weeks before they can be marketed. When is it best to bring then in, and when to leave them in the field? If the vines are in good condition, the foliage can protect the fruit from sunscald. If foliage is going down from powdery mildew or downy mildew, this may help with ripening and make harvesting easier, but also increases the risk of sunscald or injury to pumpkin handles. There can be extra work involved in bringing fruit in early, especially for growers who normally have pick-your-own harvest, but we recommend that growers harvest as soon as crops are mature and store under proper conditions, if it is feasible. Attention to curing and handling will go a long way toward improving the life of winter squash and pumpkin fruit. If you need to hold fruit in the field for pick your own or any other reason, using a protectant fungicide (eg chlorothalonil) can help protect from black rot, powdery mildew and some of the other fruit rots.

What about pumpkin stems, ie, handles? In some cases, it's the handle that sells the pumpkin. Pumpkins may not be marketable if the handle is broken off or dried up. Ideally, if the timing is right, pumpkins would be cut one to two weeks prior to marketing. However, if they are harvested now they may sit much longer before being sold. The discussion of how early to cut handles is an old one with many different opinions. One view is that it is advisable to cut the handles from the vine to save them from advancing powdery mildew and reduce shrinkage. Whether or not handles shrink and shrivel after cutting is affected by plant stress, genetics (variety), moisture and temperature conditions, and disease. There are many diseases that can affect handles, including Plectosporium, Fusarium, Black Rot, and Alternaria. Again, proper curing and storage conditions are key.

Ideally, pumpkins should be harvested when fully mature, with a deep orange color and hardened rind. However, as long as pumpkins have started to turn color, they will ripen off the vine if held under the proper conditions. While not ideal, this may be preferable to leaving them in the field if conditions are not favorable. If necessary, pumpkins can be ripened in a well-ventilated barn or greenhouse. The best temperatures for ripening are 80-85 degrees Fahrenheit with a relative humidity of 80-85%. Night temperatures should not drop below the sixties. Even if pumpkins are ripe, a period of curing can improve storage life. The curing period should be about 10 days. During this process, the fruit skin hardens, wounds heal and immature fruit ripens – all of which prolongs the storage life.

Pumpkins should be stored in a cool, dry place. Ideal temperatures are between 50° and 60° F and relative humidity of 50 - 70%. Higher humidity allows condensation on the fruit with risk of disease, and lower humidity can cause dehydration. Higher temperatures increase respiration and can cause weight loss. Temperatures lower than 50 F cause chilling injury (see squash, below). In a greenhouse, temperature can be managed with ventilation on sunny days. Unless it is quite cool, heat is not likely to be needed if the house is closed up at night.

Often it is not feasible to harvest pumpkins early and store them until they can be marketed, and so they must be 'stored' in the field. If vines and fruit are healthy, storage in the field can be successful for a few weeks. If the vines die back, damage to the fruit from sun, disease and insects is more likely. In any case, it is important to scout for insects feeding on the fruit and handles, which may include squash bug nymphs or adults, or striped cucumber beetle. Control them if damage is evident. In fields that have a history of Phytophthora blight, Fusarium fruit rot, or black rot, field storage may increase the incidence of these problems, particularly if we have a period of wet weather or a major storm while fruit is sitting in the field. This has been one of the causes of significant losses in recent years, and one reason that we recommend bringing fruit in as soon as it is mature.

Growers often plan to store winter squash for much longer than eight weeks. Fruit that are free from disease and haven't been subject to much chilling (below 50°F) should be selected for long-term storage. Fruit from fields where Phythophthora is present are not the best choice for storage.

Storage life depends on the condition of the crop when it comes in and your ability to provide careful handling and a proper storage environment. All fruit placed in storage should be free of disease, decay, insects, and unhealed wounds. When harvesting squash and pumpkins, it is important to handle the fruit with care to avoid bruising or cutting the skin. Despite its tough appearance, squash and pumpkin fruit are easily damaged. The rind is the fruit's only source of protection. Once that rind is bruised or punctured, decay organisms will invade and quickly break it down. Place fruit gently in containers and move bins on pallets. Use gloves to protect both the fruit and the workers. Removal of the stem from squash (butternut, Hubbard, etc.) will also decrease the amount of fruit spoilage because the stems frequently puncture adjacent fruit, facilitating infection.

A period of curing after harvest can help extend storage life of squash. This may be done in windrows in the field -- especially with a series of warm, dry days -- or by placing squash in a warm dry atmosphere (70-80°F) with good air circulation, such as a greenhouse, for up to two weeks. This pre-storage treatment permits rapid drying of the outer cell layers, and when combined with a dry atmosphere for storage inhibits infections that can take place at this time. Any clean cuts during harvest a likely to heal over and are no longer a source for injury or infection.

Take care to avoid subjecting squash to chilling injury. Chilling hours accumulate when squash or pumpkin is exposed to temperatures below 50°F in the field or in storage. Injury increases as temperature decreases and/or length of chilling time increases. Chilling injury is of particular concern with squash intended for storage because it increases the likelihood of breakdown. If squash has been exposed t chilling injury it should be marketed first and not selected for long-term storage. Remove squash from the field if temperatures likely to drop below fifty degrees for any length of time.

After curing, move squash or pumpkins to a dry, well-ventilated storage area. Pressure bruises can also reduce storage life, so avoid rough handling, tight packing, or piling fruit too high. Fruit temperature should be kept as close to the temperature of the air as possible to avoid condensation, which can lead to rot. Ideally, the storage environment should be kept at 55-60°F with a relative humidity of 50-70%. Lower relative humidity increases water loss, resulting in reduced weight, and if excessive, shriveling of fruit. High relative humidity provides a favorable environment for fungal and bacterial decay organisms. Under ideal conditions, disease-free pumpkins should have a storage life of 8-12 weeks and butternut squash up to three or four months. Even if it is difficult to provide the ideal conditions, storage in a shady, dry location, with fruit off the ground or the floor, is preferable to leaving fruit out in the field.

As you plan for storage and marketing, keep in mind that the market for pumpkins seems to get earlier every year. Fall decorative displays include pumpkins, and those displays begin showing up as Labor Day approaches. One of the best solutions to early-maturing pumpkins may be finding an early market.

--R. Hazzard; many thanks to the following sources: J. Howell, A. Carter, and Robert Wick. University of Massachusetts; Dale Riggs & Robert Rouse, Pumpkin Production Guide, NRAES; Maurice Ogutu, University of Illinois Extension, in Vegetable Growers News, August 2004; and Liz Maynard, Purdue University; Andy Wyendandt, Rutgers Univ.

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BRASSICAS: FALL INSECTS AND DISEASES

Many growers expand their Brassica production for fall, as these crops do especially well at cooler temperatures and the harvest season can easily be extended through October or later. These crops get their start during the high temperatures and high humidity of August, then face cooler periods of high humidity and long leaf wetness as fall comes on. These conditions can result in significant disease pressure from August through harvest.

This article is the second in a two part series designed to give an overview of the diseases and insects that affect fall Brassica crops.

DISEASES

Alternaria Leaf Spot (ALS) is encouraged by heavy dews that kept leaves wet for long periods. At least three species of Alternaria can cause serious losses in Brassica crops. Alternaria occurs on many Brassica crops, including Brassica oleracea types (eg broccoli, cabbage, collard) and Brassica rapa types (eg, bok choi, tatsoi, komatsuna). These pathogens may be seed-borne, both as spores on the seed surface and as mycelium within the seed. However, the major source of inoculum is crop debris in soil.

Symptoms of ALS are circular, small, dark spots with concentric rings (target spots) on the upper surface of leaf. Older leaves are more susceptible to infection. When humidity is high, lesions can be covered with a sooty black mass of spores. The pathogen sporulates abundantly on foliar lesions and centers may fall out to give a 'shot-hole' appearance. Lesions can grow together leading to large necrotic areas and early leaf drop. Symptoms on cauliflower and broccoli heads begin as browning at the margins of individual flowers. ALS requires leaf wetness for 16 hours to initiate infection and at least 12 hours of continuous humidity at >90% RH to develop. Note that if ALS does not have the required amount of leaf wetness, it will appear as tiny black "sooty" dots (not as the characteristic target-spot lesions). These often appear on the undersides of leaves and can be taken as an early sign of the presence of spores and the need for protective fungicides.

ALS can cause economical loss in storage if infection spreads into the upper frame leaves or head due to additional trim loss, the production of ethylene, and invasion by secondary fungi and bacteria.

Cultural practices: Because inoculum carries over in crop residue, crop debris should be destroyed as soon as possible after harvest and a minimum 3- year rotation out of Brassicas should be used. For rotation to be effective, Brassica weeds need to be controlled during the rotational period. Buy seed from a reputable source or treat with hot water to eliminate Alternaria from seed. Eliminate cull piles. Avoid overhead irrigation during head development.

For current chemical recommendations, see the New England Vegetable Management Guide – available online at www.nevegetable.org.

Bacterial Black Rot of Brassicas, caused by *Xanthomonas campestris pv. campestris* is one of the most devastating diseases of Brassica crops and can result in high losses of yield and quality. It occurs worldwide and infects all species of Brassica. In recent years, we have observed black rot to be especially common in Brussels sprouts.

Symptoms can appear at any growth stage as yellow, V-shaped lesions that extend toward the base of the leaf resulting in wilt and necrosis. It can also occur mid-leaf, as darkened dead patches of tissue between the veins. The pathogen may move into the petiole and spread up the stem or into the roots and become systemic. As the disease progresses, the veins of infected tissues turn black and the normal flow of water and nutrients is impeded. Symptoms on root crops may not be visible on foliage, but blackened veins appear in the roots. On heading crops, infection may spread into the leaves of the head. Black Rot is often followed by invasion of soft-rotting organisms.

The bacterium that causes black rot plugs the water-conducting tissue of the plant with xanthan, a mucilaginous sugar. The most important means of transmission for this pathogen is on seed and as little as 0.03% infection can cause epidemics. The bacteria can persist in infected plant debris for up to two years, especially in cabbage and Brussels sprout debris; it survives in the soil for 40-60 days. It is favored by warm temperatures and symptoms may not appear in the seedbed, allowing infected plants to be transplanted into the field. It is spread within the field by splashing water, wind, equipment, people, and insects. *X. campestris pv. campestris* can be spread long distances by infested seeds and transplants.

Cultural practices:

- Practice a three year rotation and control Brassica weeds during the rotation period.
- Select seed that has been certified as disease-free.

• Treat seed with hot water to eradicate the bacteria. Soak seed for 15- 30 minutes at 122˚ F (50˚ C), dry, and test for germination. Use an accurate lab thermometer. This process must be done carefully and it is recommended that a small sample of seed be tested for the effect on germination first.

- For greenhouse-grown transplants, use clean, sterilized seed flats and trays.
- For outdoor seedbeds, locate seedbeds where Brassica crops have not been grown for 4 years and avoid areas that receive run-off from areas previously planted to Brassicas. If this is not possible, fumigate or steam sterilizes soil in seedbeds.
- Avoid dense seeding rates which can prolong periods of leaf infection and favor pathogen spread.
- Monitor transplants and promptly remove and destroy infected seedlings.
- Do not trim seedlings as the bacteria are easily spread by contaminated tools.
- Do not work fields when they are wet.
- Use trickle irrigation instead of overhead, where possible.
- Avoid disposal of infected plant material in the field, or near fields or storage areas.
- Promptly incorporate crop residues after harvest to speed decomposition.

Powdery mildew of Brassicas. This disease is unusual in the US, but is reported to occur regularly in England and southern Ontario, among other locations, especially on rutabagas and turnips. Brussels sprouts, kale, Chinese cabbage, collards, broccoli, mustard and cauliflower are also reported to be hosts. The disease is rare in New England, but it does occur. Just as you would expect, the symptoms are white talcum-like growth on the upper leaf surface, starting as circular patches and expanding to cover the leaf. Leaves become pale green to yellow or tan, or if severely infected, curl and die. The plant is rarely killed, but growth can be stunted or defoliated, and of course if the leaves are sold the disease would render them unmarketable. Note that this is a different species of powdery mildew than those that infect cucurbits, or tomato, or various ornamental crops.

Conditions that favor this disease seem to be low relative humidity with cool temperatures, water stress of the crop, and the availability of a thin film of moisture in which spores can germinate. The white powdery growth includes mycelium and spores (conidia), which can be dispersed quite long distances by wind.

Spores overwinter “with difficulty”; however, survival of the fungus is better when the host plant material lives through the winter because this enables the fungus to produce new spores in the spring. It seems possible that we may see this disease more often if we start to have consistently milder winters which allow the survival of Brassicas, and because growers are overwintering Brassica plants through protection with row covers and high tunnels. If you see powdery mildew on your Brassicas in fall, don’t overwinter those plants!

Fungicides which are labeled for fungal diseases of Brassicas, especially those which also work against powdery mildew in other crops, should provide control of the disease. Apply at first indication of disease.

Cultural practices: Put crop residue under as soon as possible after harvest, control Brassica weeds which could also harbor the disease.

Downy mildew of Brassicas. This disease, caused by the fungus *Peronospora parasitca*, should not be confused with downy mildew of cucurbits (caused by *Pseudoperonosproa cubensis*), which is related but does not infect Brassica crops. Downy mildews tend to be specific to a certain plant family or even species within a plant family. They are in the same group of fungi (Oomycetes or ‘water molds’) that cause late blight of potato and tomato and blue mold of tobacco.

Downy mildew is an important disease of broccoli, collards, kale, cabbage, cauliflower and Brussels sprouts. It can also infect rutabaga, turnip and radish. It is encouraged by cool, moist conditions (from rain, heavy dew or fog), which are more typical in late August, September and October in our region. Infection can occur at any stage of growth. Severe infections can kill seedlings, but stem, leaf and flower/head infections can cause crop injury and loss at later stages.

The most distinctive symptom is grayish white, fluffy growth on the undersides of leaves. Irregular, angular yellow to brown spots develop on both top and bottom of the leaf. In the floral parts of broccoli or cauliflower, dark brown areas develop internally in curds or floral buds of the head. Stems and stalks of the flower head may be darkened or have black streaks, and this may be the first sign of infection in broccoli. In cabbage, internal darkening and purplish spots appear in the inner layers of the head or move upward in the head from stem infections. Secondary infection with soft rot bacteria (always smelly!) may follow the downy mildew. In cabbage, systemic invasion of the stem may occur after infection of the lower leaves. The fungus may then invade the head leaves and sporulate after the cabbage has been stored.

The fungus survives from season to season as thick-walled resting spores, called Oospores. These sexual spores can survive in the soil for extended periods and produce sporangia when conditions are moist and cool, especially at night. Disease development is favored by abundant moisture on leaves provided by dew, drizzling rain, or heavy fog. Sporulation, germination, and reinfection can occur in four to five days. The fungus may also survive in a latent state within systemically infected plants. Oospores and mycelium can be carried in and upon seed. Sporangia are carried on air currents and on wind-blown rain and when conditions are right, will germinate on leaves and produce new infections.

Cultural controls for downy mildew: Rotation out of Brassicas for at least two years; removal of crop residues which contain Oospores (may not be practical!); adequate crop spacing to encourage drying of leaves. Control in the seed-bed is very important and includes the use of clean growing medium, good drainage, and an avoidance of overhead irrigation. Resistant or tolerant varieties of broccoli have been developed; our sources list Marathon and Arcadia among these.

For current fungicide recommendations, please see the New England Vegetable Management Guide. Preventive spraying of protectant foliar fungicides may be necessary if environmental conditions favor disease development.

Blackleg, or Phoma leaf spot and stem canker, caused by *Phoma lingam*. Blackleg attacks many Brassica crops, especially cauliflower, broccoli, and turnip. Rutabaga, radish, and mustard cultivars are only slightly susceptible. This disease can spread rapidly within a field. Though it is favored by wet conditions, it may spread on seedlings in the greenhouse and cause problems even in dry, sandy fields.

Plants can become infected at the seedling stage or at any stage in the field. The initial source is probably infected seed. The disease has become less important in Brassica crops because of successful disease management strategies in seed production. Once present on the farm, management should focus on avoiding spread of the disease, and rotating out of the infected field for four years to eliminate the inoculum. Rogue diseased plants from seedbeds. Improve soil drainage and air circulation. Control Brassica weeds. Incorporate crop debris promptly after harvest to hasten decay. Avoid working in the fields when wet.

Symptoms of the pathogen start as slight lesions on stems at cotyledon stage which elongate, turn brown with a black to purplish border, and become sunken. The lesion extends up and down the stem, the stem becomes girdled and blackened, with many fruiting bodies (pycnidia) embedded in the tissue. Lesions may extend below the soil and attack roots. Diseased plants often wilt, lodge, and die. On root crops, symptoms occur in the form of cankers on the fleshy roots and a dry rot may appear in storage. *Phoma lingam* can survive for up to four years in seed and three years in infected crop debris. The pathogen infects seedlings, forms pycnidia, and produces abundant amounts of spores which exude from the pycnidia in long coils and are splashed to nearby plants to initiate new infections. The disease is favored by wet, rainy weather. Start with seed certified as disease-free or treat seeds with hot water.

Chemical recommendations: For organic growers: potassium bicarbonate (Armicarb 100): 2.5 to 5.0 lb/100 gal (0 dh, REI 4h). Start application at the first sign of disease and continue at 7-14 day intervals while conditions remain favorable for disease development.

Non-pathogenic disorders of broccoli: brown bead, heat injury, and hollow stem of Broccoli. Each of these disorders can be caused by a combination of factors – heat stress during head initiation, excessive water especially after a dry period, excessive nitrogen, rapid growth during head formation, deficiency of boron, and cultivar susceptibility. Heat injury is most often manifest as unevenness of the crown and uneven bud size on the head, as well as small head size. Brown bead appears as heads approach maturity and is usually associated with rapid growth during periods of high temperature followed by abundant rainfall. Floral buds turn tan or brown and become easily detached. These may then become infected with soft rot bacteria. Boron deficiency, which shows up as hollow stem of broccoli or cauliflower, brown discoloration of turnip or rutabaga roots, or internal discoloration of cauliflower, can be more severe if plants are water stressed or pH is greater than seven. Adequate supplies of soil organic matter, consistent and adequate water levels in the soil, and supplemental boron applied before planting if boron levels are low can all help in avoiding these problems.

-R Hazzard, Bess Dicklow, A. Cavanagh

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STORAGE DISEASES OF ONION AND GARLIC

Botrytis Neck Rot caused by *B. alli* occurs primarily on bulbs in storage. Infection in seed grown onions is initiated at bulb harvest. The pathogen overwinters as sclerotia on rotting bulbs or in the soil and may be seedborne. Onions can be non-symptomatic and disease usually develops during storage. Symptoms generally begin in the neck area as decay which gradually moves downward. Scale tissue becomes water-soaked and soft. White to gray mycelium may appear between scales and sclerotia and gray mold form on the shoulders of bulbs. The development of this disease is not well understood as onion plants remain relatively symptomless. The fungus produces conidia on dead or dying plant debris and penetration is usually through succulent neck tissue or mechanical wounds. The fungus is unable to infect well-dried neck tissue. A healthy onion with a well-cured neck is rarely affected by neck rot in storage.

In garlic, the disease usually appears first on necks near the soil line at any time after spring greenup when weather conditions permit. The disease becomes worse when it starts early in the season. Extensive development of sclerotia is best seen on maturing bulbs just before and during harvest. The fungus moves rapidly into the succulent garlic bulb's neck region, producing a water-soaked appearance. A gray mold develops on the surface of or between garlic scales, later producing black bodies (sclerotia) which develop around the neck. Before bulbing, plants may die or recover if weather permits. Bulbs infected late break down to a soft mass, and secondary infections by other organisms follow.

Black Mold caused by *Aspergillus niger* occurs in the field, during transit, and during storage. The fungus grows saprophytically on dead tissue and is a common inhabitant of the soil; spores are also common in the air. Bulb infection usually occurs through injured tissues in the neck or wounds on roots, basal stem plates, or outer scales. Uninjured bulbs are seldom infected. Seeds may be infected and the pathogen disseminated in infected seeds or transplants. Preemergence damping-off can occur if infected seed is planted. The disease is favored by warm temperatures or under warm storage conditions. Infected bulbs display a black discoloration at the neck or in bruised areas, lesions on outer scales, or black streaks beneath outer scales. As the disease develops, the entire bulb may appear black and shriveled as all scales are infected. Soft rot bacteria may invade and the bulbs exhibit a watery rot. Some bulbs will show no external symptoms, but when the bulb is cut open, central portions may be gray to black.

Fusarium Basal Plate Rot is initiated in the field on onions and garlic during growth. Affected bulbs may display no symptoms at harvest but subsequently rot in storage. Affected bulbs may appear discolored with internal scales or storage leaves appearing brown and watery. Infected onion stem plates may be brown with white mycelium. Infected garlic may display a reddish purple discoloration on stems, bulbs, or bulb sheathes.

Blue Mold of onion and garlic may be caused by several *Penicillium* species. Penicillium decay of garlic caused by *P. hirsutum* is responsible for poor plant stand in the field and storage decay. Symptoms in the field include clove decay after planting and wilted, yellowed, or stunted seedlings. Infected plants are weak and stands are poor. Other species of Penicillium cause Blue Mold on onions and may be prevalent on fresh garlic. These fungi attack a wide range of fruits, vegetables, bulbs, and seeds; they are common in the soil growing on infected animal and plant debris. Symptoms of the disease start as pale blemishes, yellow lesions, and soft spots. A blue-green mold develops on lesions. When bulbs are cut open, one or more of the fleshy scales may be discolored and water-soaked. In advanced stages, bulbs may deteriorate into complete decay. In garlic, the pathogens survive in infected cloves. Invasion of onions is usually through wounds, sunscald, or freezing injury, although the fungi are able to infect uninjured bulbs. Blue Mold pathogens are often present in internal scales of onions with neck rot.

Smudge caused by *Colletotrichum circinans* affects onions, leeks, and shallot, but not garlic. The pathogen is soil-borne, surviving in colonized onion debris and it can persist in soil for many years. The pathogen is spread by infested plant material and soil and is favored by warm, wet weather; it can complete its life cycle in a few days when conditions are favorable. Smudge appears on dried outer scales and lower portions of the bulb as dark green dots which turn black. The symptoms may be scattered but often appear in distinct circular, concentric rings. The fungus produces enzymes that break down cell walls and allow mycelium to proliferate throughout the bulb.

Storage Disease Management

- Control other diseases and insects in the field to prevent entry of storage rot organisms.
- Black Mold can be reduced by applying calcium carbonate to protect wounds caused by leaf clipping.
- Bruising and other mechanical injury should be avoided when bulbs are harvested, stored, or transported.
- In some instances, treating of bulbs with fungicide before storing may be recommended.
- Cure onions and garlic with hot, dry conditions. A healthy onion with a well cured neck is rarely infected with neck rot during storage.
- Inspect garlic and onion before storing and discard all symptomatic bulbs.
- Practices that hasten curing include undercutting bulbs to sever all roots, avoiding nitrogen fertilization late in the season, and proper plant spacing.
- Ideal storage conditions are at 32-34˚ F with 70-75% relative humidity.

-*M.B. Dicklow, UMass Extension*

Vegetable Notes, September 2, 2010

Volume 21, Number 20

SHELLED CORN FOR GREENHOUSE HEAT 2010

Agricultural Innovations Project, 2008-2011

We would like to invite interested growers to participate in a project that will increase energy independence, support local agriculture, and insulate participating growers against the kind of drastic increases in fuel costs that we saw just a few years ago.

This is the last year of a project that is exploring the economic and environmental feasibility of using locally grown grain corn as fuel for heating greenhouses. Growers who participated in 2008-2010 found that the furnaces they installed were cost efficient, reasonably simple to set up and use, and did an excellent job of reducing or eliminating the need for supplemental heat in their greenhouses.

Our goal is to foster a regional network of renewable energy producers and users with a focus on grain corn but also including other types of renewable energy. The emphasis of this project is on making the best possible use of our land for food and fuel production and not to detract from our ability to grow food crops. We're envisioning a system where fuel crops become a valuable rotational crop in vegetable farms and an alternative revenue stream for dairy farmers in a time of shrinking demand for silage; not a system in which the production of fuel shifts acreage away from food production.

We would like to find farms that represent a range of vegetable and floriculture businesses in Massachusetts and various types of greenhouse designs, crops and heating needs. We have funding to provide cost-share for purchase of one corn furnace or boiler per farm (up to 50% of the cost, maximum $3000 per farm) for a limited number of farms. Although we may not be able to provide cost-share funds for all growers who are interested, we will be able to provide useful information and contacts to all interested growers.

We have included an application as a supplement in the email version of this week's newsletter. It is also available on our website, www.umassvegetable.org. If you are interested in applying to be a part of one of these regional networks and receiving cost share for the purchase of a biomass furnace please fill out the application and return to it the address listed on the application form.

– Andrew Cavanagh, UMass Extension Vegtetable Program

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HARVEST AND STORAGE OF POTATOES: QUICK CHECKLIST ON WHAT TO LOOK FOR AND WHAT TO DO.

This season's growing conditions present a very different set of challenges for end-of season potato management compared to 2009. While there has been very little late blight in Massachusetts this season, there are other pathogens that can infect and spread during harvest and storage. Bacterial soft rot, Fusarium dry rot, pink rot, and Pythium leak are four serious tuber rotting pathogens that cause the most significant losses in storage. These diseases can be brought in on infected tubers or survive on storage debris. Many of them take only a few weeks to destroy a tuber and then spread through the storage pile. Because of generally dry conditions, we might see lower than normal levels of soft rot and pink rot. However, early maturity, high temperatures and dry conditions create other issues. Growers may be aiming for short term or long term storage and sales, or some of each, and attention to the harvest, curing, and handling issues can help maintain quality.

Two of the main management practices that will reduce losses to these diseases after harvest are allowing tuber skins to mature in the field before harvesting, and eliminating free moisture in storage areas. However, Rhizoctonia black scurf and silver scurf may be at high levels on the tubers and will increase in severity the longer the tubers remain in the soil. Therefore to avoid these diseases, as soon as skins are set, harvest should begin. If the weather remains wet during the harvest, soil may adhere to the tubers during harvest. This soil will promote conditions for soft rot.

Potatoes should be harvested at pulp temperatures that allow for successful storage. Allowable pulp temperatures will vary based on storage ventilation systems, varieties, availability of cooling air, and timeliness. If potatoes are harvested during hot weather (above 80F) and cool off slowly the likelihood of storage rot is increased. Potatoes destined for storages with refrigeration could be harvested warmer to a maximum of 62 to 65°F pulp temperature. Storages with no refrigeration should not be loaded with potatoes with a pulp temperature above 60°F. Potatoes newly loaded into storage will require fresh air, humidity, and temperature goals near 55°F during preconditioning. If pulp temperatures are higher than recommended it is more difficult to manage critical environmental conditions once in storage. Time your harvest when cooling air is available to promote open outside doors and 3 to 6 hours of fresh air per day. Questionable potato lots should be harvested closer to 55° F if they must be stored. For later harvests, avoid harvesting at temperatures lower than 45 degrees as this increases the occurrence of bruising.

Below is a list of guidelines that can be used during harvesting and storage to help prevent the spread of the diseases mentioned above and to maintain high quality potatoes:

Vine killing

* Vine kill stops tuber growth at the desired maturity, stabilizes the tuber solids, and promotes skin set.
* Mechanical or chemical methods or a combination of the two can be used to kill potato vines.
* More than one application of a chemical desiccant may be required.
* Vine killing permits easier digging and harvesting operations.

Disease management

* Foliar diseases, especially late blight, are still a threat as vines begin to die or vine killing methods are implemented. These pathogens can spread to tubers and cause problems in storage if they are not controlled prior to harvest.
* Application of a desiccant followed by a fungicide application a few days later is recommended instead of applying the desiccant and fungicide at the same time. This way thorough coverage of the remaining plant material can be achieved.

Skin set

* Most tuber diseases require a wound to get into the potato. Good skin set greatly reduces the amount of wounding at harvest and increases the storage ability of the tuber.
* Allow for skin set on the tubers in the field for at least 10-14 days before harvesting.

Wounding and bruising prevention

* Check harvesting and transporting equipment to make sure it is working properly and that it causes minimal damage to tubers
* Harvest when the soil is moist but not too wet. Tuber pulp temperatures are around 60-65°F will make the potatoes less susceptible to bruising and wounds.

Grading

* Grade out diseased tubers as quickly as possible. The longer they are mixed with healthy tubers, the higher the chance of disease spread.

Healing period

* The ‘curing’, ‘suberization’ or ‘wound healing’ period immediately after harvest is critical to successful storage.
*Store tubers at about 50-60°F at high relative humidity (95%) for 10-14 days to allow wounds to heal before placing potatoes into colder storage. Lower RH results in poor suberization.
* Airflow over and through the pile is important to supply oxygen and prevent condensation. However, do not overdry the potatoes during curing.

Storage

* Before storing potatoes, facilities should be cleaned thoroughly and inspected. Make sure to check the insulation, fans, humidifiers, and ventilation system. If any of these are in poor condition it could result in losses due to disease.
* After the curing period, cool potatoes gradually and steadily to the holding temperature suited to your goals: 38-40 F for tablestock, and seedpotatoes; 45-50F for chipping or 50-55 F French fry stock.

Diagnostics

* Don’t just guess, and don’t assume that every tuber rot that you see is late blight. Send samples to the Plant Disease Diagnostic lab to get an accurate diagnosis. Different tuber blights need different

management, and even knowing what you need to do next year to prevent the problem is vitally important. Phone for UMass Diagnostics Lab: 413-545-3209.

* A good online resource on tuber diseases can be found at http://vegetablemdonline.ppath.cornell.edu/factsheets/Potato_Detection.htm#Click2

* However, finding a photo online that looks like your problem is not the same as having a plant pathologist confirm what is on YOUR tubers!

--R Hazzard and C Cavanagh; compiled from the following sources: Vegetable Crop Update, U of WI, 8/13/10, edited by C. MacNeil, CCE, CVP for Veg Edge, Cornell CES; New England Vegetable Management Guide; Potato Production in the Northeast: A Guide to Integrated Pest Management;

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SEEDERS FOR HIGH-DENSITY HOOPHOUSE AND FIELD-GROWN CROPS

High tunnels, also known as 'hoophouses', provide a growing environment that opens the door to year-round vegetable production at a reasonable cost. These unheated structures, with one or two layers of plastic, vented by means of roll-up sides and end-wall vents, require lower energy and infrastructure inputs than full-scale greenhouses. By using interior row covers close to the crop, cold-tolerant crops can be grown through the winter for continued growth and harvest in early spring. These crops include Brassica greens such as Tatsoi, Mizuna, Yukina Savoy, Siberian kale, Winterbor kale, salad turnips such as Hakurei, radishes, lettuce, spinach, chard, and Winter sprouting Broccoli. Frost-sensitive crops such as summer squash or tomato can also be started in spring for an earlier harvest, or started in late summer to extend into fall.

Growers across New England and the US have been using and learning about high tunnels for over twenty years, but they are new to many vegetable growers in the region. This year, through a special funding program from the Natural Resources Conservation Services, over 60 new high tunnels are being built in Massachusetts. Across the US, 2300 tunnels are being built. This represents a terrific opportunity for each farmer to figure out which crops best fit their needs, markets, and yearly schedule.

This is the season for seeding greens that will grow during September-November for Dec-February harvest. The period from late November until late January, with short days, low light, and cold temperatures, won't produce much new growth, but the period both before and after can generate good crop growth and many crops can weather that dead zone to be harvested or to grow on. Greens can also be grown in the field under low tunnels or row covers for harvest in November-December.

High tunnel bed space is valuable real estate and needs to generate good yields to turn a profit. To get reliable, consistent densities, a good seeder is a vital tool. Consistent between-row and in-row spacing is key. Flexibility for different seed sizes is also important: Brassica seeds are small and round but vary greatly in size; lettuce is larger; spinach, chard, and beets are larger still. This article will attempt to review several options for one-row and multiple-row seeders based on

conversations with growers and various resources. This is a work in progress and I welcome feedback and input on what seeders work or don't work, other seeder options, or how to make each one perform best. This article presents information that is available at the time of printing; no endorsement or lack of endorsement is intended or implied.

With all of these seeders, as with most any farm implement, expect to spend some time tinkering and testing different seeding plates or rollers with various seeds in order to get just the spacing that you need.

Seeders

Earthway. Source: Johnny's Selected Seeds, Earthway Outlet, Sutton Ag, price range $90-110. Single row, 6 seed plates. Lightweight, easy to change plates. Seed plates are preset to provide spacing that is typical for the crop. For small seeded crops (eg Brassicas) use cauliflower (extra) or radish (standard set) plate; set for 1 inch space but will give a dense spacing in the row for smaller seeded Brassicas. To adjust spacing for your needs, plug some holes with beeswax or caulk.

Notes: Many growers use this seeder for a range of seed sizes in both field and hoophouse and are happy with it. Several can be bolted together to plant several, evenly-spaced rows; they can also be purchased as a multi-row seeder. One problem with this seeder is that small seeds can get caught behind the seedplate and damaged; manufacturer recommended washing plate in soapy water to solve this. Another limitation is that the seed spacing cannot be adjusted except by plugging holes in the seedplate.

Pinpoint seeder. Johnny's Selected Seeds. $239. Requires fine seedbed without residues, lumps, or stones. Designed for small seeds (lettuce, Brassicas) and close spacing within-row. Plants four rows 2 1/4" apart, or optionally two rows 4 1/2" apart or two rows 6 3/4" apart. Designed to be pulled. Handle included. Comes standard with four seed-hole sizes for small to medium size seed. http://www.johnnyseeds.com/c-460-seeders.aspx

Notes: Feedback that I have heard from growers indicates that it is difficult to get the desired efficiency and seed placement with this seeder. Requires rolling the seedbed before and after planting for a semi-firm surface and to cover seed after planting. See Six-row seeder below.

Six-row seeder. Johnny's Selected Seeds, $549. An improved version of the 4-row pinpoint seeder based on feedback about the pinpoint seeder. Requires fine seedbed without residues, lumps, or stones. Up to six rows can be planted at once with 2 1/4" spacing between rows. A roller in front firms and levels the soil. One in the back closes the furrows and drives the seed shaft. Four hole sizes are provided for seeds from raw carrots through pelleted lettuce. Three different drive ratios give spacing within the rows of 1", 2", or 4".
http://www.johnnyseeds.com/c-460-seeders.aspx

Clean Seeder. Manufactured by Jang Automation Co., Ltd, distributed by Mechanical Transplanter. 800-757-5268. One-row without fertilizer hopper, $379. Drive wheel that turns seed roller, press wheel behind. Seed rollers for varying seed sizes and number of seed holes per roller (to change seeding density). Gear ratios can be changed to alter seeding density for a given seed size. With adjustment of these three elements this seeder can give a range of seed densities. Seed hopper has a cover. Can handle more trash and unevenness in the seedbed compared to the

six-row and pinpoint seeders. Multi-row and tractor-mounted designs also available. http://www.mechanicaltransplanter.com/seeder.html

Notes: We have used this seeder at the UMass Student farm and have found it effective in giving various spacings for various size seeds, given that you take time to play around with it. Easy to collect the seeds dropped per 3 ft (one turn of the wheel) to estimate seed count. Good weight for hand use by one person.

Sutton Jr. and Mini-Sutton Jr. Seeders, Sutton Agricultural Enterprises, Inc. Price starts at $1,950 for the Sutton Jr., and $1,671 for the MiniSutton Jr. These are designed specifically for high density, small plot planting, to be hand-driven by one or two people. Sutton Jr is 80-lb Sutton Jr. while MiniSutton Jr. weighs about 65 lbs. and has a narrower handle. Large ground wheel drive in front provides seed agitation, bed is firmed both before and after seeding by PVC rollers. Sutton Jr can seed up to 17 rows on 24 inch wide bed, or seed wider between-row spacing by closing off some of the tubes or using a seed plate with fewer holes. A single hopper feeds all rows. Plastic seed plates with varying hole sizes and spacing can be changed easily and can be custom ordered to fit your needs. Larger, tractor drawn seeders are also available. http://www.suttonag.com/SuttonJr.html

Notes: one grower reports being very satisfied with this seeder for intensive greens production – seeds quickly and efficiently which is very helpful for a situation with a limited workforce.

Additional resources on high tunnels

Books

Walking to Spring by Paul and Alison Wiediger
The Hoophouse Handbook from Growing for Market
The Winter Harvest Handbook by Eliot Coleman

Online resources

Cornell University High Tunnel website, http://www.hort.cornell.edu/hightunnel/index.html
www.hughtunnels.org
ATTRA, www.attra.ncat.org. Information on season extension techniques and Specialty Lettuce and Greens: Organic production along with MANY other topics.
Noble foundation, www.noble.org

By Ruth Hazzard, UMass Extension Vegetable Program
Reprinted in New York and Pennsylvania newsletters.