

## **TRANSPLANT PRODUCTION AND FIELD TRANSPLANTING**

In Pennsylvania, sweet Spanish onions should only be produced from transplants that are either locally grown or purchased from a reputable greenhouse plant (plug) producer. Since quality onion transplants should be 10 to 12 weeks old, producing local onion transplants requires the grower to plant them in plug trays (minimum of 200 to 338 cells/tray) between January 1 – January 30 (depending on growing region in the state). Maintain the top growth of the onion transplants to a uniform height of 4 inches (this may require cutting back onion top growth several times in the greenhouse). Do not harden off the transplants by withholding water and/or nutrients; instead, acclimate the onion transplants before planting them in the field by placing them between greenhouses or open buildings during the day and covering them with a row cover at night. Do this for 3 to 5 days before transplanting onions in the field.

If using field grown transplants, be sure to grade transplants by size prior to transplanting them in the field to insure uniform bulb size and maturity at harvest. **Warning:** Check onion transplants for any insect or disease problem that could become serious in the field as onion plants begin to grow. Also, if planting field grown transplants, do not wet the plants if storage becomes necessary before planting in the field and place field grown onion transplants in 40° to 45°F storage temperature.

In Pennsylvania, transplanting occurs from approximately March 15 (southern counties) through the first week of May (northern counties). About 50,000 to 60,000 transplants are needed to plant one acre of sweet Spanish onions on raised beds with plastic mulch and drip irrigation (plasticulture system). Raised beds are generally placed on 72 to 78 inch centers; however, if equipment is adjustable and soil is friable, beds can be made as close as 66 inch centers. The use of plasticulture for sweet Spanish onion production in Pennsylvania insures consistent, high quality, large bulb sized onions from year to year. Plants are spaced on 6 inch X 6 inch spacing with 4 rows planted across a 28” to 30” wide raised bed. In addition, 2 drip irrigation lines are placed in the bed between two rows of onion transplants to maintain adequate soil moisture for sizing onion bulbs and producing sweet onions. The drip irrigation lines are placed 3 to 4 inches deep in the raised bed.

## **FERTILIZER**

A **soil test** is the most accurate guide to find out what nutrients are currently in your soil. Because of the influence of soil type, climatic conditions, and other cultural practices, crop responses from fertilizer may not always be accurately predicted. Soil test results, field experience, and knowledge of specific crop requirements help determine the nutrients needed and the rate of application. Fertilizer application for onions should insure adequate levels of all nutrients. Optimum fertilization is essential for top quality and yields. Optimum soil pH for sweet Spanish onions is between 6.0 and 6.8. Total nitrogen application for onions is 90-120 pounds per acre, with two-thirds of N applied broadcast prior to making raised beds and laying plastic in the field and one-third applied through the drip irrigation tape. Apply phosphorus and potassium as well as any magnesium or calcium based on soil test results as a broadcast application prior to making raised beds. While some sulfur in the soil is required for optimum onion production, sulfur levels in soil in excess of 25 ppm can result in pungent, not sweet onions

## **IRRIGATION**

Onions are shallow-rooted, and unless soil moisture supply is constant, they will bulb early and the resulting bulb sizes may be too small for retail market. Light, frequent irrigations should be used when onions are small to minimize leaching of nitrogen from the root zone. Increase water applications as plants and roots increase in size. Maintaining moisture near the surface, at the onion stemplate, is important in root generation. Onion roots generate at the stemplate only when moisture is present. Proper moisture management is important in alleviating pink root problems, general root health, and therefore bulb growth vigor. Also, maintaining an even level of soil moisture is important in reducing incidence of double-center bulbs.

Irrigation should thoroughly wet the soil to the 18-inch depth. This may easily be accomplished with the use of two drip irrigation tapes per raised bed. Watering should be terminated after the bulbs have reached full size, and tops have begun to fall. Soil type does not affect the amount of total water needed, but does dictate frequency of water application. Lighter soils need more frequent water applications, but less water applied per application.

## **PEST MANAGEMENT**

### **Pest Management Steps Through the Season**

*Site Selection and Pre-Plant.* Perhaps the most important pest management step a grower takes is choosing the site. Fields which have not been planted to onions or other host crops in the previous three years, with low weed pressure (no perennial weeds such as quackgrass, Canada thistle and yellow nutsedge), good drainage, and good air movement are best from a pest control perspective. Rotation is a very effective control measure for onion maggots, most onion diseases, and even weeds. Perennial weeds should be cleaned up and non-existent before planting. Where possible, selecting varieties that have some tolerance to diseases can be an important step.

*At Planting.* Planting is a critical time for applying pesticides for weed and onion maggot control. If using transplants, it is important to check the onion plants for signs of disease infection before transplanting. Minimizing injury to plants during transplanting may also lower the risk of onion maggot damage.

*Pre-bulbing and Bulbing.* The focus during these stages of crop development is to keep the plant healthy and insect populations below economic thresholds. Periodic scouting (at least once/week) is tremendously helpful in determining which diseases and insects are present on the plant and levels of pest pressure. Well developed procedures for scouting for onion thrips and leaf blight diseases, and for making pesticide application decisions, are available for producers to follow. Weed control is critical throughout these stages, and can be done through a combination of post-emergence herbicide applications and hand-weeding. Maintaining optimum growing conditions through water and soil management, and minimizing mechanical damage to plants, keep plants healthy and less susceptible to disease infections and insect infestations. Keeping equipment clean can help minimize the spread of diseases from field to field.

*Harvest.* Minimizing mechanical injury to bulbs during harvesting will help reduce the spread of post-harvest disease. Onions should be fully mature when harvested so they can cure properly.

*Post-harvest.* Proper drying of onions after harvest is absolutely critical to avoiding serious losses. Necks must be thoroughly dried and skins set to assure good shelf life. Storing onions at the proper temperature and humidity will also help. Field sanitation practices such as the destruction of cull piles and the removal of cull or volunteer onions will help reduce disease inoculum and over-wintering habitat for insect pests for the following year.

## *Onion Pests of Pennsylvania: Biology and Controls*

### **Insects**

Onion thrips and onion maggots are the two most important insect pests of onions in the northeastern US. Adult **onion thrips** (*Thrips tabaci*) are very small (1/16 in) white, yellow or brown insects with slender bodies tapered at both ends. Onion thrips have a wide host range, and are commonly found in onion plantings even where there is little history of past production. Thrips colonize onion leaf sheaths and stems. The damage caused by their feeding results in whitish blotches on leaves. Severely damaged leaves will senesce prematurely, and bulbs may be undersized or distorted. Foliar insecticides (Warrior, Ambush, Ammo and other pyrethroids, and Lannate) can be used to keep thrips populations below threshold. Onion thrips have been shown to acquire resistance to pyrethroids, so insecticides classes should be rotated.

**Onion maggots** (*Delia platura*) can become a serious insect pest where onions are grown without proper rotation. There are three generations of onion maggots per season. The first generation typically is the most damaging to direct seeded onions, with less damage occurring on transplants. Later generations can infest and damage bulbs, predisposing them to disease infections. Crop rotation and proper field sanitation are very effective cultural controls. In-furrow applications of Lorsban are highly effective where the pest has not acquired resistance to the insecticide. Foliar sprays timed to kill adults of the second and third generation are of questionable efficacy. A closely related pest, seed maggots, can also cause injury to onions, but this is not common.

**Cutworms** (*Agrostis ipsilon* and others) are an occasional pest of onions. Most species of cutworms cut the seedling just above or below the soil line and pull the plant into the ground as they feed. Several insecticides (Lannate, Ambush, Ammo) are registered for cutworm control in onions.

### **Weeds**

Onions compete very poorly with weeds, and optimum yields are only possible in fields with an excellent weed management program. Fields with low weed pressure, no perennial weeds, should be selected for growing onions. Perennial weeds such as Canada thistle, quackgrass and yellow nutsedge should be controlled before the crop is planted, as they are very difficult to control during the growing season and rhizomes will grow through the onion bulb. Because onion crops do not produce a closed canopy, volunteer annual weeds often continue to emerge throughout the growing season. Cultivation is frequently impractical, and some time spent hand-weeding is often unavoidable. Using raised beds and plastic mulch will help control weeds. Registered herbicides for use with onions include Dacthal and Prefar for preemergence applications mainly for grass control and a few broadleaf weeds; Prism, Fusilade, and Poast only for postemergence grass control and both Goal and Buctril, for postemergence broadleaf control. In addition, Dual Magnum (yellow nutsedge suppression) has been available in the past through special labels (24C) in different states.

### **Diseases**

Onions are susceptible to a wide variety of fungal and bacterial diseases. Fungal leaf blights including purple blotch (*Alternaria porri*), and botrytis leaf blight (or “blast”; *Botrytis squamosa*), infect the leaves of onions, kill foliage, stunt plant growth, and spread rapidly throughout the field. Stemphylium leaf blight (*Stemphylium vesicarium* and *Stemphylium botryosum*) has occurred in onion growing areas in the NE US, and may become a problem in

Pennsylvania as well. Downy mildew (*Peronospora destructor*) is another fungal pathogen that is potentially serious, especially during cool, wet conditions, but is not commonly found in Pennsylvania. Botrytis neck rot, caused by the fungal pathogen *Botrytis allii*, is an important post-harvest and storage disease that begins with infection in the field. This group of fungal diseases can be controlled with foliar applications of fungicides including chlorothalonil formulations, mancozeb formulations, Quadris, and Ridomil Gold. Pink root (*Pyrenochaeta terrestris*), which attacks and kills onion roots, and fusarium basal rot (*Fusarium oxysporum*) can only be controlled by rotation and other cultural practices.

Bacterial rots such as soft rot, slippery skin and sour skin can be very serious problems in onions, particularly under wet conditions. Various species of *Erwinia* and *Pseudomonas* bacteria can infect onion bulbs and leaves, resulting in a characteristic slimy, watery softening of the bulb tissue, often with a foul odor. Soft rots can spread in storage, causing serious losses.

Minimizing injury throughout the growing season, good water management, avoiding highly susceptible varieties, and proper curing of onions after harvest are cultural practices that can help in disease management. No currently available pesticides will completely control bacterial rots, although copper sprays are sometimes used to slow the spread of infection. Various species of soil-dwelling nematodes can damage onions by feeding on plant roots and injuring bulbs, resulting in lower yields. Crop rotation can be an effective control measure.

**Physiological Disorders.** Physiological disorders on onions are not considered pests. However, the symptoms shown by onions with physiological disorders are often similar to disease symptoms, and it is important to distinguish the difference in the field. Tipburn, or leaf tip senescence, can be caused by weather-related factors or by chemical damage. Sun scald can cause leaf die-back that can be confused with disease symptoms. Mechanical damage caused by rain or hail hitting onion leaves can look very similar to early stages of botrytis leaf blight lesions, as can ozone damage.

## **HARVEST**

Uniformity of maturity (rate at which onion tops turn brown and fall down – *tops-down*) is very important in bulb size uniformity and storage quality. Tops-down in hybrid varieties tends to occur rapidly, requiring only a day or two to complete top-fall. Non-uniform varieties may have tops falling over a period of several weeks with a percentage of the tops not falling at harvest. In such varieties, bulbs with early tops-down contribute to incidence of bald onions at harvest, while those whose tops resist falling do not dry properly, contributing to decay in storage.

To facilitate the drying of onions for harvest and storage, onion rows on the raised beds are undercut with a mulch lifter, lifted and bulbs left on the raised bed for field curing. After an appropriate interval (3 to 5 days), the undercut onions are harvested from the raised beds and tops removed before placing bulbs in bulk bins. Onions are left on the raised beds after lifting with their tops on to protect them from sunscald. Onions for immediate sale or short-term storage are mechanically undercut and may be topped by hand or machine and partly cured in sacks or boxes in the field prior to packing. Even though these onions are not to be stored, complete curing of necks and scales is still very important.

When onions are intended for storage, complete curing is mandatory. Care must be exercised in handling these onions to guard against sun-scald (above 90°F) and damage since these onions are much more succulent and may have very few protective scales.

## **DRYING**

Drying is generally accomplished by forcing air of a low relative humidity through the bottom of the onion pile to the top. Two to three cubic feet of air per minute for each cubic foot of onions is recommended, with the higher air-flow rate used initially to remove surface moisture and seal necks. If the weather is cool and wet, forced air at 75° to 85° F and 60-70% relative humidity is recommended. If the onions are also wet, forced air at 85° to 95° F and a relative humidity of 25-35% should be used as soon as storage loading is completed. This should be continued until the outer skins and neck are dry.

Drying can also be accomplished by placing harvested bulbs with tops removed from the field in 100 pound burlap bags. The burlap bags with onions in them are stacked two high on wooden pallets placed on top of wagon and into a high tunnel. The pallets allow for good air circulation around the burlap bags. It is also recommended that you place shade cloth over the high tunnel to reduce sunscald and sunburn problems on the onion bulbs. Onions placed in the high tunnel for 5 to 7 days dry very well.

Onions are considered cured when the neck is tight and the outer scales are dry and will rustle. This condition is reached when onions have lost 3 to 5% of their weight. If not adequately cured, onions are likely to decay in storage. The most common form of decay is gray mold rot, which occurs at the top of the bulb - whence its name "neck rot."

After curing, the relative humidity in the storage should be maintained between 60 and 70%. If the storage is too dry, the outer bulb scales will crack excessively, resulting in bald onions during packing.

## **STORAGE**

Onions are held in either common or cold storage. The storage quality of onions is influenced by variety and by the conditions under which they are grown and stored. Storage may be either in bags, crates, in pallet boxes that hold about a half ton of loose onions, or in bulk bins. Bags of onions are frequently stored on pallets and should be stacked to allow proper air circulation. Modern air-cooled storages have forced ventilation systems in which air, heated if necessary, is introduced through floor racks beneath the bins of onions. Onions in bins are stored about 10 to 15 feet deep, but soft onions at the bottom may be distorted in shape.

In the northern onion-growing states, onions of globe types are generally held in common storage. Average winter temperatures in the principal northern onion-producing states are sufficiently low to permit common storage during the winter months. Onions are damaged by freezing, the damage appearing as water soaked scales when the thawed onions are cut. Onions only slightly frozen may recover with little perceptible injury if allowed to thaw slowly and without handling. When onions are removed from storage in warm weather, they are apt to sweat because of moisture condensation. This may favor decay. Warming onions gradually, for example, to 50 F over 24 to 36 hours with good air movement should avoid this difficulty.

## **PACKAGING**

Sweet Spanish onions bulbs are sorted, cleaned, sized and graded, just prior to packaging. They are commonly packaged in 40-lb boxes.