Armyworms

WHAT IT IS The two most common species in Minnesota include the True and Fall armyworms. True armyworm ((*Pseudaletia unipuncta*) caterpillars will often have yellow to cream, or orange stripes down the side, with orange heads. Fall armyworms (*Spodoptera frugiperda*) range from brown to gray, green, or yellow-green in color with a whitish inverted Y shape between the eyes and three whitish stripes behind the head.

SYMPTOMS Defoliation of leaves can occur quickly following a high influx of moths and egg-lay

HOW TO IDENTIFY Eggs are laid in large, fuzzy masses, and many larvae can feed on a given plant, often on the upper leaves.

CONTROL MEASURES If high populations exist and damage occurs, the insect can be controlled by using Bt (*Bacillus thuringiensis*) sprays; however, only the young (early instar) larvae are most susceptible to Bt (e.g., larvae < ¼" length). Another insecticide registered for leaf-eating caterpillars on garlic includes spinosad (Entrust SC), certified for organic growers.

PREVALENCE IN MINNESOTA Both the true and fall armyworm are common in the upper Midwest. True armyworm is active in June, while fall armyworm migrates from southern states in July and August. Once a plant is defoliated, larvae will move in mass to the next available plant. Not generally a major problem in Minnesota garlic.

Other

Waxy Breakdown

WHAT IT IS Physiological condition not due to infection by microorganisms.

SYMPTOMS Cloves shrink and turn yellow and waxy inside the bulb. Bulbs sometimes become pasty or gelatinous or sometimes turn hard.

HOW TO IDENTIFY Symptoms.

CONTROL MEASURES Cause is unknown, but it has been suggested that it may be due to high temperatures during growth and/or after harvest or poor ventilation and low oxygen levels during storage.

PREVALENCE IN MINNESOTA Not highly prevalent but present.

Harvesting and curing

Knowing when to harvest has always been tricky. In general, garlic harvest in Minnesota usually extends from the second week of July through the first week in August. Different varieties will often mature at different times. Harvesting too early will result in small bulbs that do not store well. Harvesting too late will force the cloves to pop out of the skins, making them susceptible to disease and resulting in unmarketable bulbs. There are a couple of methods that can be used to determine when to harvest:

1) by early July the lower leaves will start to brown, and harvest is usually optimum when half or slightly more than half of the leaves remain green; or when a third of the leaves at the bottom have gone brown or yellow.

2) pull a few bulbs and cut them in half; if the cloves fill the skins, then the bulbs are ready to harvest.

To harvest, the bulbs should be dug with the shoots and roots still attached. At this point there is some controversy about whether the bulbs should be washed. For some soils it is easiest to wash the bulbs the day of harvest and allow them to cure for a few weeks. Some growers feel that washing the bulbs may lead to more storage diseases such as skin blotch. The alternative to washing the bulbs after harvest is to let the plants cure for three to four weeks and then brush the soil off after curing. This latter approach is less time-consuming in the short run, but can be more time-consuming in the long run if the soil is high in clay content.

For larger plantings of garlic, mechanical implements are available. A few growers in Minnesota have been using harvest implements such as modified potato/carrot diggers and other types of undercutting equipment. Such equipment is available, though at the scale that most growers are operating in Minnesota, the cost for such equipment is high.

Figure 33. Garlic should be dried in a well-ventilated room with indirect light.

After digging the plants, they should be dried in a well-ventilated room (Figure 33). There are a multitude of methods employed by growers to structure the curing process. The most important elements are air flow/ventilation (ultimate goal is that each bulb is getting air flow), in indirect light (avoid exposure to direct sunlight, over-drying or complete darkness, as this increases the likelihood of mold). Some growers accelerate the curing process by using dehumidifiers or air conditioning units, but care must be taken not to dehydrate the bulbs. The goal is to dry outer wrappers while keeping the cloves moist. One way to determine if curing is complete is to clip the stem at 1-2 inches above the top of the cloves, and if no liquid oozes out, the process is complete. Some growers believe that in order to produce a premium quality bulb, it is important to leave roots and stems on during curing, but other growers do not have the space. After about three to four weeks of curing, the shoots and roots should have dried down. The tops should then be cut about one-half to one inch above the main bulb and roots should be trimmed close to the base of the bulb. Clean bulbs by removing only the outermost skins, being careful not to expose any cloves. Any remaining soil should be brushed away. Bulbs can be graded into the following diameter sizes: less than 2 inches, 2 to 2.5 inches, 2.5 to 3 inches, and more than 3 inches. Premium bulbs are those 2.5 inches and larger.

Storage

Optimum storage conditions will depend on whether the garlic is to be used for table stock or planting stock.

Table stock garlic is best stored at 32˚-40˚ F and a relative humidity of 60-70%, but as soon as you take it out of refrigeration, it declines rapidly. Table stock garlic also can be stored at room temperature and 60-70% relative humidity with indirect light, but will dehydrate faster than if stored at 32˚-40˚ F. Storage at relative humidity greater than 70% tends to promote rooting and can lead to development of molds. Softneck garlic typically can be stored for six to eight months at room temperature, while hardneck garlic usually starts to deteriorate after about three to four months. At 32˚ F, hardneck garlic can be stored for up to seven months without significant dehydration. Temperatures between 42˚-52˚ F will cause sprouting, and humidity greater than 70% tends to promote rooting.

Because it will not be stored for very long before planting, "seed" garlic should be stored at room temperature and 60-70% relative humidity with some airflow, and should not be stored in complete darkness.

Sources for garlic seed

Seed garlic may be purchased from various vendors listed on the SFA garlic webpage, the Minnesota Grown Directory, or from vendors selling garlic online, at Minnesota Garlic Festival, and at regional farmers markets.

Further reading

Publications

Aaron, C. (1997) The Great Garlic Book: A Guide with Recipes, Ten Speed Press.

Brewster, J.L. and H.D. Rabinowitch. (1990) Onions and Allied Crops, Volume 3, Biochemistry, Food Science and Minor Crops, CRC Press.

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Koch, H.P. and L.D. Lawson (1996) Garlic: The Science and Therapeutic Application of Allium sativum L. and Related Species. Williams & Wilkins.

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Volk, G. M., A.D. Henk, C. M. Richards (2004) Genetic Diversity among U.S. Garlic Clones as Detected Using AFLP Methods. J. Amer. Soc. Hort. Sci. 129:559-569.
https://journals.ashs.org/jashs/view/journals/jashs/129/4/article-p559.xml

Useful web pages

Sustainable Farming Association's Garlic Production & Marketing Resources: https://www.sfa-mn.org/garlic-resources/

Learn about a SARE study on garlic diversity: http://www.garlicseedfoundation.info/bigNewsforGarlic.htm

First Reports of Garlic Diseases in Minnesota:

Mollov, D., B. Lockhart, E. Saalau-Rojas, C. Rosen. 2014. First report of a 16SrI (Aster Yellows) Group Phytoplasma on garlic (*Allium sativum*) in the USA. Disease Notes 97: 285. http://dx.doi.org/10.1094/PDIS-07-13-0689-PDN

Szabo, L.J., Mollov, D.S., C. Rosen, 2013. First report of garlic rust caused by *Puccinia allii* on Allium sativum in Minnesota. Plant Disease. 97:285. http://dx.doi.org/10.1094/PDIS-07-12-0686-PDN

Mollov, D.S., S. A. Subbotin, C. Rosen, 2012. First report of *Ditylenchus dipsaci* on garlic in Minnesota. Plant Disease. 96:1707. http://dx.doi.org/10.1094/PDIS-06-12-0532-PDN.

Extension webinar: Growing Great Garlic in Minnesota for Gardeners https://www.youtube.com/watch?v=DZ8yRiVx0HU

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Figure 1: Drawing by Amy Sparks.

Figure 17 & 18: Brett Arenz

Figure 24: B. Caine and C. Swett, Swettlab at UC Davis.

Figure 33: Jerry Ford