GRAIN AMARANTH

A Lost Crop of the Americas

Overview

Amaranth is a broadleaf plant that could be mistaken for soybeans early in the growing season by someone driving past a field. Late in the season, however, there is no mistaking this striking, tall crop which develops brilliant colored grain heads producing thousands of tiny seeds. Amaranth was a major food of the Aztecs and earlier American cultures, having been domesticated thousands of years ago.

After the arrival of the Spanish Conquistadors in Mexico in the early 1500s, amaranth almost disappeared in the Americas as a crop until research began on it in the U.S. in the 1970s. In the meantime, amaranth had spread around the world and became established for food use of the grain or leaves in places such as Africa, India and Nepal. In the past two decades, amaranth has begun to be grown by a much larger number of farmers around the world, in China, Russia, parts of eastern Europe, South America and is reemerging as a crop in Mexico.

The attraction of the crop to both earlier civilizations and modern consumers is the highly nutritious, golden seed. Amaranth seeds are unusually high in protein for a non-legume, running around 14 to 16% protein. Even better, the protein is well balanced in amino acids, and is high in lysine, an amino acid most grains are deficient in (legumes also have high lysine).

Amaranth was grown as a grain crop in the U.S. in the late 1970s. Although grown on only a few thousand acres each year, it is a common food item in the health food section of grocery stores. The relatively high price of amaranth, while good for farmers, is a factor limiting the extent of its current use in the food marketplace. Still, the valuable characteristics of amaranth grain, combined with its adaptation to a wide range of growing areas, make it a very promising crop for the future.

Colorful flowers appear on amaranth grain heads in August, creating attractive fields.

Plant Description

Grain amaranths are very diverse and actually represent three distinct plant species: *Amaranthus hypochondriacus* is the type most grown in the U.S., with some *A. cruentus* having being grown. *A. caudatus* is the third type of grain species. There are over 50 species in the *Amaranthus* genus, with several of them being weeds in the continental U.S., a few being ornamentals, and some having forage use potential.

Grain amaranths can vary from 2 to 8 feet tall, but the most commonly grown variety, Plainsman, is usually 5 to 6 feet tall in Missouri. Plainsman has a single unbranched stem, with a large mass of tiny maroon flowers clustered in an inflorescence at the top of the plant. Grain heads of Plainsman can range from 4 to 12 inches long, and from 2 to 8 inches wide. Seeds are small, about 1/25 inch.

Grain amaranths vary in flower, leaf, and stem color, but maroon or crimson coloring is common in all three plant parts. Some varieties have green flowers, and others are more golden. Some of the deep crimson varieties can be very striking when in full bloom. A few small clusters of flowers may occur at the first few leaf axils below the head.

While amaranth is regarded to be drought tolerant, the mechanism of its drought tolerance is not well understood. One trait that helps it in extremely dry conditions is its ability to wilt temporarily, but bounce back after a rainfall occurs.

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How to Grow Grain Amaranth

Despite its small seed, amaranth can be grown with conventional grain crop equipment. It is a crop adapted to a variety of soil types, but will do best on fertile, well-drained soils. Production practices, in terms of time of planting and harvest, and level of inputs, are similar to sorghum. Amaranth can work well as a double crop after wheat or canola in southeastern Missouri. Double crop trials in central Missouri showed that amaranth planted after winter wheat or canola would reach maturity in time, but yields were about half to two-thirds that of amaranth planted earlier. Amaranth should be placed into at least a two-year rotation with another crop; it works well in rotation with corn and soybeans.

Varieties and Seed Selection

The improved varieties of grain amaranth used in the U.S. were developed at the Rodale Research Center in Kutztown, Pennsylvania. Initially, many farmers grew one of the shorter, earliest maturing Rodale lines, called K432. In recent years, most farmers have switched to Plainsman, a release of the University of Nebraska Experiment Station, which is a selection of Rodale's K343. Plainsman is recommended for Missouri farmers and is available from certified seed growers in Nebraska, such as Phil Sanders (308-377-2231). Smaller quantities of Plainsman can be obtained from Johnny's Selected Seed in Maine (207-437-4301). Contact the Jefferson Institute (573-449-3518) for more information on seed sources, including Missouri sources.

Planting

The small seeds of amaranth produce seedlings that are tiny and somewhat fragile in comparison to crops such as corn, wheat and soybeans. Amaranth seedlings can easily be blocked from emergence by a thin crust on the soil formed after a rain. Selecting soils that are lower in clay, and managing the seedbed to minimize chance of crusting can help insure getting good stands. On the positive side, planting just 2 pounds of seed per acre, the recommended rate, produces so many seedlings, that a large number can be lost with plenty left over for an adequate stand. Amaranth is somewhat unique in the wide range of seeding rates it can be planted at without impacting yields. Field studies in Missouri showed that amaranth yields were fairly constant across a range of 1/4 to 4 pounds of planted seed per acre.

Amaranth can also be planted over a fairly wide range of planting dates in Missouri. The optimum time is early June, but it can be planted with little yield dif ference from the second week in May until mid-June. After mid-June, yields start to drop off. When planted early, amaranth will start flowering after it has accumulated enough growth and heat units; when planted later, flowering is triggered by photoperiod (day length).

Amaranth should be planted about 1/2 inch deep. Row widths of 30 inches have been the standard with amaranth trials in Missouri. The crop shades the ground well at this row spacing, and the wide rows allow a row crop cultivator to be used for weed control. This is important given the lack of labeled herbicides for amaranth. A Missouri study comparing 7.5, 15 and 30 inch row spacings found that the wider rows also gave the highest yields. Amaranth plants seem to compete excessively with each other when planted in the narrower spacings, leading to shorter, less vigorous plants and smaller grain heads.

A variety of planters have been successfully used with amaranth. Some farmers with row crop planters will put the amaranth into the insecticide box rather than the main seed box, running a tube down between the double disk openers to deliver the seed. Grain drills have been used by stopping the appropriate number of seed holes to get the desired row width. Vegetable planters can be used with a celery plate. Sometimes it is helpful to leave the soil a little loose over the amaranth seed, to help prevent crusting problems. No-till planting has been done in Missouri test plots, but insects eating seedlings were a problem; an organic insecticide should be at hand to spray if control is needed during no-till establishment.

Fertility

Amaranth does not have a high nitrogen demand like corn, but yields are responsive to good nitrogen fertility. If fertilizer nitrogen is used, rates should be moderate, around 40 to 80 pounds per acre, with the lower figure used following soybeans or other legumes. Using a leguminous cover crop such as hairy vetch or one of the clovers can provide adequate organic nitrogen for amaranth, or animal manure can be used. Amaranth can be planted late enough that legume covers can even be spring planted around April 1, allowing them to grow 8-10 weeks before killing them.

To get full benefit from the nitrogen in the residue of a cover crop, it is best to incorporate it into the soil prior to planting the amaranth. Phosphorous and potas-

sium can be applied at soil test recommended levels for sorghum; some soils may not need P or K prior to amaranth planting. Amaranth response to pH has not been studied, but it seems to tolerate pH levels down to at least 5.6.

Pest Management

Weeds

No herbicides are labeled for amaranth. Although cover crops and no-till planting can help prevent weed seeds from starting, amaranth seedlings grow slowly the first few weeks and are easily overtaken by early weeds. Therefore, the recommended approach is to plan on using a row crop cultivator for weed control, even if the crop is no-till planted into residue. Multiple passes of preplant tillage, one to sprout the weeds, and another a week or so later to kill the weed sprouts, is recommended. Ridge till is an effective conservation tillage approach that can work well with amaranth. Once amaranth gets to be 6 to 10 inches tall, it will begin growing rapidly, and can shade out and outcompete late emerging weeds.

Insects

A lot of insects like chewing on amaranth, but amaranth can tolerate a substantial amount of leaf feeding without having yield loss. Blister beetles and alfalfa webworm are the only two leaf feeders that have caused economic yield loss in Missouri so far, and may need to be treated if occurring in more than isolated patches. There are no synthetic insecticides labeled for amaranth, but various organic insecticides can be used, including certain pyrethrin and Bt products. Tarnished plant bug (*Lygus*) is often the worst insect pest on amaranth, but pyrethrins can help control it. This brown, lady-bug sized sucking insect routinely shows up in amaranth grain heads, attacking flowers and seeds. Its damage is not always readily apparent, but it can cause substantial yield losses, both by preventing flowers from developing into seeds, and by reducing seed weight.

Diseases

Amaranth does get fungal diseases, some of which can be significant, but no fungicides are labeled. In wet soils, seedlings may die from soil pathogens causing "damping off." Various root and stem rots can contribute to lodging late in the season if soils are wet in August. No viruses have been noted on amaranth, and no serious bacterial diseases have been seen.

Harvest and Storage

Timing of harvest is not as straightforward as with the commodity crops. In northern states, amaranth growers usually wait to harvest until about a week after the first hard frost, letting the frost completely kill the plant and make the crop drier for harvesting. In Missouri, Plainsman amaranth, the most common variety, will almost always drop its leaves prior to frost, usually by early or mid-October. Waiting for the crop to dry in the field must be balanced against getting it combined before pre-harvest losses from lodging or seed shatter occur. If the ground is saturated from rain and a strong wind occurs late in the season, amaranth roots may partially give way and the plant will end up leaning, making harvest more difficult. Stalk breakage is less likely, but has happened occasionally. Amaranth seeds may also start to shatter and fall to the ground if the crop is left standing too long, particularly after a frost has occurred.

Amaranth should be direct combined using a platform (all crop) grain head. Reels are usually adjusted to minimize seed shatter by raising them high or removing some of the bats. Because the seed is small and light, air speeds must be low, and cylinder speed must be turned down. One farmer recommends a cylinder speed of 570 rpm, a fan speed of 500 rpm, and a concave setting of 3/4 inch. Other farmers have run the cylinder speeds at even lower settings to better preserve seed quality. The lower screen or sieve must be adjusted to effectively screen out the amaranth seeds. Some farmers put in a wire mesh over the lower sieve to help screen out the chaff.

A reasonable approach when adjusting the combine settings is err on the side of including excessive flower parts in with the seed, rather than blowing too much seed out the back of the combine. If the harvested seed has a lot of trash in it, cleaning and drying of the grain should begin immediately. Cleaning the grain is important to get full value, since the crop is used for food purposes. Grain should be stored at about 10-12% moisture.

Note: More details on amaranth production methods, including planting and harvesting tips based on direct farmer experience, can be found in the "1999 Amaranth Production Manual," published by University of Nebraska Extension Service (call the Jefferson Institute, 573-449-3518, to get a copy or obtain ordering information).

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Utilization

The amaranth species as a group is used for a wide variety of purposes. Although the crop is used exclusively for seed production in the U.S., in other regions of the world there are many other uses. In Africa and the Caribbean, amaranth is commonly eaten as a pot herb, with individual leaves picked off the plants periodically. Farmers in China are reportedly growing over 100,000 acres of amaranth as a forage for hogs. Many amaranths have become popular ornamental plants. Thomas Jefferson is believed to have planted them along his garden paths at Monticello.

As a food crop, amaranth not only has high protein, but high fiber as well. There may also be dietary benefits from the relatively high levels of tocotrienols in the seed. The seeds have some desirable functional characteristics, having been processed in popped, flaked, extruded, and ground flour forms. Since the food uses are similar to such cereal grain grasses as wheat and oats, amaranth is sometimes called a "pseudocereal."

Most of the amaranth in U.S. food products starts as a ground flour that is blended with wheat or other flours to make cereals, crackers, cookies, bread or other baked products. Most commercial products use amaranth as a minor portion of the ingredients, even if the product is touted as an amaranth product, such as "amaranth" breakfast cereal, which may be only 10 to 20% amaranth. Utilization studies have shown amaranth can often be blended at 50% or even 75% levels with other flours in baked products without affecting functional properties or taste.

Amaranth has certain seed components with potentially high value uses. It has a relatively high fraction of squalene in its seed oil, which sells for thousands of dollars a pound; whether the squalene can be economically extracted has yet to be determined. The anthocyanin (reddish) pigments in amaranth flours and vegetation appear to have great potential for competing with sugar beets as a source of natural, non-toxic red dyes. Perhaps most intriguing is the microcrystalline starch in amaranth seed, which is about one-tenth the size of corn starch particles. The small size of the starch could be of value in both food and industrial uses.

A traditional use of amaranth in Mexico and other countries is to mix popped amaranth with a sweet, sticky foodstuff, such as molasses or honey, to make a type of snack bar or snack cake (not unlike a granola bar or Rice Krispy bar). The whole seed is sometimes used in a type of porridge or as a condiment on other foods. The ground flour is used in a variety of baked breads.

Markets and Economics

If the market demand for amaranth were larger, there would be thousands of farmers growing it at its current price. It is very easy to show on paper how to make a profit growing amaranth, but much harder to market a large quantity of seed into the small but growing health food market. Grown conventionally, amaranth brings around $0.40 per pound, while organic amaranth may sell for $0.65 per pound or more. Since Missouri amaranth can routinely yield 1000 pounds per acre, and sometimes higher, amaranth's gross returns easily beat commodity crops. Production costs are about the same as sorghum and soybeans and may be less. Seed cleaning is somewhat of an extra expense, but the big cost is transportation to market. None of the main amaranth buyers have delivery points in Missouri — it all has to be trucked out of state.

The three main buyers of amaranth grain in the U.S. are Arrowhead Mills (Texas), Health Valley (California) and Nu-World Amaranth (Chicago, Illinois). Larger companies that use amaranth in their food products, such as Pepperidge Farm, usually obtain their amaranth from one of the above three companies. Arrowhead Mills and Health Valley both sell processed foods with amaranth into the retail marketplace, and Arrowhead Mills sells the whole seed and bags of amaranth flour as well. Call the Jefferson Institute at 573-449-3518 for current marketing information.

Rather than selling all their amaranth on a bulk basis to one of the companies above, some farmers in the Midwest and Great Plains have developed their own direct marketing. Some sell amaranth to local bakeries, while others have built a mailing list of consumers who buy amaranth in small quantities. Many of the individuals who use substantial quantities of amaranth are allergic to wheat, but find that they can substitute amaranth for wheat without an allergic reaction, since amaranth is gluten-free.

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Published by the Jefferson Institute, Columbia, MO, a non-profit research and education center supporting crop diversification (ph: 573-449-3518). Development of this publication was funded by the USDA-CSREES Fund for Rural America program, as part of a cooperative project with the University of Missouri and other universities.

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Revised 10/02