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GROWING GRAIN AMARANTH AS A SPECIALTY CROP

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Amaranth, an ancient crop originating in the Americas, can be used as a high-protein grain or as a leafy ve\getable, and has potential as a forage crop. Grain amaranth species have been important in different parts of the world and at different times during the past few thousand years. The largest acreage ever grown was during the height of the Aztec civilization in Mexico during the 1400's. During the past two centuries grain amaranth has been grown in scattered locations, including Mexico, Central America, India, Nepal, China, and eastern Africa. Research on amaranth by U.S. agronomists began in the 1970's, so optimum production guidelines and uniform, adapted varieties have not yet been fully developed. Only a few thousand acres of amaranth are commercially grown in the United States, and markets for that small acreage are fragile. Growers are advised to begin with a few acres, and to have a contract or identify buyers before planting the crop.

Plant Description

The two species of grain amaranth commonly grown in the U.S. are *Amaranthus cruentus* and *Amaranthus hypochondriacus*. Grain amaranths are related to redroot pigweed *(Amaranthus retroflexus)*, but are different species with different characteristics. The grain amaranths have large, colorful seed heads and can produce over 1000 pounds of grain per acre in Minnesota, though a portion of this grain yield may be lost in harvesting.

Grain amaranth plants are about five to seven feet tall when mature, and are dicots (broad-leaf) plants with thick, tough stems similar to sunflower. The tiny, lens-shaped seeds are one twenty-fifth of an inch in diameter and usually pale-colored, while the seeds of the pigweed are dark-colored and lighter in weight.

The crop is reportedly drought-tolerant, similar to sorghum, provided there is sufficient moisture during the early growing period. Frost damage is not a problem because the crop is not sown until late May or early June. However, frost plays an important role in the harvest of the crop. Since amaranth is an annual crop native to the southern latitudes of North America, it does not mature completely in Minnesota's short growing season. A frost is necessary to terminate the crop's growth so that the plant material will be dry enough to harvest.

Varieties and Seed Source

Uniform varieties of grain amaranth have not yet been developed. Available material consists of selected lines that vary in their uniformity and degree of adaption to temperate latitudes. The Rodale Research Center in Pennsylvania and the USDA Plant Introduction Station at Ames, Iowa, are two locations where significant work has been done in developing amaranth varieties. A small number of commercial breeders are also working with the crop. While the Ames research group is not yet releasing its lines, Rodale has been distributing a number of lines, including some that have been grown successfully in Minnesota, R1041, R1011, K343, K283, and K266. University trials at Rosemount from 1977 to 1982 showed yields ranging from 300 to 3800 lbs/a for the 20 lines tested. Amaranth seed is also available commercially (see Table 1), but at prices as high as $25 per pound.

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Table 1. Sources of grain amaranth seed.

Johnny's Selected Seeds, Albion, ME 04910
Mellinger's, Inc., 2310 W. South Range Road, North Lima, OH 44452
Plants of the Southwest, 1812 Second St., Sante Fe, NM 87501
Rodale Research Center, RD 1 Box 323, Kutztown, PA 19530
The Good Seed Company, P.O. Box 702-D4, Tonasket, WA 98855

Production

Planting

Planting should be done when the soil temperature is at least 65°F., and after early weed growth has been controlled by tillage or a contact herbicide. Seedlings are fragile, so it is important to have a fine, firm seedbed. Seedbed preparation can be done with a disk or spiketooth harrow, followed by cultipacking and planting, preferably using a planter with press wheels. Seeds should be planted no more than 1/2 inch deep, depending on soil texture and surface moisture at planting time. Crusting can be a serious problem, and although no solutions have been researched, rotary hoeing may be helpful. Poor emergence, as low as 50%, is not uncommon. Since seeds are shallow planted, there is potential for them to wash out on sloping ground.

An optimum plant population has not been established, but one-half to two pounds of seed per acre is considered suitable (approximately 600,000 seeds per pound). Row spacing should be based on the cultivator equipment available. A number of planter types have been used successfully to deal with the small seeds of amaranth. Approaches that have proven successful include: using a vegetable planter with a small plate appropriate for carrots or celery; installing special amaranth seed plates in a sugar beet planter; using the insecticide application box as a planter; or using a standard grain drill. Grain drills are not recommended due to problems in controlling seeding rate and depth, but one can be used if the amaranth seeds are diluted with a "carrier" like ground corn. A mixture suitable for drilling consists of one-half pound of amaranth with four and one-half pounds of ground corn. Set the drill for a seeding rate of five pounds per acre.

Fertilization

There is currently little data available on the fertilizer response of amaranth, although it appears to be intermediate between small grains and corn in fertility needs. Nitrogen will be the most limiting nutrient under most environments. Phosphorous and potassium should only be applied in soils that are especially deficient in these nutrients.

Weed Control

Since amaranth is not planted until early June, many weeds will already have emerged. These early weeds must be controlled by tillage or a contact herbicide prior to planting. Grain amaranths grow slowly during the first several weeks, so three or four cultivations may be needed during this period to control weeds (**no selective herbicides are labeled for use with amaranth**). Once the amaranth plant is about a foot tall it begins to grow rapidly and is competitive with weeds. Two species of weeds which are especially competitive with amaranth in Minnesota are lambsquarter and redroot pigweed. Fields with high populations of these weeds should not be used for grain amaranth production. Since grain amaranth seeds do not undergo dormancy, and since plant growth is not vigorous early in the season, it is unlikely that amaranth would be a weed problem in succeeding crops.

Insects and Diseases

Tarnished plant bug, flea beetle, and amaranth weevil, have been identified as potentially significant insect pests of amaranth. The insect most likely to affect yields is the tarnished plant bug, a sucking insect which often reaches high populations in the seed head during the critical seed fill stage. Flea beetles damage young leaf tissue. The adult amaranth weevil feeds on leaves, but the larval stage is more damaging because they bore into the central tissue of roots and occasionally stems, causing rotting and potentially lodging. No significant disease problems have been conclusively identified for grain amaranth. One possible problem is a damping-off fungus, which can kill seedlings.

Harvest

Management during harvest is a most critical stage in grain amaranth production. Without careful harvest techniques it is possible to lose the majority of the seed. Before harvesting can begin a killing frost must occur followed by a week of good drying weather (there are no approved desiccants for amaranth). If the stems and leaves are too wet, the seeds become sticky and adhere to the inside of the combine as well as the straw discharge. Shattering during the cutting process can also cause losses, so adjustments should be made to minimize shattering of the heads. When reel heads are used it may be helpful to remove several reel bats or raise the height of the reel. Row headers perform better at harvesting amaranth than reel heads for combining amaranth. A regular combine can be used if fitted with appropriately-sized separator screens.

Handling and Storage

Plans should be developed for handling and storage of the grain before harvest begins. It is important to clean the grain to remove plant and foreign material which will increase the chance of molding. Cleaning can be done using a 1/16 inch screen top, and a 1/23 inch screen, 22 x 22, or 24 x 24 wire mesh on the bottom. A gravity table can be used to separate out particles of the same size but of different weight, such as the dark pigweed seeds. Maximum moisture for storing the grain is approximately 11%. Small amounts of grain can be dried by blowing air across the amaranth; heated air may be necessary at certain times. The optimum way to store the grain after cleaning and drying is in wooden storage bins or in heavy duty (4 or 5 ply) paper bags. University studies at Rosemount, Minnesota showed average test weight of 63 pounds per bushel.

Potential Uses

Food Uses

Grain amaranth has been used for food by humans in a number of ways. The most common usage is to grind the grain into a flour for use in breads, noodles, pancakes, cereals, granola, cookies, or other flour-based products. The grain can be popped like popcorn or flaked like oatmeal. More than 40 products containing amaranth are currently on the market.

Nutritional Value

One of the reasons there has been recent interest in amaranth is because of it useful nutritional qualities. The grain has 12 to 17% protein, and is high in lysine, an amino acid other grain crops are low in. The grain is high in fiber and low in saturated fats, factors which contribute to its use by the health food market.

Forage Uses

Little is known about the production and utilization of amaranth as a forage. The leaves, stem and head are reportedly high in protein (15-24% on a dry matter basis). A relative of grain amaranth, redroot pigweed, has been shown to have 24% crude protein and 79% *in vitro* digestible dry matter. Vegetable amaranths, which are closely related, produced 30 to 60 tons/a of silage (80% moisture) on plots in Iowa. In areas where corn silage yields are low due to moisture limitations, grain amaranth may become a suitable silage alternative after further research.

Processing and Marketing

Perhaps the greatest problem facing the development of amaranth as a crop is finding markets for the grain. The crop has only been grown commercially during the 1980's, and the markets are still very small. A farmer entering the market with grain from several hundred acres of amaranth could cause a surplus and drastically lower prices. For this reason amaranth should be grown only after identifying a market for the crop, and preferably after arranging a contract with a buyer.

Farmers that grow amaranth have marketed their crop in a number of ways. Some sell small bags of the whole grain or flour mail-order to consumers. Many of these purchasers are allergic to wheat products. Other growers sell to local or regional health food stores or restaurants. There are also a few middlemen who buy grain from the farmers and market it to the larger health food companies. Health food companies that have developed grain amaranth products include Health Valley Natural Foods, Arrow Mills, Walnut Acres, and Nu-World Amaranth.

For More Information . . .

Additional information on producing grain amaranth is available in Minnesota Experiment Station Bulletin AD-SB-2949, "Amaranth, Quinoa, Ragi, Tef, and Niger: Tiny Seeds of Ancient History and Modern Interest" (1986), and the "Amaranth Grain Production Guide" published annually by the Rodale Research Center (RD 1, Box 323, Kutztown, PA, 19530).

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