Division of Marketing
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1997 Grant Final Report

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1997 Grant Project Final Report
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Introduction

Garlic (*Allium sativum*) has been used as a flavoring in food for more than 5000 years. The plant is also thought to have medicinal applications, because of the plant's sulfur containing compounds, which have strong antibacterial properties. The earliest records and wild strains indicate its origins in central Asia. Garlic was thought to be brought to China, the largest consumer of garlic in the world today, by the Mongols. Ancient Egyptian records show garlic was revered then as it is today. It was later brought to the Mediterranean area, where its notoriety in the southern Italy cuisines is well known. Garlic was first brought to the new world by Cortez, where it was prized by native Americans.

Between 1975 and 1994 garlic production in the United States more than tripled. Today, the US produces approximately 500 million lbs., with production rising about 10 percent per year. The US imports another 100 million lbs. Annual per capita consumption is approximately 1.6 lbs. The majority of US garlic is produced in California. In Gilroy California, the self proclaimed garlic capital of the world, the much publicized garlic festival attracts more than 90,000 visitors annually.

Garlic, like an onion, is a monocotyledenous member of the Amaryllidaceae family. Unlike the onion, the bulb is made up of a number of cloves (2-10 depending on the variety). These cloves are generally encased in a sheath and bound at a central axis plate at the bulb plate. Garlic does not produce a true seed and is therefore propagated vegetatively. In some varieties, a bulbet is formed at the top of the plant, which can be used for starting a new plant. In general though, production of garlic is done by breaking up bulbs, a process termed "cracking", and planting the individual cloves. The onset of the bulb is influenced by photoperiod and temperature.

The two important subspecies that are cultivated today are *sativum* and *ophioscorodon*. One difference between the two that makes them easy to distinguish is the stem, the *sativum* has a soft stem or neck, the *ophioscorodon* has a stiff, woody stem and commonly termed "hardneck". Essentially all garlic found in local grocery stores is the *sativum* type. They are well adapted to their climate and soil conditions. The second subspecies or the "ophio" tend to produce better in colder climates and are increasing being grown in northern temperate climates. Areas in upstate New York and southern Ontario have been quite successful in cultivating this subspecies. In 1995, the US imported approximately 100,000 lbs of hardneck grown in Canada.

The objective of this project was to evaluate and demonstrate the commercial production of garlic in Wisconsin. It was to seek an alternative to leaf tobacco growing in the south and western regions of the state. Tobacco has always been considered a high value cash crop to local farmers, but over the past decade or more, allotments have been drastically cut. Garlic may be one crop to fill that void.

Project Activities

The following is a chronology of the project over the past two years.

Ground preparation on approximately 1/3 acre began in early September 1997. The area to be planted, which was previously an alfalfa field, was cut and treated with Roundup. In early October, the area was plowed under and disced. Planting stock was ordered from suppliers and the bulbs arrived in mid-October. A shipment of 250 lb. of Canadian variety from southern Ontario and 30 lbs. of the standard California variety from local wholesalers was obtained for planting. Approximately 20 man-hours were used to divide the bulbs into cloves. All the bulbs were planted in one day using a two person single-row tobacco planter. A small low-geared tractor (Ford 3000) was used to insure proper bulb spacing at 4-5 inches and at a depth of 2 inches. Row spacing was 30 inches. Approximately 19,000 cloves were sowed in twenty four rows approximately 250 ft long. Mean clove weight was 6.7 gm., std. dev. 3.6 gm.

Cloves were expected to sprout in early to mid April but because of the unusually warm winter of 97-98, garlic shoots were first observed breaking ground on February 24. This anomaly was a concern as cold temperature may damage plant growth and overall production for the season

Conditions were generally quite favorable for the growth of the garlic plant in the spring. Cool temperatures and timely rains resulted in large healthy plants (Figure 1). The recommended 80 lb/acre of nitrogen was broadcast spread in three treatments every two weeks starting on March 15.

Weeds were a continual problem. Production guideline stress the importance of proper bed preparation to control weeds and clearly that was found to be the case here. The plot was cultivated once and rototilled twice. In addition, the whole plot was hand-weeded twice. Four rows were treated with Dacthal, a preemergent herbicide in early May, which in the short term, was moderately successful. As the summer progressed though, little lasting effect was seen.

A drip irrigation system was installed in mid-May. This system consisted of a 1 inch main line, laterals and T-Tape® running down each row. This low pressure set up was only used once because of adequate precipitation but worked successfully

As of June 12, 1998, the vegetative growth of most plants had ceased as expected. Plants were generally over 2 ft. in height. A central stem or scape began emerging during the last three weeks of June. This stem was subsequently removed so as to direct the growth into bulb production. A few scapes were left on plants for comparison and a definitely loss in bulb size was observed. A total of 130 lbs. of scapes were collected and shipped to an oriental food wholesaler in Chicago. The price was $1.00/lb. This may provide secondary income off the plants depending on ones labor costs.

The field plot was hand weeded and cultivated twice in the month of June and once in early July. Harvest began on July 15. A cultivator with one wide shovel was tested for loosening the bulbs and was found to be moderately successful. Approximately 10 percent of the bulbs experienced some damage. The majority of the crop was dug and harvested using a garden fork. The dirt was removed and the tops and roots were cut off using pruning shears (Figure 2). All the garlic was placed in banana boxes and filled 3-4 inches deep. The boxes were placed in a shed and allowed to air dry.

The hardneck variety far out produced the softneck. The 240 lbs. of Canadian garlic produced 1200 lbs.(5:1 return) of bulbs. The 30 lbs. of California produced only 40 lbs. of bulbs (less than a 1:1 return). The California bulbs were also much smaller in size and did not keep well through the summer. The average Canadian bulb size was 70.9 grams and clove size was 10.7 grams. These clove weights were slightly greater than the previously year's planted stock (6.7 grams).

In October, 1100 lbs. were again split into cloves and replanted. Some Penicillium mold was noted on the bulbs The planting effort took 46 man-hours. The test plot was now expanded to 1.6 acres. A two row tobacco planter was used in the second year (Figure 3) .

During the winter, a number of contacts were made at stores and vegetable brokers to find outlets for the following year's crop. In addition, after placing numerous advertisements in newspapers around the midwest, a single row potato digger was purchased that assisted in the harvest of next years crop.

Some garlic continued to sprout and grow into the month of December. Cold weather tended to be preceded by snow cover so winterkill was thought not to be a problem. Similar to the previous year, the cloves began to sprout and grow in earnest in March as soil temperatures rose. To our dismay, a large percentage of the cloves either failed to sprout, or sprouted and then died back. Upon digging some of the cloves up, we found them all to be soft and decaying around the basal portion of the cloves. The estimated loss was greater than 50 percent (Figure 4).

Possible causes for this die off was herbicide residue, pH, nutrient imbalance, winter temperatures and disease. Samples of cloves and soil were sent to UW Plant Pathology, University of California-Davis, and other experts in Washington, New York and Canada. It appears the reason for the die-off was a fungal disease called *Fusarium oxysporum*. This fungus is soil borne and occurs naturally. Also called basal plate rot, this fungus causes a decay to the roots and basal plate. A pink color is commonly seen at the base of the bulb, where a wet or dry decay takes place. There is no chemical control for this condition. Reasons for this condition are excess moisture, damaged cloves or clove that have not been stored properly.

The remaining garlic was cultivated once and nitrogen applied twice (80 lb/acre). Some looked stunted and other plants looked fairly healthy. An application of Fusilade DX ®was applied in late May for grass control.

In late June, I attended the Ontario Garlic Growers Conference in Ridgetown, Ontario. This conference brought together over 250 growers from the region (Figure 5). We visited two farms, one growing 17 acres, the other growing 25 acres of garlic (Figure 6). These medium-scale garlic growing operations are a relatively new enterprise in Canada (last 10-15 years) and the techniques and methods are still evolving. Producers who attended grow from garden size plots to 50 acres. A lot of the conference dealt with topics that one can not find in printed information on such as adapting existing equipment to fit the needs of garlic, drying bulbs, and marketing in eastern Canada and US.

Our second year crop was harvested again in mid July. Using the potato digger to raise the plants, the harvest went quicker (Figure 7). We removed the shaker on the digger for fear of damaging the bulbs. With just the front shovel lifting the plant, the bulbs were then picked up by crews and tops and roots removed. Curing and storage was

handled differently this round. Bulbs were placed in shallow racks (commercial bread transport trays) and placed in the basement with fans and dehumidifier (Figure 8). Temperature was kept at 68°F and humidity at 65%. The bulbs seemed to store better and no mold growth was observed. The total yield was approximately1400 lbs., close to the amount planted. This was obviously disappointing and a result of the over winter loss.

All except 100 lbs. was replanted this October. A new planter was designed and built to follow the techniques used in Canada (Figure 9). The planter mounds the dirt eight inches high, in a 20 inch wide hill and then spaces two rows, 10 inches apart down the middle of this ridge. The double rows are on 64 inch centers. This design has two advantages. First the ridge and furrow approach keeps the cloves out of the saturated soils in the early spring and the soil warms faster. Secondly, the two close rows allows for one drip irrigation line to be run down the center of the row. Thirdly, the spacing allows for the digger to harvest two rows simultaneously.

Conclusions

Both successes and failures were observed in this project. The first year's results were quite encouraging. The plants grew quite well and a high yield was gotten on a small area. The second year told a different story. A large loss in the spring led to a poor yield. What is more unsettling is not knowing exactly what led to the large die off. True, the fungus fusarium was found in the bulbs, but reference books suggest this infection could be secondary to some other factor(s) that initially weakened the cloves. These factors include herbicide carryover, excessive soil moisture, improper storage, and physical damage to cloves during planting. To a greater or lesser extent, all of these factors could of played a role in the loss. The field was previously planted in corn, in which residues of applied herbicides could be present. In addition, the early spring of 1999 was unusually wet. In fact some rows were partially washed out. Storage might also of been a factor. The Canadian growers went to great efforts to make sure their sheds had proper air circulation during the curing and storage of the bulbs. This definitely could of been a stress factor during the storage period of August 1998, when the first year's crop was stored in high humidity and high heat with little air circulation.

During the second year, our techniques and procedures were modified to counter the factors described above. Bulbs were stored in cooler, low humidity conditions. This fall, the cloves were planted in ridge and furrow rows to minimize excessive moisture. Unfortunately, the merits of these change won't be evaluated until next spring.

As far as the marketing of this garlic, again, because there hasn't been a large quantity to sell, the market haven't truly been tested yet. A number of retailers and wholesalers have been approached and a number of garlic samples given out. A few have expressed interest are willing to try moving some. Like any other commodity, a market will need to be developed over time and require public education. Potentially, the local or regional consumer may be willing to pay a premium for a Wisconsin vs. California product.

Recommendations

Clearly, garlic can be grown in Wisconsin. This root crop has successfully been grown by gardeners, farmer's market producers, and community based agriculture growers for years. Whether there is a niche for larger scale operations is unclear at this time. This farm will continue to grow it for the next couple of years to more fully evaluate its economic viability in the state. If other farmers wish to try garlic as a cash crop, the following points should be kept in mind.

1. Start small. Start with a garden plot and expand in successive years. This will give you time to learn about the plant's requirements and labor needs. One can theoretically expand five fold each year, which means five times the work- **for each step!**
2. Prepare the bed before planting. Most growers are on a two to three year rotation, with grain and legumes planted in the off years to build up organic matter and nitrogen. This is also important for weed control.
3. Nitrogen is the most important nutrient and it's required in its early growing stages. Garlic also requires water (1 inch per week) during its vegetative growth phase of April-June. If it doesn't have the necessary nutrients or water, small plants and subsequent small bulbs will result. Remember, garlic has a short growing season, so unlike other Wisconsin longer season crops, there is no time to "catch up".
4. Proper curing and storage is critical. Buildings such as tobacco sheds and open containers or racks are important for air circulation

Figure 1. First year planting in 34 inch rows. Note the small amount of winter loss and health of plants. April 1998.

Figure 2. Harvesting first year crop. Cutting of stems and roots from plants previously windrowed.

Figure 3. Two-row Ellis tobacco planter used to plant the second's year garlic.

Figure 4. Spring of 1999. Note the large loss of plants that occurred during this second year.

Figure 5. Attending the annual garlic growers conference in Ontario. Grantee meeting the association president, Garth Burrows, at the field trials.

Figure 6. Ontario garlic field. Plants here are spaced in groups of three 17 inch rows.

Figure 7. Potato digger used to lift plants for harvest.

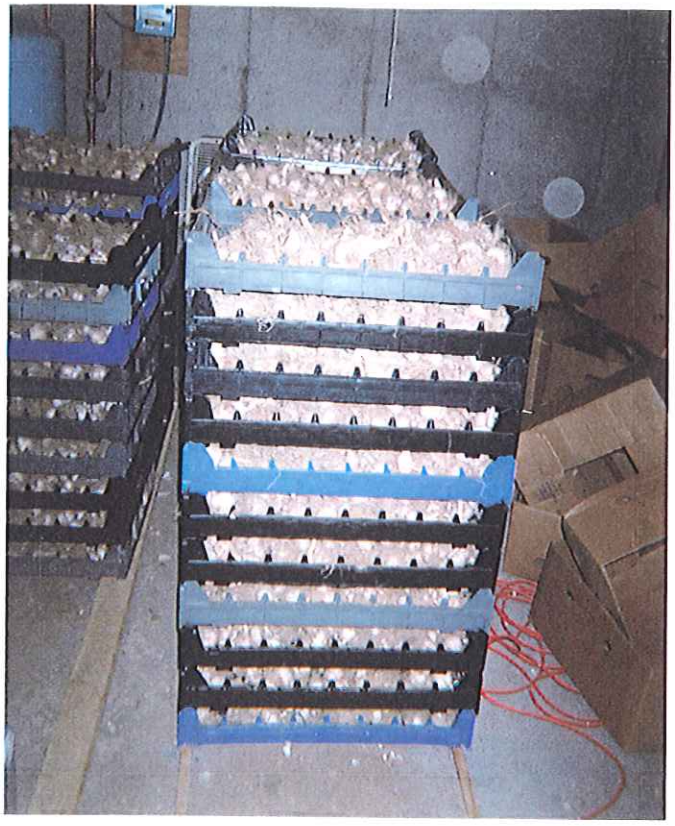

Figure 8. Bread racks used to dry and store garlic.

Figure 9. Custom built garlic planter. Note side weirs that push dirt towards the center to mound dirt as cloves are being planted. Cloves are dropped down tubes into planting shoes.