

Most documented
growers and
consumers of the



**ASSIGN
BUSTER**

Most of us are familiar with tomatoes, whether they come on our hamburgers or we eat them right off the vines in our gardens. However, tomatoes were not always considered to be a delicious food as we see them now. Tomatoes originated in South America during the times of the Mayan Empire, but they were not considered edible until approximately a century ago. The fruit of the plant when discovered was believed to be extremely poisonous since they are of the nightshade family, and were typically used in ornamental gardens or to decorate homes. (TAMU Extension). History of the Tomato Cultivated tomatoes are descendants of wild type tomatoes grown by Native Americans in the mountains of Peru, Bolivia, and Ecuador.

Some areas in those mountains today are still abundant with many wild type tomatoes. The first cultivated tomato species was carried down from the Andes mountains into Central America and Mexico around the same time as maize by a migratory group of Indians. However, because the fruit of the tomato is so highly perishable, this was one of the last crop species adopted by modern societies. After the plant was carried into Central America, it began to appear worldwide. The Italians are the first documented growers and consumers of the tomato with records dating back to almost 1550.

Approximately 25 years later, the plant was being seen across all of Europe (TAMU Extension). Economic Importance The tomato is now one of the leading fresh market crops in the United States, ranking fourth among all fresh market crops per capita use. Fresh market tomato production in the United States has trended upwards over the past several decades, with growth occurring most substantially during the 1980s.

Florida and California account for approximately two thirds of all fresh market tomatoes in the United States annually. The tomato market is most active in the spring when Florida and other Southeastern states, as well as California, begin to package and ship their crop (USDA ERS). During the 2016 tomato season, prices ranged from \$8.95 to \$12.

95 depending on size and variety (Packer). In 2012 global harvests yielded more than 162 million tons of tomatoes, worth more than 55 billion dollars (Marcia). Characteristics of the Tomato The Solanaceae family is a large family consisting of approximately 2500 species that grow in numerous habitats all across the world. “The Solanaceae family includes several plants of agronomic importance, including potato, eggplant, pepper, and tobacco, as well as tomato.” Currently, 360 varieties of tomatoes have been genetically sequenced. Tomatoes have a diploid genome of simple architecture that is distributed across 12 chromosomes (Sato). The tomato genome is estimated to be about 900 Mb long and contains 31,760 genes. Tomatoes are a summer crop, being grown harvested and sold throughout the summer months.

This means that the fresh crop of tomatoes to be sold can only be found during this time of year, however, there are stored crops that may be found in markets throughout the rest of the year. If I were to work with tomatoes to genetically modify them, I would wish to work to make the plant more tolerant to colder climates and temperatures so that fresh tomatoes can be sold and enjoyed by consumers during a longer time period throughout the year. Improvement of the Tomato Even though tomatoes are considered a summer time crop, there are some types that are considered early season

varieties that are more tolerant to cold weather. To create a plant with cold tolerance I would choose to breed two plants that already have some sort of cold tolerance.

Most of the cold tolerant tomatoes are of the determinate or dwarf type, so when selecting a variety to breed with these would be the best options (Northern). Scientists have also been working with tomatoes to make them more tolerable to colder temperatures by introducing a cold resistant gene that comes from a fish, the winter flounder (Lallanilla). For my purpose, these are the two types of plants that I would like to work with to breed a winter grown, or more cold tolerant tomato plant. Unfortunately, there is little information to be found about the inheritance of these traits from one generation to the next. In cases like this it is typically assumed that the traits have quantitative inheritance with low heritability. To begin the breeding process to adapt tomatoes to a cooler climate, I would begin by selecting two parent plants to begin breeding with.

For my parent varieties I would choose the Cold Set Tomato and the Black Prince Tomato. Originating in Canada, the Cold Set tomato is an open pollinated, indeterminate species. It is a globe type tomato with a sixty-five day fruit production cycle.

The plant is also tolerant to light frost. The Black Prince tomato is a heirloom variety that is also indeterminate. This tomato is also a globe type tomato that has a seventy day fruit production cycle. The Black Prince tomato originated in Siberia and tolerates cold climates extremely well (Tomato). The

Pedigree Method When breeding tomatoes, either backcross or pedigree breeding practices are used.

For my purpose, since I am starting with two preestablished parent plants, I would use the pedigree breeding method. When using the pedigree method, typically three crosses are made. In each cross the male plant will be one variety (variety A) and the female plant will be of a separate variety (variety B). In each of the three replications, crosses will be made by pollinating four to six flowers between the two plants. For example, since variety B is our female variety, four crosses will be made using the pollen from the variety A (male) plants to four flowers on the variety B plants. Once fruit is produced on each of the six plants, seed will need to be collected from three fruits from each plant (McKenzie).

The pedigree method will typically take about eight seasons to complete the breeding cycle. The first step will be the growth and crossing of the three groups (six total plants) of parent plants. This first season will produce between five hundred and five thousand seed. These will be planted in season two to become the F₂ generation. From the F₂ generation, approximately 250 plants will be selected. These plants will be grown as F₂: 3 progeny rows.

From these progeny rows, the best individual rows will be selected and then from these rows, the best individual plants (two or three plants) will be selected. In season three, the F₃: 4 lines will be produced. From these lines, the best crop families will be chosen. From these families, the best rows and then best two plants in each row will be chosen. In the fourth season, the F₄:

5 lines will be produced. The same steps as were used in season three will be used to choose the best single plant in each row. During the fifth season, the F5: 6 generation will be produced.

From these plants, the best crop families will be chosen and then harvested in bulk. Season 6 will bring the testing of the F5: 7 generation lines. These tests will be replicated at two separate locations using one replication per test location. During season 7, multi-environment test will begin on the F5: 8 generation.

Each individual plant will be analyzed at each location and individual fruits will be harvested based on appearance and what is determined to be typical for fruit from the plants. This will initiate the development of a pure seed line. Season eight will be a continuation of the multi-environment tests. This will involve the growth of approximately one hundred F8: 9 generation plants. These plants will be evaluated as were the plants in season seven to continue the development and enhancement of the pure seed line (Fehr). Secondary Traits The main focus of this breeding line is primarily to develop an early season or late season cold tolerant tomato so that the crop's fresh market life may be extended.

However, as the progeny lines are produced and tested, the plant will not just be evaluated for cold tolerance. Since the tomato is such a consumer-driven crop, the fruit will have to be analyzed for appearance. Also, the plant will need to have some resistance to typical tomato diseases such as fusarium and mosaic viruses, however these are likely secondary characteristics of the cultivar.

Breeder Seed Production To fully understand the release of breeder seed to the public, I turned to the legal documentation written by the State of Texas and the Texas A&M AgriLife Extension service. This document outlines that the breeder hold full responsibility for completing and submitting a seed Release Proposal. After this is done, to release new plant material, or seed, a public notice of availability must be made and the requests for those materials may be made by individual breeders or private firms. At this point, applications for intellectual property rights such as patents or plant variety protection may be made.

After this, individual breeders, private companies, and industrial groups may choose to enter partnerships with the breeder releasing the new material to gain access to the genetic property. All distribution of plant materials after all of these previous processes are completed must be fully documented to avoid any future problems such as ownership disputes, loss of property rights, and unauthorized distribution of materials (TFSS).