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The panel on "Harvesting Vine-Ripe Tomatoes in Florida" were, l to r: Robert Heisey, Harry Klee, Jay Scott, moderator, Elizabeth Baldwin and Wayne Hawkins, speaking.

## WORKSHOP

## CONSIDERATIONS IN HARVESTING VINE-RIPE TOMATOES IN FLORIDA[1]

INTRODUCTION
BY
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*Editor's note: In the rush of getting together Vol. 110 of the Proceedings, we omitted this Workshop. Apologies! Here it is in full.*

Consumer dissatisfaction with the eating quality of commercial tomatoes (*Lycopersicon esculentum* Mill.) is well known. There are several reasons for this. Fruit are often refrigerated in the marketing chain or by the consumers themselves. Consumers do not allow the fruit to fully ripen after purchase which are not table-ripe, and some fruit are immature at harvest when the harvesting system is for green fruit. One way to overcome the last problem is to harvest the fruit when they begin to show some red color, a system termed vine-ripe harvesting. Mexican tomatoes are harvested primarily at the vine-ripe stage which is facilitated by growing extended shelf life (ESL) varieties. ESL varieties are hybrids with one parent possessing the ripening inhibitor (*rin*) gene. These hybrids combine this gene with a high level of firmness to provide fruit which can withstand the rigors of vine-ripe harvesting, packing, and shipping to long distance markets. The eating quality of *rin* hybrids is not superior to that of mature green harvested varieties due to the association of off flavors with the *rin* gene. Plant breeders are working with *rin* and other systems to improve vine-ripe harvesting and this is one topic to be discussed by Dr. Bob Heisey. Other approaches to developing varieties with long shelf life are being explored by biotechnological approaches and this will be discussed by Dr. Harry Klee. The complex effects of variety and stage of fruit maturity at harvest will also be discussed by Dr. Elizabeth Baldwin. Can large-scale vine ripe harvesting be done in Florida? Wayne Hawkins of the Florida Tomato Committee will give his views on this and provide some historical perspective. I also hoped to have a grower perspective on vine-ripe harvesting but unfortunately the industry spokesman had to cancel.

[1]Workshop arranged by Dr. Elizabeth Baldwin, U.S.D.A., Winter Haven, Florida.

## The Vine-ripe Tomato Workshop, My Comments

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I have been associated with Florida agriculture for most of my life and have been employed as an association executive working for or with the Florida tomato industry for nearly 36 years. During this time, I have observed many changes. Some of these have been very dramatic and some have been quite subtle, but collectively they add up to a spectacular conclusion. We are now picking four times as many tomatoes per acre compared with 30 or 40 years ago. Cultural practices have changed, varieties have changed and customer preference has also changed.

The first tomatoes shipped from Florida in the late 1800's were picked green, wrapped in tissue paper, packed in barrels and sent north by boat and train. Several different packs followed and when trains were more readily available, the industry shifted to 60-lb. wirebound crates still packed with tissue wrapped green tomatoes.

In the 40's and early 50's, several growers started harvesting tomatoes at the vine-ripe stage. These were tomatoes that showed a tinge of color on the blossom end at time of picking. In later years the vine-ripe term was replaced by the more realistic breaker and riper stages. Also, mature green and breaker and riper stages were picked at the same time from the same plants.

With the advent of better transportation there was a new break-through using ethylene gas to start the ripening process. I remember how dangerous some of the first gas rooms were. They had a tendency to blow up every now and then. The reason, of course, was operators were using too high a concentration of gas. Anyway, the system of using gas canisters was perfected, ethylene generators were developed and IFAS perfected a new flow-through system to ripen tomatoes. Some variations of all of the above are still used today.

Applying ethylene gas to mature green tomatoes to start the ripening process coupled with semi-truck deliveries greatly increased the marketing area for fresh Florida tomatoes. The gassed tomatoes were more durable than the vine-ripened product and could be transported long distances without damaging the fruit. The key part of the puzzle that was not understood for many years was temperature control. Many tomatoes were stored and shipped at very low temperatures. Tomatoes should never be chilled below 55 degrees fahrenheit. Several hours of chilling temperatures kills the tomato. It will continue to turn red but it will not ripen.

Many wholesalers, retailers and consumers still keep tomatoes too cold. The hydrator in a home refrigerator is usually about 40 degrees fahrenheit. Tomatoes should never be

stored at this temperature. They are a fruit and should be stored at room temperature, just like bananas.

Following Castro's take-over in Cuba in the early 1960's, Mexico became Florida's number one competitor. Many Florida producers started joint ventures in Mexico and in essence taught the Mexicans how to grow tomatoes. Labor was cheap and plentiful and gas rooms were not available, so Mexico became a producer of breaker and riper tomatoes or vine-ripes if you prefer. A few greens were harvested and some shippers built gassing facilities, but Mexico still remains primarily a vine-ripe producer. Until recent years their quality was inferior to the Florida product and was sold at discounted prices since they had a tendency to be soft, were quite runny when sliced, and had a very short shelf life.

Some of the newer extended shelf life varieties remain firm for long periods of time and now compete strongly with Florida tomatoes. They cut like an apple and are crunchy, but they are called vine-ripened tomatoes and last a long time on the display rack. This makes them appealing to the retailer, regardless of how they taste.

Why does the consumer buy this product? She associates a vine-ripe tomato with the red-ripe tomato she picks in her garden or remembers picking in someone else's garden at sometime in her life. She demands vine-ripe tomatoes from her grocer, which he supplies, but she is still not satisfied because it doesn't taste like the red-ripe tomato she remembers.

So now let's look at the big question. Why then doesn't the Florida tomato producer deliver red-ripe or at least vine-ripe tomatoes to the grocer for the consumer to enjoy?

The answer is pure economics. Many growers have tried and failed to deliver the so-called wanted product. First, red-ripes are too fragile. If you go into a field and pick a bucket of red-ripes, carry them to your car and take them home and place them on the table—at least one-third will be severely bruised, mashed, split or otherwise culls. Any good ones would be damaged in shipment even if you packed them in egg cartons.

What about breakers and ripers? About 15 percent of the Florida crop is picked at this stage. It is picked right along with the mature greens, therefore, it is also easily bruised or damaged. In most cases it is sold for a discount even though it is considered a premium product by the consumer. If you pick a field strictly for color, you can cut down some on the damage, but if you pick just for color, you would have to pick three or four times a week and maybe even daily in hot weather or at periods around the full moon. The price of labor and the availability of labor make this virtually impossible. Mexico has unlimited labor, pays less per day than we do per hour and picks a crop 40 to 50 times. We normally pick a crop three to four times over a 30 to 40 day period.

This past season Florida experienced severe labor shortages in some areas. This is not something new. During World War II, off-shore labor was imported into Florida and some of this was for harvesting tomatoes and other vegetable crops. This continued until about 1947 and still is used today for sugar cane harvest in Florida and apples and other crops in other areas of the U.S. Several growers on the east coast of Florida are considering using off-shore labor to harvest tomatoes this season.

In the 60's and early 70's the Florida tomato industry looked hard at mechanical harvesting because of severe labor shortages. A harvester was produced that would pick the fruit with less damage than now occurs with hand picking. The problem was we didn't have a variety for this type of harvest. It is a destructive harvest so you can only pick it once. Most of our varieties have to be picked about three times to get the yields necessary to be economically feasible.

Also, it is questionable that high color tomatoes could be picked mechanically without creating severe damage. We had a couple of varieties that could. They looked good and tasted good, too—but, you had to peel them before you could eat them because the skin was so tough. This changed the breeding strategy. Instead of breeding for tough skin tomatoes the emphasis was placed on thick walls, fewer locules and very meaty tomatoes.

In the past few years a number of taste tests have been conducted comparing vine-ripened tomatoes versus mature green tomatoes. In each test, the fruit was picked at the two different stages of ripeness, properly ripened controlling temperatures and offered for tasting on separate plates. Salt, pepper, dressings, etc. were available if someone wanted them. In every single test where the degree of maturity of the products at time of picking was not known to the taster, the properly ripened mature green tomato was picked three to one over the properly ripened vine-ripe tomato. The major comments were: better flavor, better texture, better appearance and more like the ones I grow in my backyard. When the taster knew the maturity of each sample they were tasting, the preponderance of answers was "no difference."

To me this is very enlightening. It tells me we have a great product to start with. We simply don't handle it properly after harvest. We allow the middle men to determine how and when to ripen it and we do a sorry job marketing the finished product.

No one wants a "mature green" tomato unless maybe they want to serve fried green tomatoes. We need to change our terminology. There is no definition for a vine-ripe tomato except one that is showing color at time of shipment. Technically, we could sell tomatoes out of the gas rooms as vine-ripe tomatoes. Morally, this might not be right, so we don't do it. But, why can't we sell them as farm ripe, Florida ripe or some other kind of ripe? They are as ripe when shipped as most tomatoes picked and sold as breakers and tests show they will fully ripen to a better product than those picked as breakers if temperature is controlled properly. The big secret is not what you have, but what you call it. In other words, no more mature greens!!

This sounds simple, but it isn't. People who have been selling or buying "mature greens" for 10, 20, 30 or 40 years or more don't change easily, but we must start. And, the time is now!

The Florida Tomato Committee has made several subtle changes in the regulations over the past two seasons to encourage shippers to become more involved in place-packing tomatoes with color. Several large growers are experimenting with these new packs now. If successful, I think you will see more of a shift to this type of pack. It will allow us to offer a place-pack of tomatoes comparable to the Mexican vine-ripe.

Another area that I strongly recommended was considered this year and that is mandatory gassing for at least 48 or 72 hours. At least half of Florida shipments are gassed or degreened by the receiver. Numerous research shows that the earlier you gas tomatoes, the more effective the results. Turning this very important post harvest procedure over to the buyer is a big mistake. History proves that tomatoes gassed in Florida immediately after harvest have far fewer problems or requests for adjustments on the other end.

The Florida Tomato Committee's education and promotion plan will also continue the education process on proper temperatures, storing, ripening and preparation of fresh Florida tomatoes with wholesalers, retailers and consumers. A video on proper ripening and storage has been produced and is being widely distributed to wholesalers and retailers. A second video covering the same subjects will be made and distributed to food service organizations throughout the marketing area and articles directed to the consumer are being distributed to food publicity editors on a monthly basis.

In summary, I want to emphasize a few key points. A big increase in the shipments of vine-ripened tomatoes from Florida may not be economically feasible because of the many concessions granted to Mexico by the U.S. We have a good product now, if we ripen it ourselves, handle it properly and market it effectively. Let's get our act together; forget about the term "mature green" tomatoes and start selling farm ripe or Florida ripe tomatoes. We must take control of our post harvest handling problems, develop better ways to determine maturity and start selling tomatoes for what they are worth.

Thank you.

## Extending Shelf Life of Tomatoes by Conventional Breeding

ROBERT HEISEY
*Asgrow-Seed Company*
*San Juan Bautista, California*

The development of ESL varieties adapted to Mexican climatic conditions has allowed Mexican growers to compete effectively in the U.S. tomato market with a vine-ripe tomato. Adaption of these ESL varieties to Florida conditions could benefit Florida vine-ripe grower-shippers.

The new ESL hybrids incorporate conventional genes discovered in tomato germplasm over the last 30 years. Improved firmness, and slower ripening resulting from the use of these genes, *rin*, *nor*, and *alc*, allow for longer shelf life, longer shipping distances, and less shrink for the end handler.

Increased quality other than firmness has not been delivered to the consumers however. The challenge to breeders and growers alike, both in Florida and Mexico, is to deliver a vine-ripe tomato to the consumer, one which has the old-fashioned "backyard" tomato flavor.

## No Genetically Engineered Tomatoes Coming Soon

HARRY KLEE, EMINENT SCHOLAR
*University of Florida*
*Gainesville*

The use of biotechnology in altering the genetic composition of agricultural commodities is increasing exponentially. A good example of the trend toward genetically engineered crops is cotton. Insect tolerant cotton varieties have gone from zero to greater than 80% of the planted varieties in the southeastern US in just the last two years. In the entire US, approximately 4.5 million acres of genetically altered cotton was planted in 1997. That number is expected to increase to 7.5 million acres in 1998. The simple reason for that increase is that biotechnology has delivered what the farmer wants: a product that yields more with less cost.

So what is biotechnology doing for tomato? At this point, very little. Why? Market forces have not provided sufficient incentive for biotechnology companies to focus the resources that they have mobilized for corn, soybean and cotton. Biotechnology has principally focused on agronomic traits such as insect, virus and herbicide tolerance. Tomato acreage, needs and cultural practices have not provided the needed financial incentives.

What about issues of fruit quality? Everyone agrees that the flavor of tomato could be substantially improved. Everyone agrees that a better tasting tomato would be a desirable and valuable product. But there is no agreement on what that product should be. Do we want sweeter? More acidic? More aromatic? Before the weight of biotechnology can be brought to bear on a complex biochemical problem, the problem needs to be defined. This has not yet occurred. Further, if the current harvest and distribution system does not capture the potential of the germplasm already existing and the grower cannot guarantee the quality of his product after it leaves his hands, then what's the point of engineering a better tasting tomato? Yes, we have ways to increase sugars, acids, and volatiles. But until there is a mechanism in place to capture the price premium that repays the investment, there will be no genetically engineered tomatoes on your supermarket shelf. In the meantime, biotechnology will happily focus on other crops all the way to the bank.

## The Effects of Harvest Stage and Genotype on Tomato Flavor

ELIZABETH A. BALDWIN
*USDA*
*Winter Haven, FL*

The basic message of my talk is that there are differences due to harvest maturity and genotype:

(a) For harvest maturity, there is a difference in tomato flavor quality after ripening dependent upon maturity of harvest within the green stage. There are 4 designated stages of maturity in full sized green tomatoes ranging from immature green (M1), through M2, M3, and mature green (M4), which can only be determined by cutting the fruit open. The stages M1 and M2 definitely ripen with inferior quality. There were no apparent differences in flavor between mature green tomatoes (M4) and other more advanced harvest maturities (with various amount of red color visible on the surface of the fruit) until fruit were harvested red ripe. Only red-ripe harvested fruit seemed to offer better flavor than those harvested mature green (M4).

(b) For genotype, there were differences due to genetic background between normal cultivars and especially when the *rin* gene (homozygous *rin* fruit don't ripen and thus are more firm) is present. Most *rin* hybrids that we tested were more firm than normal cultivars, but showed lower levels of important flavor volatiles and scored lower in sensory tests even if they were harvested at a later stage of maturity.