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TO: COUNTY EXTENSION DIRECTORS AND AGENTS (VEGETABLE AND HORTICULTURE) AND OTHERS INTERESTED IN VEGETABLE CROPS IN FLORIDA
FROM: J.M. Stephens, Extension Vegetable Specialist

VEGETARIAN NEWSLETTER 80-6

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I. NOTES OF INTEREST

A. Jim Montelaro Ill

It is with sadness that I report that Dr. Jim Montelaro suffered a stroke on May 16. Jim is still confined to the Alachua General Hospital in Gainesville where he is receiving physical therapy treatment to restore use of his left arm and leg presently immobilized. I'm sure that he would appreciate a note of encouragement from his many friends throughout the state. He is able to receive visitors. We look forward to a complete recovery. His address is Room 355, Alachua General Hospital, 801 SW 2nd Avenue, Gainesville, Florida 32602.

(Maynard)

B. New Faculty Member

Michael B. Lazin joined the Vegetable Crops faculty at Gainesville on May 8. He has a joint teaching-research appointment. A native of Philadelphia, Mike received the BS from Delaware Valley College and the Ph.D. in Vegetable Crops from Cornell University. We are pleased that Mike has joined us and we welcome him to Florida.

(Maynard)

C. Research Reports From Sanford

Three recent Research Reports have been released from the Sanford AREC that may be of interest.


Copies can be obtained from the Vegetable Crops Department or Sanford AREC.

(Maynard)

II. COMMERCIAL VEGETABLE PRODUCTION

(NO ARTICLES)
A. Ethylene in Postharvest Biology -- An Overview

Ethylene, one of the simplest organic compounds, causes many responses to horticultural crops and products. It probably causes some of the problems that county Extension Agents are asked to solve. We can probably be most effective in helping our commercial horticultural industry, home gardeners, and consumers by increasing our own knowledge of ethylene and its roles. The following article on Ethylene in Postharvest Biology -- An Overview by Dr. Adel A. Kader should be helpful to all county horticultural agents. This article was first published in the University of California Perishables Handling Newsletter, Issue #44, December, 1979. Other articles related to ethylene also appear in that issue. Horticultural agents interested in single copies can obtain them from Dr. Mark Sherman, Vegetable Crops Department, University of Florida, Gainesville, FL 32611.

ETHYLENE IN POSTHARVEST BIOLOGY: AN OVERVIEW

by Adel A. Kader, Extension Pomologist, University of California

Ethylene is one of the simplest organic compounds which have an effect on physiological processes of plants. It is a natural product of plant metabolism and is produced by all tissues of higher plants and by some microorganisms. Ethylene is considered the natural aging and ripening hormone and is physiologically active in trace amounts (0.1 ppm). Its effects on harvested horticultural commodities can be desirable or undesirable. Thus, it is of major concern to all handlers of fruits, vegetables, and ornamentals.

Physical Properties:

Ethylene is a two-carbon hydrocarbon with a double bond (CH₂=CH₂) and it is a gas at normal temperatures and pressures. It is a colorless gas with a faint sweetish odor that can be detected in parts per million concentrations. Ethylene gas is flammable at 3.1 to 32% (by volume) in air. At high concentrations, ethylene is both an anesthetic and asphyxiant. Thus, adequate safety measures should be practiced when ethylene is added in ripening rooms. The minimum explosive concentration of ethylene (31,000 ppm) is at least 3000 times the concentration needed for stimulation of fruit ripening and should never be used commercially.

Ethylene as an air pollutant:

Ethylene can be a major component of air pollution and it comes from:

1. Natural sources: plants, soil, natural gas, burning vegetation.

2. Man-made sources: industrial, combustion of coal and oil, refuse burning, operation of motor vehicles, cigarette smoke, fluorescent ballasts, rubber materials exposed to heat or UV radiation, etc.

Ethylene production by horticultural crops:

The amounts of ethylene produced by horticultural crops vary greatly. Climacteric fruits produce large quantities of ethylene coincident with their ripening. The rate of ethylene production by fruits is influenced by many factors including the following:
1. Physiological age -- higher rates with advanced maturity and ripeness stage.
2. Temperature -- higher rates with increased temperatures between 32°F (0°C) and 77°F (25°C); temperatures of 86°F (30°C) or higher inhibit ethylene production.
3. Oxygen level -- reduced rates with low O₂ levels especially below 8%; elevated (>21%) O₂ levels increase C₂H₄ production rates.
4. Carbon dioxide level -- elevated CO₂ levels may either increase or decrease C₂H₄ production rates depending on the commodity.
5. Other hydrocarbons -- propylene, acetylene, etc., can enhance ethylene production by plant tissues.
6. Stresses -- physical damage, disease, waterlogging, fumigation, etc., are all stresses which stimulate C₂H₄ production by plant tissues.
7. Inhibitors -- some chemicals (i.e., amino-ethoxyvinylglycine) inhibit C₂H₄ production by plant tissues.

Biosynthesis of ethylene in fruits:

Research by several postharvest biologist for many years has helped expand our knowledge of where does ethylene come from in fruits. Some important discoveries were recently made by Dr. S. F. Yang and his associates (UCD Dept. of Vegetable Crops) in relation to intermediate compounds and enzymes involved in ethylene biosynthesis. We now know that ethylene is synthesized from the amino acid methionine via S-adenosylmethionine (SAM) as an intermediate. SAM fragments to 2 components including 1-aminocyclopropane-1-carboxylic acid (ACC) which is an amino acid. This is converted, with the help of ethylene synthase enzyme, to ethylene, formate, CO₂, and ammonium ion. Oxygen is required for the latter step to take place. It was also found that treating plant tissues with ACC stimulates their ethylene production.

Mechanism of ethylene action in fruits:

Various proposals have been made as to how ethylene exerts all of its effects in fruits but more research is needed before its mode of action can be understood. Many of the factors mentioned above which influence C₂H₄ production also affect its action. For example, decreased temperatures, reduced O₂ levels, elevated CO₂ levels, and some inhibitors (i.e., silver ion) reduce ethylene effects on harvested horticultural commodities.

Ethylene production by pathogens:

Ethylene is produced by many species of bacteria and fungi which are pathogenic to harvested horticultural commodities. Also, diseased plant tissues produce higher levels of ethylene than healthy ones. Banana fruits infected by Pseudomonas solanacearum bacteria lose their green color faster than healthy fruits. Carrot and sweet potatoes infected by Ceratocystis fimbriata fungus produce more C₂H₄ than non-infected roots. Tulip bulbs infected by Fusarium oxysporum f. sp. tulipae fungus can produce enough C₂H₄ to cause gummosis when diseased and healthy bulbs are stored in the same room. Ethylene produced by Pencillium digitatum fungus promotes degreening of citrus fruits.
Desirable effects of ethylene:

1. Ethylene can stimulate abscission of fruits and help facilitate their harvesting.
2. Ethylene can be used to stimulate sprouting of seed potatoes before planting.
3. Ethylene can be used to promote faster and more uniform ripening in fruits picked horticulturally mature. This is the most important desirable effect of \( \text{C}_2\text{H}_4 \), which is the natural regulator of fruit ripening. It influences most of the processes associated with ripening and not only color. Faster ripening can mean reduced time between harvest and consumption of fruits which also means better quality and nutritive value to the consumer.

Commercial application of ethylene:

Ethylene may be used commercially to achieve faster and more uniform ripening of fruits, i.e., bananas, tomatoes, honeydew melons, casaba melons, mangos, papayas, persimmons, etc. It is effective only if applied to fruits before ripening is initiated. In this case, ethylene enhances maturation and triggers subsequent ripening. If the fruits have already begun to ripen, they will produce their own ethylene and any added \( \text{C}_2\text{H}_4 \) will be useless.

A concentration of 100 ppm \( \text{C}_2\text{H}_4 \) for 24 to 48 hours is generally adequate for most fruits. The optimum temperature range for fruit ripening is between 20°C (68°F) and 25°C (77°F) with a relative humidity of 85-95%. Adequate air circulation within the room to insure uniform distribution of the gas is important. It is also essential to insure that \( \text{CO}_2 \) produced by respiration does not accumulate in the room by using adequate continuous air exchange or by opening the room for air change every 24 hours, then regassing.

Degreening of citrus fruits by \( \text{C}_2\text{H}_4 \) treatment helps remove chlorophyll (green color) from the rind without affecting other components of the fruit.

Ethylene can be applied by one of the following methods:

1. Addition of measured quantities of ethylene from gas cylinders or lecture bottles. Banana gas is diluted ethylene (with an inert gas) which is not flammable and thus more safe to use.
2. Use of ethylene generators where a liquid is heated to produce ethylene. The number and location of these generators to achieve desired concentration depend upon room size.
3. Use of ethylene-releasing chemicals such as Ethephon (2-chloroethane phosphonic acid) which release ethylene upon changing the pH to the alkaline side. This is widely used on processing tomatoes before harvest. None of these chemicals are approved yet for postharvest application.

Undesirable effects of ethylene:

There are numerous examples of undesirable effects of ethylene on harvested horticultural crops. These include:

1. Accelerated ripening and softening of fruits during storage when not desired.
2. Accelerated senescence and loss of green color in some immature fruits (cucumbers, squash, etc.) and leafy vegetables.
3. Russet spotting on lettuce.

4. Formation of bitter principle (isocoumarin) in carrots.

5. Induction of stress metabolities, i.e., impomeamarone in sweet potato roots.

6. Sprouting of potatoes - either stimulation or retardation depending on concentration and duration of exposure to ethylene.

7. Abscission of leaves (cauliflower, cabbage, foliage ornamentals, etc.)

8. Toughening of asparagus.

9. Abbreviated storage life and reduced quality of cut flowers - e.g. "sleepiness" of carnations.

10. Physiological disorders in flowering bulbs: \( \text{C}_2\text{H}_4 \) (0.1 ul/l or higher) inhibits elongation of shoots and roots in several bulb species; induces gummosis, bud necrosis, and flower-bud blasting in tulips, promotes flower-bud abscission in lily and leaf abscission in hyacinth.

Sources of ethylene during postharvest handling:

Based on a survey of ethylene concentrations and its possible sources during postharvest handling of lettuce, it is clear that the problem areas are cold storage rooms used for holding the commodity at various points in the handling and distribution system.

Avoiding exposure to ethylene:

A. Exclusion of ethylene from storage rooms.
   1. Use of electric fork-lifts.
   2. Use of \( \text{C}_2\text{H}_4 \)-absorber on the exhaust system of fork-lifts.
   3. Avoiding other pollution sources.
   4. Avoiding mixing \( \text{C}_2\text{H}_4 \)-producing commodities with those which are sensitive to \( \text{C}_2\text{H}_4 \).

B. Removal of ethylene from storage rooms.
   1. Use of adequate ventilation (air exchange).
   2. Use of ethylene absorbers.
      a. Potassium permanganate (for example, "Purafil" which is alkaline \( \text{KMnO}_4 \) on aluminum silicate pellets).
      b. Activated and brominated charcoal alone or in combination with \( \text{KMnO}_4 \) (such as "Stay-Fresh absorbers").
   3. Use of ozone or ultraviolet radiation (which oxidizes \( \text{O}_2 \) to ozone) to oxidize ethylene: \( \text{C}_2\text{H}_4 + [\text{O}] \rightarrow \text{CO}_2 + \text{H}_2\text{O} \)

In this system, UV at 185 nm produces ozone which oxidizes ethylene while UV at 254 nm destroys the remaining ozone which is very harmful at very low...
concentrations to all commodities.

4. Use of low pressure system (hypobaric storage).

Methods of determining ethylene concentration:

Generally ethylene is analyzed by gas chromatography which is a very sensitive method (10 parts per billion can be routinely detected). However, this is strictly a laboratory technique and air samples will have to be collected then transported to the laboratory for analysis.

Two methods are available for determination of ethylene concentration away from the laboratory. Although less accurate than gas chromatography, they are much less expensive and probably adequate for commercial use. These methods are:

1. Use of the Kitagawa gas detector system which includes a piston-type volumetric pump into which direct-reading detector tubes are inserted. Analysis is based on chemical reaction of a reagent in the detector tube with ethylene in the air sample. The extent of this reaction is then translated into concentration from a calibration chart. Detectable ethylene concentration range is 0.1-100 ppm and accuracy is ±10% for this method.

2. Snoopy Electronic Ethylene Detector is a new portable instrument which is capable of detecting 0.1 ppm \( \text{C}_2\text{H}_4 \) in a 1 ml gas sample with ±5% accuracy. For more information contact Bio-Gas Detector Corporation, 4245 Okemos Rd., Okemos, MI 48864.

Conclusions:

It is clear from this overview that ethylene plays a major role in postharvest biology of harvested horticultural commodities. Because of the wide range of desirable and undesirable effects of ethylene, it is very important to understand specific responses including physiological disorders of each commodity to ethylene. Then, the postharvest handling systems currently used for horticultural crops must be evaluated in relation to their sensitivity to ethylene action, and must be modified accordingly.

Research should continue to further identify the mode of ethylene action, its possible involvement in various physiological disorders, its effect on pathogens, etc. Also, new effective and economical methods for ethylene removal must be given high priority in research and development efforts.

-End of Kader article-

(Kasmire)

IV. HOME VEGETABLE GARDENING

A. Mounding Tomatoes For Better Yields

A Florida gardener and Urban Gardening Program Aide, Mr. Wade Ellis, has innovated a technique for growing home garden tomatoes that has proven so successful that I am going to pass it on to others with his permission.

Using tomato mounds prepared in his unique way, Ellis has consistently grown plants which produce almost unbelievable yields of quality fruits. It is not
unusual on each plant to find 40 to 60 tomato fruits ranging in size from large to small. He relies on the 'Flora-Dade' variety transplanted about mid-March in the Jacksonville area. By late May and early June, the plants are literally breaking-over with the abundance of fruit. Of course, he supports the plants upright with string and two or three stakes per mound.

The simple technique involves building a mound of soil over a pile of cow manure. Here is how to construct the mound and plant the tomato.

1. Prepare the soil into seed bed condition as usual, liming if need is indicated by soil test, and treating for nematodes if necessary.

2. On the selected site or row for the tomatoes, measure three feet between each mound center.

3. Place a double layer of unfolded newspaper flat on the soil surface at each planting site. The paper appears to reduce the leaching away of moisture and nutrients.

4. In the center of the paper, place a shovelful (one gallon) of rotted cow manure.

5. Depress the center of the pile with the fist or trowel, making a central cavity almost down to the newspaper.

6. Measure one and one half cups of common garden fertilizer (6-6-6, 6-8-8 or 8-8-8) and place it in the central cavity. Do not mix the fertilizer with the manure.

7. Using a hoe or rake, pull the soil from around the edges of the newspaper up over the manure until a mound is formed three to four inches above the manure pile. Again, do not mix the soil, manure, and fertilizer.

8. Now, dig a planting hole on top of the mound just deep and large enough to accommodate the root ball of the tomato plant. Place the plant in the hole, water, and firm soil around the stem. Keep roots at least one inch above the fertilizer. A slight depression round base of plant will help hold water until it soaks into the soil.

9. Water the plant root zone with a little liquid fertilizer solution for a week or two until the plant starts to grow. Then, no more fertilizer is needed for the rest of the time the tomato is alive.

10. Insert two or three sturdy 4 to 6 foot tomato stakes around each mound. Confine and support the single plant to these stakes with cord as it grows. It is important that the plant be staked or supported by a wire cage, for the plant is growing primarily above the ground. Wind or other forces can easily topple non-supported plants.

11. Water and care for the growing plants as usual. Roots will penetrate the paper and grow into the soil beneath, but most of the roots will be concentrated in the mound. With the 'Flora-Dade' variety, it is not necessary to prune the plants.

(Stephens)
B. Know Your Minor Vegetables - Angelica

Angelica (Angelica archangelica) is a European perennial plant sometimes grown in this country as a culinary herb. In addition to garden angelica, other common names are archangel and masterwort.

History - This member of the parsley family, related to carrots, grows in fields and damp places, from Labrador to Delaware and west to Minnesota. Syria is believed to be its point of origination.

Many species have been used since early times where it has been regarded most highly for its medicinal and magical properties, especially in counteracting poison and plague and warding off evil. Its name probably derives from these properties. One species is called "Holy Ghost" (A. sylvestris), while the common is A. archangelica.

Uses - Fresh angelica has a powerful, peculiar, pleasant soft musky odor and a sweet taste (pungent after-effect). The odd flavor and odor are due to a volatile oil contained in all parts of the plant.

The fresh stems and leafstalks are used as garnish and for making candied angelica. The seeds and the oil distilled from them are used in flavoring foods, and the aromatic roots are used in medicine. People in the north, particularly the Lapps use it as a foodstuff, condiment, medicine, and even chew it like tobacco. The Norwegians use the crushed roots in their bread. Laplanders eat the stalks and Icelanders both the roots and stems, raw with butter. In Finland, the stems are cooked with flavoring provided by the leaves, while in Norway a bread is made from its roots. Eskimos in North America use the stalks like celery.

Wild angelica (Angelica sylvestris) has a lot of uses related to its hollow stems. Children squirt water through them, they are used like a pea-shooter, and the hollow stems have even been used in espionage for spying through holes in curtains.

Description - The robust growing angelica plant is five to six feet tall and resembles wild carrot. It has large petioles and a purple colored root. Leaves are compound and flowers are borne in umbels like the carrot. It is a perennial plant that flowers every two years.

Cultural - The plant thrives best in a moderately cool climate in semi-shade; therefore, it is unlikely to grow well in Florida. The plant is most readily propagated from division of old roots, which can be set either in the fall or spring about 18 inches apart in 3 foot rows. Seeds germinate very poorly, especially if more than a year old. When seeds are obtained, start seedlings in a seed bed, then transplant to the garden. In order to increase root development, the plants are often transplanted a second time, at the end of the first year's growth. For the same reason, the tops are often cut back to prevent the formation of seed.

Harvest - Roots, stems, and seeds are harvested and used as needed, with some parts being ready 3 to 4 months after planting. Sometimes the roots of the first-year plants are dug, but usually the harvest of roots is deferred until fall of the second year. The roots are then washed and dried in open air. Estimations of yields are not available. Dried roots should be kept in tightly closed containers to preserve the aroma.

Seeds/Plants - Several herb supply catalogs list angelica starting material for sale.

(Stephens)
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