VEGETARIAN
A Vegetable Crops Extension Publication
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I. NOTES OF INTEREST

A. Vegetable Crops Calendar

1. 1983 Florida Tomato Institute
   September 8, 1983

2. Florida Association of Extension Professionals
   1983 Annual Conference
   Don CeSar Beach Resort
   September 7 - 9 1983

3. American Society for Horticultural Science
   80th Annual Meeting
   McAllen, TX
   October 16-21 1983

4. Florida State Horticultural Society
   The Plaza Hotel
   Daytona Beach FL
   Nov. 1 - 4 1983

B. New Publications

1. Slicer Cucumber Cultivar Trial, Research Report
   SAN 84-1 by J.M. White

2. Carrot Production Trials, Research Report
   SAN 84-2 by J.M. White
   Both are available from Sanford AREC,
   P.O. Box 909, Sanford, FL 32771

3. Broccoli and Cauliflower Production in Florida,
   Extension Circular 555 by S.M. Olson and M. Sherman
   is available from your local County Extension Office.
II. COMMERCIAL VEGETABLE PRODUCTION

A. Edible Aroids (Araceae)

The edible aroids include plants from several genera that store starches in stem structures that generally develop into corms. The most common include: taro (Colocasia esculenta (L.), Schott.), cocoyam (Xanthosoma spp. (L.) Schott.), swamp taro (Cyrtosperma chamissonis (Schott.) Merr.), giant taro (Alocasia macrorrhiza (L.) Schott.) and elephant yam (Amorphophallus spp.). Taro originated in Asia and is considered to be one of the first domesticated food plants. Cocoyam originated in tropical America, giant taro probably originated in Sri Lanka, swamp taro grows wild in the Indo-Malaysian region and elephant yam grows wild in Southeast Asia, suggesting those areas as centers of origin.

World edible aroid production is estimated at $4.4 \times 10^6$ Mt/annum. Major production regions include Nigeria, Ghana, Japan, Papua New Guinea and Ivory Coast with 40, 28, 13, 5, and 4% of the world production, respectively. The production is in mixed cropping systems or in back yard gardens.

The first introduction of edible aroids into the southern part of the U.S. is not well documented. Caribbean Indians probably carried cocoyam planting material with them in their travels among the islands. Taro arrived during the times of slave trade in the Colonial period of the United States. Hawaiians probably brought taro with them to Hawaii from Tahiti about AD 1100.

In the family Araceae, the edible aroids cover several genera with the most widely grown being taro and cocoyam. The cultivated species of cocoyam, known as tannia in the English-speaking Caribbean, include: white-fleshed X. caracu and X. sagittifolium, yellow-fleshed X. atrovirens and purple-fleshed X. violaceum. Their separation into separate species needs closer investigation, since fertile seeds can be recovered in most interspecific crosses within this group. X. brasiliense is grown only for its edible leaves and does not form a large stem or corm as do the others. Additional less common species and several varieties have been outlined by Coursey.

Taro cultivars are often divided into two groups: 1) wetland or flooded taro that produces one large corm with few cormels, and 2) dryland taro that produces several small cormels rather than one large corm. The former, known by the name dasheen in the English-speaking Caribbean, appears to have a shorter shelf life and has been established as C. esculenta var. esculenta. The latter, known as eddoe in the Caribbean, has been classified as C. esculenta var. antiquorum. Other less common aroids include swamp taro, giant taro and elephant yam. These are very regional in their cultivation. Besides being eaten as a staple food the edible aroids are also grown for ceremonial purposes, starch
production and security against times of famine. In the South Pacific and Caribbean, the aroids are often the only food plants remaining after a hurricane has passed over the land. Cultivar names are very regional and are often related to plant physical characteristics such as pigmentation or places. For example, 'White' and 'Jamaica' are taro cultivars that are commonly found in the Caribbean. Presumably, the latter was grown originally in Jamaica and was carried to the other islands. Much confusion in edible aroid taxonomy remains and research in this area would be beneficial. Until such research is done, there is little use in dividing the aroids into groups smaller than those described above.

The first organized introduction of aroids into the U.S. was initiated by the U.S. Department of Agriculture Board of Plant Introduction early in the twentieth century. Through regional trials a cultivar of C. esculenta from Trinidad was selected for advanced trials. This "dasheen" was adapted to production as far north as the Carolinas, maturing in seven months. It was widely tested in the Southeast over a 10 year period. However, a strong market for the crop never developed, despite considerable promotion of it as a new food.

Large scale cocoyam production in Florida began with the arrival of Cuban exiles early in the 1960's. Acreage expanded to the current estimated 2,000 ha of production in Dade County. Taro production in Florida is limited to a few hectares. However, there remains potential for greatly expanded production. With a few exceptions, all edible aroid cultivars produce a starchy main cylindrical corm, ranging up to 500 cm in height and 200 cm in diameter, depending on growing conditions, plant genotype and age. Depending on species and cultivar, few to many lateral starch-filled cormels develop below the soil surface at the corm base as the plant matures. For the white and purple-fleshed cocoyam, the preferred types are those that produce large cormels with a distinct dormancy period, since sprouted cocoyam cormels have a lower starch content and inferior eating quality. In this case the corm is not eaten. These types have a long shelf life and are better suited for shipping than the other aroids.

Although the starch-filled corms or cormels are the part most often consumed, young unopened leaves and occasionally fully expanded leaves as well as blanched petioles of selected clones are eaten as cooked potherbs. Leaves are often used in the preparation of callaloo, a popular soup in the Caribbean. The starchy corm or cormel is prepared and consumed in many of the same ways as the potato. However, peeling and boiling appear to be the most common method of cooking. For populations dependent on wetlands for energy foods, edible aroids may be a better choice than rice from the standpoint of human nutrition. In fact, taro equals the potato for amino acid content. Acridity, associated
with presence of a proteinaceous compound in all plant parts is a problem in most genotypes. Although the acridity is usually destroyed in processing, some genotypes require more processing than others before they are edible.

The aroids grow best in warm, humid regions with regular rainfall. Soil type is generally not a limiting production factor. The ability to control water and drainage appears to be more important. Some taro genotypes can be grown under flooded conditions, provided that water is not allowed to overheat. Taro has a better tolerance of saturated soils than cocoyam, which must be grown on beds if flooding is likely. Taro also possesses some degree of salt tolerance since it is grown on South Pacific atolls.

Soil is cultivated prior to planting to remove weeds. Cuttings are planted in rows at up to 20,000 plants/ha in pure stand or they are planted at various spacings in mixed plantings. The top 1 to 5 cm of the corm with 5 to 15 cm of the petiole attached is usually used for planting material. For wetland taro, planting material generally has a long petiole with a small portion of the corm attached, while cocoyam cuttings have more corm and less petiole. Once planted, growth quickly begins if moisture is adequate. When planting material is in short supply, small unmarketable cormels can be used or the corm can be divided into several sections. These are stored until the wounds heal and one or two buds have enlarged. When sections of the corm other than the top are used, multiple shoots may develop. This is considered to be undesirable and excess shoots are often removed. Fertilizer at a rate and timing similar to cassava is recommended with modifications determined by soil analysis and climatic factors. The use of fertilizer late in the growing season is not usually recommended. It has been suggested that late fertilization leads to an undesirable texture change in the edible portion. Generally the edible aroids are planted in areas where irrigation is not needed or is easily applied if needed. Supplemental irrigation is not cost effective unless the market price is very high.

Weeds are controlled through cultivation by hand or tractor and in the case of wetland taro, by flooding. Herbicides are being tested and can be effective in controlling some weeds. However, none are registered for use on the edible aroids. Insect pests are mostly regional, causing varying degrees of damage. Aphids, spider mites and whiteflies are common, but seldom cause yield reduction. Meloidogyne spp. and Rotylenchulus reniformis nematode associations are the most common of those observed on the edible aroids. Damage appears to be quite variable. More research is needed before the full impact of nematodes on the edible aroids will be known. Diseases appear to cause greater problems, with corm and root rots caused by Pythium spp., Sclerotium rolfsii,
Phytophthora spp., Rhizoctonia spp., and Erwinia spp. being the most important. Of these, leaf burning disease of cocoyam, probably the same as "mal seco" in Puerto Rico, is reported to be caused by Pythium myriotylum and results in root death and yield reduction. Use of cormels rather than corms as propagative material reduces disease severity. Foliation diseases caused by Alternaria tenuissima, Cerospora spp., Cladosporium colocasiae or Xanthomonas spp. can cause damage on a regional basis. Virus and virus-like diseases can result in a wide range of symptoms including plant death. Dasheen mosaic virus (DMV) infection appears to be world-wide causing leaf distortion and feather mottling in some cocoyam genotypes, while taro is generally symptom-free. Yield reduction from DMV infection has not been documented in cocoyam or taro.

Aroid harvesting is labor intensive with little mechanization. It begins 7 to 15 months after planting when the plants are mature. Maturity is not a discrete event, but rather it is based on plant age and growth patterns. When taro is mature, the main plant produces progressively smaller leaves until the corm goes dormant. It is considered to be mature and ready for harvest when reduction in leaf size is noticeable. In cocoyam, maturity is based on the size of the corm and cormels rather than leaf development. For the white and purple-fleshed cultivars harvesting begins when the cormels are of marketable size, 12 to 20 cm long and 6 to 9 cm in diameter. When grown in mixed plantings, soil is removed from the base of the main plant and the larger cormels are removed. The soil is then replaced to allow the plant to continue growing. This process can be repeated 3 to 4 times after which the entire plant is usually removed. Harvesting of the yellow-fleshed types is based on the main corm development with the preferred diameter being at least 10 cm.

Flooded taro in Hawaii is drained prior to harvest, allowing the soil to crack and break the roots. Fields are reflooded and corms are harvested with the aid of hand tools. The leaves are then removed and the corms are washed and later rafted to the road. For cocoyam in Florida, plant tops are removed prior to harvesting. A lifting device similar to the potato digger is used to bring the corms and cormels to the soil surface. They are then sorted and packaged by hand. Taro marketing is commercialized in Hawaii with some being processed into poi, a cooked paste made from the red pigmented cultivar 'Lehua maoli' and others into chips. In southern Florida cocoyams are marketed in a similar manner to other fresh vegetables. Otherwise, in the tropics, corms and cormels are harvested as needed and a day's supply is carried to the market for local sale, while some are exported to Europe and North America. Refrigeration at 10 C with a high relative humidity as well as treatment with a fungicide dip are used to prolong storage life in shipment.

(Reprinted from article by S.K. O'Hair, AREC Homestead) - Stall-
B. Plant Nutrient Removal—Full Bed Mulch Tomatoes

Extension agents, fertilizer field men and crop consultants need to consider soil test results, fertilizer recovery and crop removal when designing sound fertilizer programs for vegetable growers. Most of the crop removal figures available for vegetables are rather old, are from canning crop studies, or are from western (arid) production areas.

A recent study by Extension workers in the Manatee-Hillsborough area on full bed mulched tomatoes may be useful to other areas with some modification. The study showed that the fresh weight of the "average" plant grown commercially in this area weighed 10.6 lbs. without fruit or roots. Several hundred samples on 9 farms spring and fall crops are averaged. The yield of 26.3 lbs of marketable fruit and 13.1 lbs. of immature fruit was from the high yielding grower group but the top growers often exceeded this 39.4 lbs total by 5 or 6 lbs.

The composition on a dry weight basis was found to be:

<table>
<thead>
<tr>
<th>Element</th>
<th>Plant(%)</th>
<th>Fruit(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1.95</td>
<td>3.08</td>
</tr>
<tr>
<td>P</td>
<td>0.20</td>
<td>0.45</td>
</tr>
<tr>
<td>K</td>
<td>2.81</td>
<td>4.88</td>
</tr>
<tr>
<td>Ca</td>
<td>3.28</td>
<td>0.18</td>
</tr>
<tr>
<td>Mg</td>
<td>0.80</td>
<td>0.22</td>
</tr>
</tbody>
</table>

The average dry weight of the plants on a percentage basis was 7.9% and for the fruit (mature and immature) average 3.9%. The dry weights are only important for calculation purposes as recommendations are usually based on pounds of nutrients per acre relating to the fresh weight of a growing crop.

The calculations generated show the removal by 1,000 tomato plants grown under similar cultural conditions. In most tomato production areas of Florida the application rate of 240 lbs of N, 150 lbs. of P₂O₅ and 360 lbs of K₂O is used. The acre unit is quite variable because distance between beds can range from 5 to 12 feet; whereas, the number of plants per 1,000 linear bed feet is much more constant (18 to 30 inches between plants).
The removal was as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Plant (lbs)</th>
<th>Fruit (lbs)</th>
<th>Total (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>16.5</td>
<td>48.6</td>
<td>65.1</td>
</tr>
<tr>
<td>P</td>
<td>1.8</td>
<td>7.0</td>
<td>8.8</td>
</tr>
<tr>
<td>K</td>
<td>23.7</td>
<td>76.8</td>
<td>100.5</td>
</tr>
<tr>
<td>Ca</td>
<td>27.7</td>
<td>2.9</td>
<td>30.6</td>
</tr>
<tr>
<td>Mg</td>
<td>6.8</td>
<td>3.5</td>
<td>10.3</td>
</tr>
</tbody>
</table>

The next question is how can these figures help in formulating fertilizer recommendations?

If we consider the rather widely accepted efficiency of uptake figures: N- 50 to 70%, P- 20 to 30% and K- 50 to 60% we could develop a potential base need level of NPK:

<table>
<thead>
<tr>
<th>Element</th>
<th>Uptake (lbs)</th>
<th>Efficiency of uptake (%)</th>
<th>Elemental oxide requirements (lbs)</th>
<th>Oxide requirements (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>65.1</td>
<td>60%</td>
<td>108.5</td>
<td>108.5</td>
</tr>
<tr>
<td>P</td>
<td>8.8</td>
<td>25%</td>
<td>35.2</td>
<td>81.0</td>
</tr>
<tr>
<td>K</td>
<td>100.5</td>
<td>60%</td>
<td>167.5</td>
<td>210.0</td>
</tr>
</tbody>
</table>

These oxide requirements then must be translated into material equivalents, of course. For instance, it would require approximately 400 pounds of a 20% superphosphate to supply the 81 lbs of P₂O₅ absorbed per 1,000 plants.

These needs would be modified considerably depending on soil test results, whether the field is a new or old field, and the yield level desired. These figures are for growers who want to aim for high yields.

The 1,000 plant concept, or 1,000 feet of bed row, or even the 100 linear feet of bed, provides ready conversion for the wide range of "acre" concepts that exist in the Florida tomato industry.

-Marlowe-
A. Bitter Cucumbers

Both consumers who buy fresh cucumbers in the marketplace and those who grow them at home are quite often able to taste an objectionable amount of bitterness in the fruit. Many theories have been advanced to explain the cause of bitterness and how to deal with it.

Certain cultivars seem to be bitter more often than other cultivars, but even the non-bitter types are sometimes bitter. There is speculation that many cultural conditions contribute to the bitterness. Irrigation frequency, plant spacing, fertilization rates, and harvest period have all been considered to have something to do with it. Most of these factors were studied, but none were found to be influencing the degree of bitterness.

Perhaps the best explanation was provided by Dennis Pittenger in the California newsletter, Vegetable Briefs. According to Pittenger, the bitterness is due to the formation of two terpenoid compounds called "cucurbitacins" in the seedlings, roots, stems, leaves, and fruit. The presence of this bitter-causing compound in the plant tissue is controlled genetically. A dominant gene produces extremely bitter fruit and a recessive gene inhibits the formation of cucurbitacin in foliage and fruit.

Coupled with the cucurbitacin is an enzyme, elaterase, which hydrolyzes the cucurbitacin to non-bitter compounds. It is this elaterase activity that is thought to be governed by non-genetic influences such as environment and cultural practices.

The amount of bitterness in cucumbers appears to vary from year to year and from one location to another. Such a phenomenon may occur because elaterase production is stimulated or depressed under certain environmental conditions. Cool temperatures in particular seem to enhance bitterness.

When the bitter principle accumulates in the fruit, it accumulates non-uniformly among fruits and within the fruit. The bitterness is always found in and just under the skin of the fruit, never in the interior. The bitterness penetrates more deeply at the stem end than at the blossom end.

To minimize the problem, cucumbers should be grown under cool conditions whenever possible, and with optimum soil moisture and fertilization. New varieties should be selected, since they tend to have less bitterness than older varieties such as 'Straight Eight.'
Since bitterness is in or near the peel, removing the peel is the best way to remedy the situation. Direction of peeling makes no difference, according to the results of peeling tests. In very bitter cucumbers removal of a good portion of the stem end might be necessary in addition to deep peeling.

-Stephens-

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