Unique Challenges for Florida Growers

- *Weather Events*
- *Poor Soils*
- *Pest & Disease Pressure*
- *Labor*
- *Development & Urban sprawl*
- *Regulations*

Figure 1. Florida is also the lightning capital of the world. Lightning can blast crops leaving circular patterns and poses a formidable risk to field workers. Photograph by: Thomas Wright.

Figure 2. Hurricane Wilma damage and flooding. Photograph by: Monica Ozores-Hampton.

"The fact that Florida is the number one producer of fresh market pepper and tomato in the United States is quite remarkable given the unique challenges to growing vegetables in Florida and is a testimony to the resourcefulness and skill of the growers engaged in producing these crops."

WEATHER EVENTS:

While Florida's normally mild semitropical climate may seem ideal for the cultivation of warm season crops like peppers and tomatoes, producers have to deal with wide variations in temperature ranging from blazing hot to freezing cold. High temperatures can inhibit pollination and fruit set while all parts of extreme southern peninsular Florida can experience an occasional frost and more rarely a devastating freeze that can inflict millions of dollars in crop loss in a few short hours.

Florida receives bountiful precipitation however, the majority of the annual rainfall (50 to 70 inches in the major production areas) occurs during the wet season, which typically extends from May–June through mid October. During the long dry season, which coincides with the major part of the production cycle, it is not uncommon to go weeks and sometimes longer without a drop of rain. Given this reality it is impossible to successfully produce vegetables without irrigation.

Throughout the dry winter months, weather fronts passing across the state can result in uncharacteristic heavy rainfall as cold dry Arctic air collides with moist tropical air masses. Tropical storms can drop as much as 5 – 10 inches (or more) of rainfall in a few hours or days **(Figure 2)**. Thus, growers may spend nearly as much time and money pumping water off their fields as they do irrigating their crops.

This environment necessitates that growers provide for exquisite drainage by planting on raised beds and maintaining elaborate canal systems to remove excess water from the land. Intense rains can also result in leaching of fertilizer depriving crops of needed nutrients as well as resulting in non-point source pollution of ground water in some instances.

During the winter months, much of peninsular Florida can be blanketed by dense protracted fogs and heavy night dews resulting from the interaction of cooler terrestrial air and warmer air masses moving in from the surrounding waters. These events can occur on a nearly daily basis for extended period of time in some seasons and may endure until 9 or 10 AM before eventually dissipating. These events cause ideal conditions for the development of disease, which can be difficult to control until environmental conditions ameliorate.

Florida's geographical location makes it extremely vulnerable to direct hits from tropical weather systems and hurricanes originating in the Atlantic and/or Gulf of Mexico. Looking at a map of hurricane strikes over the last 100 years it becomes readily apparent that no area of the state has been spared and most areas suffer a direct hit every couple of decades. These violent events can leave plantings in a shambles resulting enormous losses in a brief period of time **(Figure 2)**.

"Climate is what you expect, weather is what you get..."

Prepared by: Gene McAvoy

TOMATO AND PEPPER PRODUCTION:
Unique Challenges for Florida Growers

POOR SOILS:

Most of the soils used to produce peppers and tomatoes in Florida are some sort of sand ranging from coarse "ball bearing" sands to fine "sugar" sands. In other pepper and tomato producing regions, most notably in the Homestead area, what passes for soil is basically pulverized limestone from ancient coral reefs. In either case, Florida's soil is merely a media to hold plants that provides little in terms of nutrients beyond what the grower supplies.

LOW ORGANIC MATTER CONTENT:

As a result of the high average temperature and high annual rainfall, the organic matter (OM) content of many agricultural soils is extremely low, often a fraction of a percent at best. Due to both low OM and the porous nature of these sands, Florida's soils have very low water holding and cation exchange capacity. Some soils can literally go from a flood to drought condition in less than two weeks if rain does not occur or irrigation is not provided.

POOR FERTILITY:

Low native fertility and low cation exchange capacity dictate that growers use high rates of fertilizer to supply all the essential nutrients that their crops require to produce. This situation makes leaching, especially under high rainfall or poor irrigation management, a distinct possibility, a factor that can contribute to non point source nutrient loading of surface water adversely affecting environmental sensitive areas nearby. In some instances on some of Florida's uncoated sands the exchange capacity is so low is that there is nothing to bind minerals to what are basically miniature glass beads that even some nutrients such as phosphorus that are typically considered to be immobile elements become mobile moving with ground water.

pH PROBLEMS:

The pH of Florida soils can vary widely as well ranging from very acid as low as 4.2 on native Pine Flatwoods fine sands to quite alkaline as high as 7.8 – 8 on the Rockdale soils and marls of Miami-Dade. Since much of the irrigation water used in agriculture is extracted from the limestone underlying the state, the pH of many originally acid soils can increase dramatically over time moving from an acidic to an alkaline condition in response to sustained irrigation, which can add as the equivalent of a ton of lime per acre on a yearly basis. These extremes of pH can induce either nutrient toxicity at the lower end of the pH scale or nutrient deficiencies as pH increases above 7 that a successful grower must learn to anticipate, diagnose and rectify.

PEST AND DISEASE PRESSURE:

Given the state's humid subtropical environment and warm average annual temperatures, insect, weed and disease pressure is constant and can be intense at times. Unlike other more temperate pepper and tomato producing areas, most of the state's growing regions do not experience hard freezes that so effectively reduce pest pressure.

Pest control costs for Florida growers surpass those encountered in many other growing regions of the United States.

Per acre production costs for pepper and tomato in Florida often exceed $10,000 per acre in large part due to the high cost of pest control.

EXOTIC AND INVASIVE SPECIES:

Florida's environment is also favorable for the introduction, survival and establishment of exotic pests entering the state from other countries. It is estimated that at least one new introduced pest or disease enters the state each year.

In 1997, *Tomato yellow leaf curl virus* infected whiteflies blew into the state by hurricane winds most likely from the Dominican Republic **(Figure 3)**.

In 2005, chilli thrips were detected in the state and since have been found in a least 16 counties across Florida. This pest has the potential to become a major pest of peppers and other vegetables and ornamental plants.

Figure 3. A tomato plant infected with *Tomato yellow leaf curl virus*, left, stands next to disease-resistant plant developed by UF/IFAS. Once infected with the disease, tomato plants no longer grow normally, and no longer produce marketable fruit. Photograph by: Ernest Hiebert.

Prepared by: Gene McAvoy

TOMATO AND PEPPER PRODUCTION: Unique Challenges for Florida Growers

Surveys of vegetable producers in southwest Florida indicate that growers spend from 6% to over 30% of their time and energy trying to comply with and maintain documentation required by various regulations.

LABOR:

Successful tomato and pepper production depends on an adequate supply of labor to plant, nurture, harvest and pack the crop. Florida's vegetable industry is heavily reliant on migrant labor. Unfortunately many of these laborers enter the US illegally and have attracted the attention and ire of many citizens and legislators who seek to curb the flow of undocumented labor into the country.

Competition for labor from the construction, fast food, hotel, landscape and others industries could negatively impact the supply of labor and force wage increases.

Figure 4. Rapid development and increasing land values throughout Florida are prohibitive for agricultural development. Photograph by: Jeff HansPetersen.

DEVELOPMENT AND URBAN SPRAWL:

Rapid development has gobbled up much of the prime agricultural land previously used for tomato and pepper production in eastern Palm Beach, Homestead and more recently in southwest and west central Florida.

Development has also raised real estate prices to levels, which prohibit the purchase of land for agricultural use in most areas of the state. In some areas land sells for in excess of $100,000 per acre and it is almost impossible to find any land for less than $15-20,000 an acre suited for crop production any where in south Florida **(Figure 4)**.

As housing encroaches on agricultural areas, neighbors may object to pesticide spraying, the movement of heavy equipment on roadways and other operations associated with agriculture.

REGULATORY ISSUES:

Successfully negotiating the regulatory environment can be a daunting task. The acronyms for the rules and the names of the agencies that administer them present a veritable alphabet soup for the typical grower.

BMP:	Best Management Practices
FWC:	Florida Fish and Wildlife Conservation Committee
FDACS:	Florida Dept. of Agriculture and Consumer Services
FDEP:	Florida Department of Environmental Protection
EPA:	US Environmental Protection Agency
SWFWMD:	Southwest Florida Water Management District
WPS:	Worker Protection Standard

Layered on top of legislative regulations may be buyer-mandated programs such as food safety or fair wage programs that have begun to emerge in recent years.

Competition from offshore producers has also emerged as a factor affecting vegetable producers in Florida. Besides the lower cost of land and labor, many of the areas currently in competition with Florida's growers are not bound by the regulatory tangle that vegetable producers in Florida must negotiate.

In response to many of the factors discussed above pepper and tomato production in Florida is now primarily controlled by a relatively small number of large corporate agribusinesses that have the ability to spread risk between multiple production centers and the resources to endure the adversity of a poor market year or years.

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IPM Integrated Pest Management Florida

UF UNIVERSITY of FLORIDA IFAS Extension

TOMATO AND PEPPER PRODUCTION:
Cultivar Selection

"Profit" may be the only word needed to describe the importance of variety selection. Profit potential depends partly on selecting varieties suited to the farming operation.

Figure 5. It is important to be selective when picking a tomato variety. Photograph by: George Hochmuth.

"There is nothing more optimistic than a seed catalog..."

Figure 6. Through breeding, new varieties are produced with a combination of desirable qualities. Photograph by: Milt Putnam.

HOW TO SELECT THE RIGHT CULTIVAR:

Cultivar selection is one of the critical decisions that the commercial grower must make each season. Variety selection is a dynamic process **(Figures 5 & 6)**. Some varieties may retain favor for many years while others might be supplanted by newer cultivars after a few seasons.

Cooperative Extension Service publications and commercial seed catalogs provide information on varieties adapted to local conditions.

- **STUDY** and use reliable results from local performance tests, including on farm trials, other growers' experience, vegetable and seed trade literature and university studies.
- **DISCUSS** results of university and seed trade variety trials with the people who did them. Knowing more about the evaluation will make you better able to use the results from it to your advantage.
- **RESEARCH THE MARKET** to clarify what is valued and accepted. Growers should know their target market and be prepared to grow what the market dictates. Keep in mind that most markets tend to see yield as the grower's concern and quality as theirs.

ON FARM TRIALS will help identify varieties that may be potential candidates for production.

Following the maxim **"If it ain't broke, don't fix it"** growers sometimes identify and stick with favorite varieties. This approach is understandable but it shouldn't prevent a producer from trying new varieties.

Variety selection may be an opportunity to expand a market or overcome certain production obstacles. When trying new varieties, do so on a small scale basis but make it a fair test by growing them under the same conditions likely to be encountered in the field. Whether the new varieties work or not, the process of testing them will often provide valuable information that can help in some other aspect of your operation.

ACCURATE RECORD KEEPING:

To gain the most benefit from on farm trials, results should be recorded and documented. Keeping accurate records of yield and other data is important but often overlooked.

"Mental notes" on yield or overall performance are usually not as accurate as actual measurements. Give every field a name that stays the same from year to year to ensure accurate record keeping.

With good variety records, growers can identify which varieties will perform best in which fields, which season (early-mid-late) and other production conditions (e.g., climate, disease and insect pressure).

Trial records will also help identify new varieties that may be integrated into the production program.

The pedigree of new varieties often has elements in common with older or previous varieties. Accurate records regarding the performance of related varieties may help when selecting new ones **(Figure 7)**.

Prepared by: Gene McAvoy

A GOOD VARIETY WILL PROVIDE THE BEST BLEND OF:

- Horticultural traits desired by the market
- Maturity needed to match the cropping season, supply the market, and reduce the risk of weather-related crop failure
- High marketable yield potential
- Dependable resistance to diseases, insects, stress, and physiological disorders (e.g., blossom-end rot)

Figure 7. On-farm trials and accurate record keeping identify potential candidates. Photograph by: Ken Pernezny.

SELECTION CRITERIA:

Production and market forces increasingly demand that growers establish identities in the marketplace, partly through supplying unique, high-quality products. For growers, changes in consumer preferences could mean an increased emphasis on using variety selection to distinguish themselves in the market. However, it is critical not to overlook these important selection factors:

MARKETABILITY: The harvested plant product must have characteristics desired by the packer, shipper, wholesaler, retailer and consumer **(Figure 8)**.

In pepper, these qualities include pack-out, shelf life, shape (blockiness), number of lobes, color (both mature color and shade of green for immature fruit), size, firmness, pod wall thickness and more recently, some markets are interested in nutritional quality and taste.

In tomato, the market seeks many of these same qualities including color, shape, flavor, shoulder color, firmness, pack-out, shelf life, shipping and ripening characteristics.

HORTICULTURAL TRAITS: The characteristics of the plant habit and architecture must be suitable for cultural and climatic conditions in the growing area, and the marketed product must be acceptable and uniform.

YIELD: The variety being considered should have the potential to produce crops at least equivalent to those already grown. In many cases, harvested yield may be much less than potential yield due to marketing constraints.

DISEASE RESISTANCE: The most economical and effective means of pest and disease management is through the use of varieties with genetic resistance or tolerance.

ADAPTABILITY: Successful varieties must perform well under the wide range of environmental conditions encountered in Florida.

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Figure 8. Market tomatoes and peppers. Photograph by: Tara Piasio.

TOMATO AND PEPPER PRODUCTION:
Tomato Cultivars for Florida

KEY TO ABBREVIATIONS:

ASC – Alternaria stem canker - *Alternaria alternata* f.sp. *lycopersici*

BSK – Bacterial speck - *Pseudomonas syringae* pv *tomato race* 0

CLS - Cladosporium leaf mold - *Cladosporium fulvum*

F-R 1,2,3 - Fusarium wilt Race 1, 2,3 - *Fusarium oxysporum* f.sp. *lycopersici* races 1,2,3

FCR – Fusarium crown rot - *Fusarium oxysporum* f.sp.*radicis-lycopersici)*;

N – Root knot nematode - *Meloidogyne arenaria, M. incognita* & *M. javanica*

Stemph – Gray leaf spot - *Stemphylium solani*

TMV – *Tobacco mosaic virus*

ToMV - *Tomato mosaic virus*

TSWV – *Tomato spotted wilt virus*

TYLCV – *Tomato yellow leaf curl virus*

V1 - Verticillium wilt - *Verticillium albo-atrom, Verticillium dahliae* race 1

R – Resistant

IR – Intermediate Resistance

T - Tolerant

***Note** – while this list includes a number of varieties currently popular with Florida growers, it is by no means a comprehensive list of all varieties that may be adapted to the state. At present 4 - 5 cultivars probably constitute 80 – 90% of commercial production in Florida.

ROUND TOMATOES*:

Amelia – Main season. Resistance to F-R 1,2,3, N, V1, intermediate resistance to Stemph and TSWV. Vigorous determinate plant with an excellent leaf canopy ideal for green and vine ripe harvest, crack tolerant skin. Firm, aromatic fruit. Harris Moran.

Bella Rosa – Resistant to TSWV. Determinate type. Heat tolerant. Produces firm, uniformly shaped fruit. Sakata.

BHN 444 – Midseason. Resistance to F-R 1,2, TSWV, V1. Large to extra-large, globe shaped fruit. Determinate bush with good cover. High yields, good firmness, good flavor. Pruning not required. BHN Seed.

BHN 586 – Midseason. Resistance to FCR, F-R 1,2, N, V1. Large to extra-large, deep globe shaped fruit. Determinate, medium to tall vine. Large, firm, uniform green fruits are well suited for mature green or vine-ripe production. BHN Seed.

BHN 640 – Midseason. Resistance to F-R 1,2, TSWV, V1, F-R 3 tolerance. Large to extra-large, globe fruit with uniform green shoulders. Determinate bush with good cover. BHN Seed.

Crista - 74 days, Resistance to, F-R 1,2,3, N, intermediate TSWV, V1. Large, deep globe fruit, tall robust plants. Does best with high fertility and pruned to three leaders. Good flavor, color and shelf-life. Harris Moran.

Crown Jewel - Resistance to ASC, FCR, F-R 1,2, Stemph and V1. Determinate with medium-tall bush. Uniform fruit have a deep oblate shape and good firmness and quality with uniformly-colored shoulders and jointed pedicles. Seminis.

FL 47 – Midseason. Resistance to ASC, F-R 1,2, Stemph, V1. Very large, deep oblate fruit. Determinate, medium size bush. Very firm, smooth, uniform green fruits are adaptable to both mature-green and vine-ripe harvest. Seminis.

FL 91 – Midseason. Resistance to ASC, F-R 1,2, Stemph, V1. Large, deep, oblate firm fruit with uniform green shoulders. Strong, determinate vine with heat-set capabilities. Heavy early yield with high packout. Seminis.

HA 3073 – Midseason. Resistance to F–R 2,3, V1, TYLCV. High quality, medium size globe shaped fruit. Consistently high yielding. Hazera.

Linda – Main season. Resistance to ASC, F-R1, 2, Stemph, V1. Large, round fruit with excellent firmness, sturdy, determinate bush with good cover. Competitive yields of large, smooth, uniform shouldered fruit with a small blossom end scar. Sakata.

Phoenix - Early midseason. Resistance to ASC, F-R 1,2, Stemph and V1. Hot-set tomato. Determinate, vigorous vine with good leaf cover for fruit protection. Large to extra-large, high quality, firm, globe-shaped fruit are uniformly-colored with jointed pedicles. Seminis.

Quincy – Full season. Resistance to ASC, F-R 1,2, Stemph, TSWV and V1. Tall determinate plant. Large and extra-large fruit with a deep oblate shape fruit are firm and uniformly colored with excellent quality. Seminis.

RPT 6153 – 77 days. Resistance to, F-R 1,2, Stemph and V1. Large, vigorous bush. Good eating quality and fancy appearance in a large sturdy shipping tomato. Firm enough for vine-ripe but it also gasses. Seedway.

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Prepared by: Gene McAvoy

ROUND TOMATOES*: *cont.*

Sebring – Main season. Resistance to FCR, F-R 1,2,3, Stemph and V1. Medium to tall determinate, bush. Extra-large to large, smooth, deep oblate fruit with uniform green shoulders, tight blossom ends. Outstanding yield potential. Seminis.

Solar Fire – 73 days. Resistance to F-R 1,2 3, Stemph and V1. Medium, compact vines don't require pruning. Large, flat, round, firm fruit. Sets well in heat. Tends to be free of fruit disorders. Harris Moran.

Soraya – 80 days. Resistance to FCR, F-R 1,2,3, Stemph and V1. Strong, large bush. High quality, very smooth beefsteak, typically producing large and extra-large fruit. Continuous set. Syngenta Rogers Seed

Talledega – Midseason. Resistance to F-R 1,2, Stemph, TSWV and V1. Determinate bush for stake culture. Large to extra large globe to deep globe shaped fruit. High resistance to TSWV. Some heat setting ability. Performs well with light to medium pruning. Syngenta Rogers Seed.

Tygress – Main season. Resistance to ASC, F-R 1,2, Stemph, ToMV, TYLCV and V1. Deep oblate, smooth, uniform high quality fruit. Vigorous, determinate plant. High yield potential. Seminis.

ROMA TOMATOES*:

BHN 410 – 73 days. Resistance to BSK, F-R 1,2, Stemph and V1. Compact to small bush. Concentrated high yield. Large smooth blocky fruit tolerant to weather cracking. Jointless. BHN Seed.

BHN 411 – 73 days. Resistance to BSK, F-R 1,2, Stemph and V1. Compact plant. Concentrated set. Large smooth fruit is tolerant to weather cracks and has reduced tendency for greywall. Jointless. BHN Seed.

BHN 685 – Midseason. Resistance to F-R 1,2,3, TSWV and V1. Determinate, vigorous bush Large to extra-large, deep blocky globe shaped fruit. Pruning not recommended. BHN Seed.

Marianna – 74 days. Resistance to ASC, F-R 1,2, N and V1 and tolerant to Stemph. Determinate, small to medium sized plant with exceptional fruit set. Fruit are predominately extra large and extremely uniform in shape. Fruit wall is thick and external and internal fruit color is very good with excellent firmness and shelf life. Sakata.

Monica – Midseason. Resistance to BSK. F-R 1,2, Stemph and V1. Vigorous bush with good cover. High percentage of firm extra large, elongated fruit. Jointed pedicel and uniform green fruit color. Sakata.

Sunoma – Main season. Resistance to BSK, F-R 1,2, N, Stemp, TOMV and V1. Determinate with good fruit cover. Medium-large, elongated cylindrical fruit maintains fruit size through multiple harvests. Widely adapted. Seminis.

CHERRY TOMATOES*:

BHN 268 – Early. Resistance to F-R 1, V1. Determinate, small to medium bush. High yields. An extra firm cherry tomato that holds, packs and ships well. BHN Seed.

Camelia – Midseason. Resistance to F-R 1, TMV, V1. Indeterminate bush. Deep globe, cocktail-cherry size with excellent firmness and long shelf life. Outdoor or greenhouse production. Siegers Seed.

Cherry Blossom - 70 days. Resistance to ASC, BSK, F-R 1,2, N, Stemph, V1. Determinate type. Large cherries, holds and yields well. Seedway.

Super Sweet 100 VF– 65 days. Resistance to F-R1, V1. Indeterminate vine. Produces large clusters of round uniform fruit with high sugar levels. High yield potential. Siegers Seed. Seedway.

Shiren – Resistance to F–R 1, 2, V1, N, ToMV. Compact plant with high yield potential and nice cluster. Hazera.

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KEY TO ABBREVIATIONS:

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BSK – Bacterial speck - *Pseudomonas syringae* pv *tomato race* 0

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***Note** – while this list includes a number of varieties currently popular with Florida growers, it is by no means a comprehensive list of all varieties that may be adapted to the state. At present 4 - 5 cultivars probably constitute 80 – 90% of commercial production in Florida.

GRAPE TOMATOES*:

Brixmore – Very early. Resistance to N, ToMV, V1. Indeterminate. Very uniform in shape and size, deep glossy red color with very high early and total yield. High brix, excellent firm flavor. Harris Moran.

Cupid – 59 days. Resistance to ASC, F–R 1,2, and Stemph. Intermediate resistance to BSK. Vigorous, indeterminate bush. Oval-shaped fruit have an excellent red color and a sweet flavor. Seminis.

Jolly Elf – Early season. Resistance to F-R 2, V1 and cracking. Determinate plant. Extended market life with firm, flavorful grape-shaped fruits. Average 10% brix. Siegers Seed, Seedway.

Santa – 75 days. Resistance to F, N, TMV and V1. Vigorous indeterminate bush. Firm elongated grape shaped fruit with outstanding in flavor and up to 50 fruits per truss. Thompson and Morgan.

St. Nick – Mid-Early season. Indeterminate bush. Oblong, grape-shaped fruit with brilliant red color and fantastic flavor. Up to 10% brix. Siegers Seed.

Smarty – 69 days. Vigorous, indeterminate bush with short internodes. Plants are 25% shorter plant than Santa. Good flavor, sweet and excellent red color. Seedway.

Sweet Hearts – Early season. Resistance to CLS, F-R 1, ToMV. Indeterminate plants with continuous sets and full clusters to the top of the plant. Brilliant red color, very uniform, excellent flavor, good resistance to cracking. High brix, excellent shelf-life. Sakata.

Tami G – 60 days Vigorous, indeterminate bush picks for an extended period. Very sweet, firm, fruit. Yields well. Seedway.

Figure 9. Harvested tomatoes in wash tank. Photograph by: Monica Ozores-Hampton.

KEY TO ABBREVIATION:

BLS – Bacterial leaf spot, many races - race 1, 2, 3, 5 resistance available depending on cultivar.

CMV – *Cucumber mosaic virus*

PeMV – *Pepper mottle virus*

PVY – *Potato virus Y*

Stip – Pepper stip or Pepper spot - a physiological disorder characterized by small discolored spots on pods on maturity

TEV – Tobacco Etch Virus

TMV – Tobacco Mosaic Virus

Tobamovirus Po – strain of TMV

TSWV – *Tomato spotted wilt virus*

Figure 10. Remember that yield is a characteristic more important to growers than to consumers. Keep your market in mind and the characteristics important to them, i. e., pack-out, shelf life, shape (blockiness) number of lobes, color (both mature color and shade of green for immature fruit), size, firmness, pod wall thickness and taste. Photograph by: Tara Piasio.

***Note** – while this list includes a number of varieties currently popular with Florida growers, it is by no means a comprehensive list of all varieties that may be adapted to the state. At present 4 - 5 cultivars probably constitute 80 –90 % of commercial production in Florida.

COMMON PEPPER CULTIVARS FOR FLORIDA*:

Alladin (X3R®) – uniform, blocky large, green to yellow bell fruit. Resistant to BLS 1,2,3 (X3R®), Tobamovirus Po, PVY 0 and TEV. Seminis.

Aristotle – dark green anthocyaninless pods, heavy set, thick walls, large fruit size. Matures red. Resistant to BLS 1,2,3 (X3R®), PVY, Tobamovirus Po. Seminis.

Brigadier – Erect, broad season adaptability, large size fruit. Matures red. Resistant to BLS 1,2,3, PVY. Syngenta/Rodgers.

Crusader – erect, good cover, firm at mature red stage. Resistant to BLS 1,2,3, PeMV, PVY, Stip, TMV. Syngenta/Rodgers.

Double-Up – medium large 3-4 lobed green-red pods. Resistant to BLS 1,2,3, TMV. Sakata.

Enterprise (X3R®) – blocky, large to extra-large, 3 to 4 lobes green to red fruits. Resistant to BLS 1,2,3 (X3R®) and Tobamovirus Po. Seminis.

Excursion II – medium size green to red fruit. Resistance to BLS 1,2,3, PVY, TMV, TSWV. Abbot and Cobb.

Legionnaire – continuous set, uniform green to red fruit. Resistant to BLS 1,2,3(R), Stip(T), TMV(R). Syngenta/Rodgers.

Paladin – early, blocky to deep blocky, extra-large fruits. Matures red. Resistant to Phytophthora(T), TMV. Syngenta/Rodgers.

Olympus – uniform shape and size, thick-walled pods. Matures red. Resistant to BLS 1,2,3. Enza Zaden.

Orion – Large, 4-lobed, thick-walled blocky green to red fruit. Resistant to BLS 1,2,3. Enza Zaden.

Patriot – green-to-red blocky thick walled fruit, early maturing with concentrated fruit set. Resistant to BLS 1,2,3,5, and PVY. Harris/Moran.

Polaris – Uniform blocky green to red fruit. Resistance to BLS 1,2,3. Western Seed.

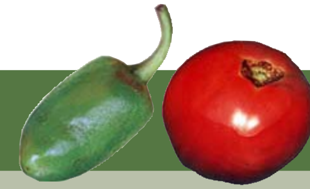
Revolution – cold tolerance, concentrated early set, firm, uniform, extra-large green to red fruits. Resistance to BLS 1,2,3,5, intermediate resistance to CMV and *Phytophtora capsici*. Harris/Moran.

Sentry – erect bush, blocky green to red fruit, performs well under high temps. Resistant to BLS 1,2,3, PVY, and Stip. Syngenta/Rodgers.

Snapper – Very large, very uniform field pepper for both green and red harvest, 3-4 lobed blocky fruit. Resistant to BLS 1,2,3, Tobamovirus Po. Enza Zaden.

Telestar – good canopy, medium-dark green to red pepper, smooth shoulders, blocky, thick-walled, 4-lobed pods. Resistant to BLS 1,2,3, PVY, TMV. Hazera.

Wizard X3R® – concentrated set, high percentage of large to extra large green to red pods. Resistant to BLS 1,2,3 (X3R®), TMV. Seminis.



The cheapest, easiest and most efficient way for growers to reduce losses from diseases is to plant resistance varieties.

Figure 11. Using varieties of pepper with resistance to bacterial spot is an IPM approach. Photograph by: Ken Pernezny.

Lock & Key Resistance:

When a pathogen infects a host, its "key" either does or does not fit the "lock" of that host. When there is a variety of different "locks" and "keys," the likelihood of a matching infection and the growth of an epidemic (or infestation) is reduced considerably.

If every door in the town has the same lock, and every household has the same key that fits every lock, the system of locking will be ruined by uniformity.

Thus, vertical resistance offers temporary resistance in agriculture. When a matching strain of the parasite appears, the resistance fails in **every** host individual of that crop and, and, shortly afterwards, of that entire cultivar.

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DON'T RELY ON RESISTANCE ALONE:

The use of resistant cultivars may cause a race shift in pathogen populations to races that are unaffected by the resistance present in the crop.

In many cases disease resistance is not absolute and may be overcome if the pathogens changes or if environmental conditions overwhelmingly favor disease development.

TYPES OF RESISTANCE:

There are two kinds of host resistance to plant diseases: **vertical** and **horizontal**.

Vertical resistance is controlled by single genes. In the plant/disease pathosystem (i.e. the interaction between a host and pathogens) each host individual may have several vertical resistance genes, which constitute a biochemical lock. Each pathogen individual may have several parasitism genes, which constitute a biochemical key (see sidebar). This is how vertical resistance works.

Horizontal or multi-gene resistance functions equally against most strains of the parasite. However, it does not provide the high level of resistance seen with vertical resistance.

Certain limitations may make breeding for disease resistance difficult or impossible. These include finding a source of genes for resistance or finding them in a distantly related crop making it difficult to impart the desired resistance into the crop.

In other cases, genes for resistance may be so tightly linked with undesirable traits that they prove useless.

Some pathogens such as bacterial spot have the ability to produce several races that are capable of attacking the host in this case multiple resistance genes must be combined to provide complete protection **(Figure 11)**. **For more information, see Disease Management Chapter.**

In pepper, the use of varieties with resistance to the predominant races of bacterial spot and certain viruses is an important approach to disease management. Almost all pepper cultivars in commercial production in Florida contain genes for resistance to bacterial spot races 1, 2 and 3 as well as one or more viruses.

Recently new genes, which impart resistance to additional bacterial spot races, have been incorporated into commercial varieties. Resistance has also been identified for *Phythopthora* (partial) and tomato spotted wilt and has been incorporated into commercially available cultivars.

In tomato, the use of varieties with resistance to *Fusarium* and *Verticillium* is employed widely as is resistance to alternaria stem canker and gray leaf spot. Although many varieties boast nematode resistance, it is important to note that this can breakdown under heavy nematode pressure and high soil temperatures and may be less reliable under Florida conditions. In the future, it is likely that growers will select cultivars with resistance to fusarium crown rot and viruses, such as TSWV and TYLCV, as the horticultural qualities of these varieties improve and are accepted by growers.

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