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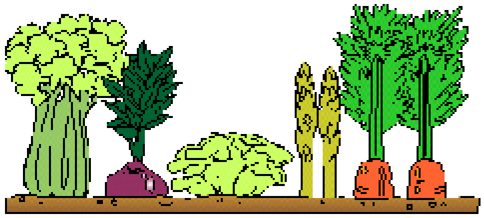

Vegetarian Newsletter

A Vegetable Crops Extension Publication
Vegetarian 02-01
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University of Florida
Institute of Food and Agricultural Sciences
Cooperative Extension Service

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Print Version

Events Calender

2002 Postharvest Horticulture Industry Tour - March 4-7, 2002. Visit postharvest operations from harvest through shipping in central and southwest Florida. Special rates are available for county and statewide faculty. Contact Steve Sargent (sasa@mail.ifas.ufl.edu, 352-392-1928, ext. 215) or Mark Ritenour (mrit@gnv.ifas.ufl.edu, 561-467-3877).

Commercial Vegetable Production

Reducing Mechanical Damage During Transplant Digging Increases Early Season Fruit Yiled of Strawberry

Commercial strawberries are propagated asexually by producing daughter plants on stolons originating from a mother plant. Bare root transplants are produced in open fields, where daughter plants remain attached to the mother plant and are allowed to root into the soil. According to Latimer (1998) the goal of transplant production is to produce plants which: 1) withstand the stress of handling, transportation and transplanting, 2) adapt rapidly to the field environment, 3) establish and resume active growth soon after transplanting and 4) produce acceptable yields without reduction or delay compared to other establishment methods. Water management (Leskovar, 1998), pre-transplant nutrition (Dufault, 1998), transplant size (NeSmith and Duval, 1998; Latimer 1998), transplant age (Vavrina, 1998) and transplant root structure (Nicola, 1998) may all be contributing factors to a strawberry plant's success in the fruiting field.

To supply the demand for plants in Florida, most bare-rooted green-top transplants for winter production are mechanically harvested using modified potato digging equipment, in high latitude (> 42^{o}) or high altitude nurseries. A typical harvest operation involves the following procedures; plants are 1) removed from the soil using digging equipment, 2) placed in large bins using pitchforks, 3) transferred to a packing facility, 4) separated from each other by hand, 5) counted and placed in plastic lined boxes (400 to 600 plants per box) and 6) pre cooled and shipped to Florida in refrigerated trucks. During harvesting and packing operations, transplant petioles, leaves and crowns may be crushed and/or broken. Damaged plants are likely to take longer to resume normal growth after establishment in the fruiting field. High demand for fruit in late fall and early winter creates a lucrative market for Florida strawberry producers. A plant which resumes growth quickly and produces more fruit early in the season is highly desirable for Florida strawberry growers. Earlier plantings are not feasible due to the transplants need to be exposed to chilling and short day lengths in the nursery to initiate flowering in the fruiting field. Therefore, it is essential to produce transplants that will rapidly resume growth in the fruiting field. The influence of transplant digging and packing operations on subsequent strawberry fruit yield has not been determined. The purpose of this study was to compare the performance of hand and machine dug transplants in the fruiting field.

Material and Methods

Transplants of 'Sweet Charlie' and 'Camarosa' were randomly selected from plants that were dug and packed using standard mechanized harvesting and packing practices in a commercial transplant producer's field in Nova Scotia, Canada. On the same day, additional plants, from the same field, were carefully dug and packed entirely by hand, minimizing all potential damage during transplant harvest and packing operations. Soil was removed from the roots of all transplants. Transplants were shipped in the same container to the Gulf Coast Research and Education Center, Dover, Fla. (GCREC-Dover). Transplants were set 2 Nov.1999 and 10 Oct. 2000 on black plastic mulch in the annual hill cultural system. Cultivar and digging method were arranged in a 2 X 2 factorial design replicated four times with 16 plants per treatment. Overhead irrigation was used for 10 hours/day for 10 days to establish transplants. All other irrigation was through drip tape placed underneath the polyethylene mulch. Frost protection, by overhead impact sprinkler irrigation, was applied six times during the 2000-2001 season. Plant fertilization and pest control were maintained in accordance with University of Florida extension service recommendations (Maynard and Olson, 2000). Fruit were harvested twice weekly beginning on 5 Jan. 2000, and 15 Dec. 2000 for the 1999-2000 and 2000-2001 season respectively. All harvested fruit were graded for marketable weight, marketable number and cull fruit (number of small (< 10g), misshapen and diseased fruit). Data were organized monthly and seasonally and analyzed by analysis of variance using SAS statistical software (SAS Institute, Cary NC).

Results and Discussion

Monthly and seasonal marketable yields for strawberry production in the 1999-2000 season revealed significant treatment differences for digging technique and cultivar, and a significant interaction of the two in January and March of 2000 (Table 1). Marketable yield for hand dug transplants were higher than machine dug transplants for 'Camarosa' and ‘Sweet Charlie’ during most harvest periods and for the whole season. The exception was for March 2000 when 'Sweet Charlie' machine dug plants had slightly higher yields. 'Camarosa' produced higher yields than 'Sweet Charlie' over the course of the season. There was a 127% and 30% increase in marketable yield for hand dug 'Sweet Charlie' and 'Camarosa' respectively in January 2000. During March 2000, yield differences of -2% and 42% occurred between hand dug and machine dug transplants of 'Sweet Charlie' and 'Camarosa', respectively.

Significant treatment differences were found due to digging technique and cultivar during December of the 2000-2001 season (Table 1). 'Sweet Charlie' and 'Camarosa' which were hand dug performed 126% and 120% better than machine dug plants respectively. However, for the rest of the season no differences were detected for digging technique and no interactions between digging technique and cultivar were detected. The unusually low air temperatures during January (Table 3) may have been a major contributing factor in the lack of treatment differences. Above ground development of all plants appeared to be minimal during this period. Cultivar had a significant effect on marketable yield each month and for the whole season. As typically observed, 'Camarosa' produced less fruit than 'Sweet Charlie' during the month of December but significantly higher amounts every other month.

Total number of marketable fruit harvested were significantly affected by digging technique during 1999-2000, with hand dug plants producing a greater number of fruit (Table 2). 'Camarosa' produce a greater number of fruit than 'Sweet Charlie' during the 2000-2001 season. More fruit were produced during the 1999-2000 season than the 2000-2001, probably due to the fact that there was unusually cold weather in west central Florida during January 2001 (Table 3). January is a time when flowers are initiated for the main crop harvested in February and March. Average fruit weight was affected by cultivar both seasons with 'Camarosa' having heavier mean fruit weight (Table 2). Number of culled fruit was significantly higher for 'Sweet Charlie' than 'Camarosa' for the 1999-2000 season.

Early production of fruit is highly desirable to Florida growers, with fruit produced in December and January commanding 2-3 times the price of fruit produced later in the season (Florida Agricultural Statistics, www.nass.usda.gov/fl). Currently, growers in the major production area of Florida are looking at containerized transplants to increase their early yields. Research to date on containerized transplants has shown an increase in early marketable yields when compared to typical bare root transplants (Hochmuth et. al, 2000). Their higher early yield may be partially or wholly explained by the lack of mechanical damage containerized transplants receive during harvesting, packing and shipping operations. Containerized transplants do not undergo mechanical harvesting operations, which limits the amount of damage prior to planting. These transplants are left in trays and packed 50 to 200 plants to a box, whereas a similar size box can contain up to 600 bare root transplants. These less compacted conditions may limit damage during shipping. Containerized transplants are roughly double the cost of machine dug bare-root plants, however the increased production of high value early fruit may offset this cost.

It is likely that the mechanical damage a green-top bare rooted transplant receives during digging, packing and transport from the nursery to the fruiting field seriously affects its performance in Florida fruiting fields. A reduction in performance, especially early in the season, can have a dramatic effect in terms of monetary returns to growers. Further research examining means to reduce transplant damage during harvest, packing and shipping needs to be conducted.

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Table 1. Fruit yield data for mechanically dug and hand dug 'Sweet Charlie' and 'Camarosa' strawberry transplants grown in the annual hill production system at Dover, Fla.

	Marketable weight (tons/acre)^{z}				
	Dec.	Jan.	Feb.	Mar.	Total
	1999-2000				
Digging Technique(DT)					
Hand Dug		3.10	5.21	5.40	13.71
Machine Dug		1.89	3.69	4.49	10.07
Cultivar (C)					
Sweet Charlie		2.13	3.70	4.34	10.17
Camarosa		2.85	5.20	5.55	13.60
P values (F-Test)					
DT		0.0001	0.0018	0.0226	0.0001
C		0.0002	0.0019	0.0046	0.0001
DT X C		0.0050	0.6206	0.0140	0.4717
	2000-2001				
Digging Technique(DT)					

Hand Dug	0.70	1.98	3.23	3.02	8.93
Machine Dug	0.31	1.76	3.30	2.65	8.03
Cultivar (C)					
Sweet Charlie	0.64	1.21	3.15	1.38	6.38
Camarosa	0.37	2.53	3.38	4.30	10.58
P values (F-Test)					
DT	0.0007	0.1883	0.7463	0.3393	0.0991
C	0.0089	0.0001	0.2806	0.0001	0.0001
DT X C	0.2320	0.0906	0.8547	0.2788	0.2932
[z] Numbers represent means of four treatment replications of 16 plants each. Multiply number by 2.24 to convert to metric tons per hectare.					

Table 2. Seasonal data for number of marketable fruit, average fruit weight and total number of cull fruit of mechanically dug and hand dug 'Sweet Charlie' and 'Camarosa' strawberry transplants grown in the annual hill production system at Dover, Fla.

	Marketable Fruit (1000's / Acre)	Average Fruit Weight (g)	Total Culls [z] (1000's / Acre)
	1999-2000		
Digging Technique(DT)			
Hand Dug	581	21.7	181
Machine Dug	420	21.7	153
Cultivar (C)			
Sweet Charlie	510	18.2	255
Camarosa	491	25.2	79
P values (F-Test)			

DT	0.0001	0.9876	0.2303
C	0.4485	0.0001	0.0001
DT X C	0.5809	0.3664	0.5243
	2000-2001		
Digging Technique(DT)			
Hand Dug	414	19.3	97
Machine Dug	366	19.7	75
Cultivar (C)			
Sweet Charlie	327	17.7	90
Camarosa	453	21.3	82
P values (F-Test)			
DT	0.0604	0.2864	0.0171
C	0.0001	0.0001	0.3129
DT X C	0.1937	0.2043	0.4700
[z] Numbers represent means of four treatment replications of 16 plants. Multiply number by 2.47 to convert to number of berries per hectare.			

Table 3. Monthly average high and low temperature(^{o}F) average for Plant City, Fla for the 1999-2000 and 2000-2001 seasons, and the historical average[z].						
Time Period Season	1999-2000		2000-2001		Historical	Average
	High	Low	High	Low	High	Low
November	76.9	56.6	76.0	51.4	79.6	55.7
December	70.9	50.3	71.5	48.7	74.6	50.2

January	71.5	49.2	68.5	42.1	72.7	48.2
February	74.7	48.9	79.6	56.8	74.4	49.7
March	81.3	56.8	77.5	55.7	79.7	54.6

(John R. Duval, Craig K. Chandler, Daniel E. Legard, GCREC-Bradenton; Peter Hicklenton, Agric. Canada, Kentville, Nova Scotia, Canada - Vegetarian 02-01)

Biologically-based Disease Management Products in Florida Vegetable Production

Methods of biological control of diseases are becoming more widely used in conventional production systems as well as in organic production systems. Reported advantages of biocontrol methods include increased safety of transport, handling and application; reduced environmental effects; reduced re-entry and harvest intervals; minimized potential for development of resistance; and applicability to IPM programs. Biological fungicides may act to suppress the population of the pathogenic organism through competition with pathogenic organisms, stimulate plant growth which may allow plants to quickly outgrow any pathogen effects, or damage or destroy the pathogen by means of toxins produced.

A number of soilborne fungi are considered to be limiting to the production of conventionally and organically grown vegetables for the fresh market. Members of the genera *Fusarium*, *Pythium*, *Phytophthora*, *Sclerotium*, and *Rhizoctonia* are of primary concern. Several biologically-based disease management products have been developed for use against these fungi. The 8 organisms commercially available in the US as controls for soil-borne diseases in vegetable crops are listed in Table 1. Several are found in more than one product, generally distinguished by the formulation. The Organic Materials Review Institute has labeled 8 of these products as allowable for use in certified organic operations.

A survey by Glades Crop Care of South Florida tomato, potato and pepper growers in 1996-1997 indicated that, while the majority of growers commonly used IPM techniques of scouting, resistant varieties and cultural controls, the "add(ition of) mycorrhizal organisms to transplant or field soil to mitigate soil-borne diseases" was not commonly used. Frantz and Mellinger (1998) cite the lack of clearly demonstrated efficacy as the primary barrier to the use of biologically-based disease management products.

A wide variety of disease-suppressing organisms, including most of those listed in Table 1, have been tested in Florida on different crops and under different conditions. A summary of the results is listed in Table 2. Sources for the specific tests are listed in the Literature Cited section or were provided by the companies producing the biocontrol products. As suggested by the Glades Crop Care survey, results varied with crop, variety, cultural conditions and method of application. However, some studies do show the potential that biofungicides have for controlling soil-borne diseases. It is important to note that biological control organisms are not meant as stand alone disease control strategies, in that they suppress but do not control disease. Therefore, these organisms should be evaluated as components within an integrated system of cultural, chemical and biological controls. Variations due to site, year, level of disease, cultivar, etc. are the norm and therefore tests must be repeated over time and location to produce useable results. Information on yield as well as on disease response and the inclusion of on-farm trials will be more likely to result in adoption of the technology by growers.

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Table 1. Commercially Available Biologically-based Disease Management Products for Control of Soil-borne Organisms in Vegetable Crops.

Active ingredient	Product	Disease	Crop	Company
Burkholderia cepacia (*Pseudomonas cepacia*)	Blue Circle[x]	Damping off diseases	vegetables	Stine Microbial Products
	Deny[x]	Fusarium, Pythium, Rhizoctonia, nematodes	vegetables	CCT Corp

	Intercept^{z}	Fusarium, Pythium, Rhizoctonia	vegetables	Soil Technologies
Bacillus subtilis	Epic	Alternaria, Fusarium, Rhizoctonia	legumes	Gustafson, Inc.
	Kodiak	Alternaria, Fusarium, Rhizoctonia	legumes	Gustafson, Inc.
	Companion$^{z, y}$	Fusarium, Phytophthora, Pythium, Rhizoctonia	horticultural crops	Growth Products, Inc
Trichoderma harzianum	PlantShield^{x}	Fusarium, Pythium, Rhizoctonia, Sclerotinia	cabbage, cucumber, tomato, turnip	BioWorks, Inc.
	RootShield (drench and granules)^{x}	Fusarium, Pythium, Rhizoctonia, Sclerotinia	cabbage, cucumber, tomato, transplants	BioWorks, Inc.
	T-22 Planter Box^{x}	Fusarium, Pythium, Rhizoctonia, Sclerotinia	vegetables	BioWorks, Inc.
Trichoderma harzianum, Trichoderma viride	Promote Promote Plus^{x}	Fusarium, Pythium, Rhizoctonia solani	greenhouse crops	JH Biotech, Inc
Gliocladium virens GL-21	SoilGard 12G^{x}	Pythium, Fusarium oxysporum, Rhizoctonia solani, Sclerotinia minor, Sclerotium rolfsii	vegetables	ThermoTrilogy Corp
Gliocladium catenulatum	Primastop	Pythium, Rhizoctonia	greenhouse crops	AgBio Development, Inc.
Myrothecium verrucaria (dried fermentation products)	DiTera WP^{x}	nematodes	food crops	Valent USA Corp
Streptomyces griseoviridis Strain K61	Mycostop^{x}	Fusarium, Pythium Phytophthora	vegetables	AgBio Development, Inc.

z may not be available
y EPA Experimental Use Permit
x Allowed for organic production by the Organic Materials Review Institute

Table 2. Summary of results on vegetable crops in Florida.

Active ingredient	Product	Disease	Crop	Type of test	Results
Burkholderia cepacia	Deny	*Phytophthora capsici*	Pepper	Field (transplant drench)	Lower disease incidence
	Deny	*Pythium aphanidermatum*	Greenhouse cucumber	Greenhouse (seed treatment)	No reduction in severity of wilt
	Deny	Nematodes	Tomato	Field (transplant drench)	Equal control to Vydate
	Deny	*P. capsici*	Pepper	Field (transplant drench)	No reduction in disease incidence
Bacillus subtilis	Kodiak		Pepper, tomato	Field (transplant treatment)	Colonized roots
	Kodiak	*P. capsici*	Pepper	Field (transplant drench)	Reduced disease incidence
	Kodiak	*P. capsici*	Pepper	Field (transplant drench)	No reduction in disease incidence

	Kodiak	*P.aphanidermatum*	Greenhouse cucumber	Greenhouse (seed treatment)	No reduction in severity of wilt
	Quantum	*Fusarium* crown rot	Tomato	Field (transplant treatment)	Reduced disease incidence on average 30%
	Quantum	*Pythium* and *Fusarium* root rots	Celery	Field (transplant treatment)	No effect on length and weight Reduced disease incidence in combination with *Glomus intraradices*
Trichoderma harzianum	Not listed		Tomato	Greenhouse	Colonized roots Increased plant height and weight
	Not listed	*Fusarium oxysporum*	Tomato	Greenhouse Field	Did not control disease
	strain KRL-AG2	*Fusarium* crown rot	Tomato	Field (transplant drench)	Reduced disease incidence Did not increase yield
	T-22		Beans	Field (grower trial)	Higher yield than untreated control
	T-22		Tomato, pepper	Field (transplant treatment)	Colonized roots
	T-22	*Fusarium* crown rot	Tomato	Field (transplant treatment)	Reduced disease severity and incidence (not significantly different from control)
	T-22	*P.aphanidermatum*	Greenhouse cucumber	Greenhouse (seed treatment)	No reduction in severity of wilt

	T-22	*P. capsici*	Pepper	Field (transplant drench)	No reduction in disease incidence
	RootShield	*Fusarium* crown rot	Tomato	Field (transplant treatment)	Improved transplant growth Good root colonization Higher yields in fumigated soil (not significantly different from control)
Gliocladium virens	not listed	*Pythium* spp.	Tomato	Field	Control equal to metalaxyl
	Glioguard		Tomato, pepper	Field (transplant treatment)	Colonized roots
	SoilGard		Tomato, pepper	Transplant study	No plant stimulation or yield increase
	SoilGard	*P.aphanidermatum*	Greenhouse cucumber	Greenhouse (seed treatment)	No reduction in severity of wilt
	SoilGard	*P. capsici*	Pepper	Field (transplant drench)	No reduction in disease incidence
	SoilGard	*Fusarium* crown rot	Tomato	Field (transplant treatment)	No reduction in disease incidence or severity. No increase in yield on fumigated soil. Trend for increased yield on non-fumigated soil.

(Betsy Lamb, IRREC-Ft. Pierce and Erin Rosskopf, ARS-USDA -Fort Pierce - Vegetarian 02-01)

Vegetable Postharvest Information on The Internet

Rapid access to timely, unbiased information is vital to maintaining competitive produce growing, packing and shipping operations. Ten years ago, one often needed to travel a considerable distance to the nearest university or college library to access scientific and extension publications or recommendations. In the past decade, however, computer technology and on-line resources have become much more extensive, reducing the need to physically travel to libraries. Even newsletters, with the most up-to-date information, are increasingly being sent out to subscribers via the Internet and e-mail more rapidly than by regular mail. On the Internet, one can find a wide variety of information ranging from commodity handling recommendations to market reports, and from procedures for maintaining food safety to specifications on products and services. Other benefits of the Internet include 24-hour access to the most current information, searchable databases of information, e-mail links to people with additional information on a subject, and the potential to form on-line discussion groups to share ideas on a particular topic. With the growing number of web sites containing valuable, easy-to-access postharvest information, the incentive is greater than ever for individuals (esp. industry) to utilize these resources.

How and where does one actually find postharvest information on the Internet? One way is by using a web search engine such as Google (http://www.google.com/), Alta Vista (www.altavista.com), HotBot (www.hotbot.com), or Yahoo (www.yahoo.com). Web ‘crawlers’ such as "Dogpile" (http://www.dogpile.com/) can often find more information by pooling the resources of several different search engines. One drawback of using search engines, though, is that they often return sites not particularly related to the topic of interest but simply have the search word(s) present somewhere in the page. Once a useful web site has been found, it often includes links to similar web sites so that further information on that topic can be found by following the links. By saving or "bookmarking" particularly useful sites with links to other related sites, one can easily return to the source of information.

The University of Florida’s main postharvest site is the UF Postharvest Programs and Information website (http://postharvest.ifas.ufl.edu). At the site, one can search for information using key words or by using the topical index to browse information organized into the following subject areas:

Pre- Harvest Factors Affecting Quality

Maturity Standards & Quality Attributes

Use of Ethylene

Packinghouse Operations

Fresh Cut Produce

Packaging

Cooling, Humidity Control & Cold Storage

Commodity Guides

Diseases, Disorders & Decay Control

Sanitation & Food Safety

Quarantine & Pest Control

Transportation

Marketing, Economics, Trade & Statistical Information

Modified & Controlled Atmospheres

General Postharvest Information

In each of the above sections, information from UF sources is featured, but links to other university/government organizations and selected commercial sites are also provided. Links to sites other than UF/IFAS sites are provided as a service and do not imply endorsement of information or products. The general postharvest information section in particular includes links to other sites containing a broad range of additional postharvest information. The UF Postharvest Programs and Information web site also includes contact information for UF faculty involved in postharvest research and/or extension. A section featuring upcoming and previous events is included with materials (handouts) from different past UF postharvest workshops such as the Postharvest Institute. This site is continuously updated, so check back often for the latest postharvest information and programs offered by the University of Florida.

(Ritenour, Sargent, and Brecht - Vegetarian 02-01)

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