University of California Cooperative Extension, Yolo County
70 Cottonwood Street, Woodland, CA 95695 530-666-8143
http://ceyolo.ucdavis.edu

28 MARCH 2006
(Volume 46-2)

TOMATO INFO

AGE OF TRANSPLANTS
PLUGS: # OF PLANTS PER
FROST DAMAGE
NITROGEN SOIL SAMPLING

TRANSPLANTING DELAYS RESULT IN OLDER PLANTS

With wet weather-caused planting delays, what is the impact of transplanting 9-week old plants rather than the customary 6-week old plants?

Field experiments conducted by UC Vegetable Crops Specialist Tim Hartz over a 2-year period suggests canning tomatoes tolerate a broad range of handling conditions prior to field planting. Neither stand establishment nor yield outcome was impacted. Plants included commercially-grown seedlings from 3 or more houses. Manipulations prior to field planting included additional N-P fertilization, moisture stress, cool-temperature holding and 48-hour dark exposure to mimic shipment in containers. The field conditions immediately after transplanting included frost and extreme drying winds coupled with delayed irrigation in a sandy loam soil. We were surprised to see little impact from various conditions, which mimicked different handling conditions during transit to grower fields. Age of plants was not a part of the experiment.

Dr. Hartz directed me to a 1993 review of 14 scientific papers published in research journals examining the influence of transplant age on tomato fruit yield. The authors, Charles Vavrina and Mike Orzolek, are experts on greenhouse-grown tomato transplant culture from horticultural departments at University of Florida, Immokalee and Penn State University, respectively. The following is their summary:

"As early as 1929, university scientists began the quest to determine the ideal age at which to transplant tomatoes. The investigations have included seedlings of 2 to 15 weeks of age produced in wood, peat, plastic or Styrofoam containers. Early researchers often omitted descriptions of soil mixes and nutrient regimes, and used a wide variety of container types. Later investigators were inclined to use commercial soilless mixes, well-defined nutrient regimes and polystyrene trays. Pioneers of transplant age research tended to use plants of 7 weeks or older, whereas work within the past 30 years has concentrated on younger plants. Many researchers drew conclusions after only 1 year of experimentation, while others found that results varied across years. Prior to the 1980s, virtually all studies were initiated and conducted in areas far from the thriving transplant industry established in the southeastern United States. Southern-grown transplants often were not included for comparison, and few studies were implemented using plants grown under commercial conditions. After more than 60 years of transplant age research, it appears that transplants of 2 to 13 weeks can produce comparable yields, depending on the many factors involved in commercial production."

Vavrina, C.S. and M.D. Orzolek, Tomato Transplant Age: A Review, HortTechnology, July/Sept, 1993 3(3), p 313-316.

Included in the paper was a discussion of the practical limitations and other considerations about transplant age. They agreed more is at work than the single issue of age. Recognizing the economic incentive of using 2 to 4-week old plants, they also realized the challenge of handling and establishing very young plants in the field. The report was filled with studies of primarily fresh market tomatoes including bare-root transplants. While we'd prefer local studies, these collective experiments suggest tomato yield potential has not been lost in the aging process.

Upshot: The transplants received will likely be taller than normal as well as be subject to more disease pressure from rainy weather. Be prepared to bury plants deeper than normal. Monitor plants more carefully for disease upon delivery. Be vigilant with scouting after transplanting, especially if rainy weather persists.

MULTIPLE PLANTS PER TRANSPLANT PLUG

Authored with Mike Murray, Farm Advisor & County Director, in Colusa, Sutter/Yuba counties and Michelle Le Strange, Farm Advisor, Tulare, Kings and Fresno counties.

Processing tomato growers have long understood that a desirable target for a direct seeding stand is multiple plants in a clump. Field studies have consistently demonstrated yield increases with multiple plants over single-plant configured stands. Even as seeding equipment became capable of sowing a single seed in a drop, planting multiple seed units per drop remained the norm. Hand weeding and thinning crews were instructed to leave multiple plants rather than thinning to a single plant as a less costly, more productive practice.

As transplanting became popular for establishing a stand of canning tomatoes, the greenhouse-seeding target became a single seed per plug. While the industry examined multiple plants per cell, the practice did not become the norm.

In 2002, a field test in Colusa County was initiated to examine the benefit of multiple plants per plug. In 2004, testing at Fresno's Westside was designed to evaluate the purported benefit of higher plant populations in discouraging beet leafhopper transmission of the curly top virus. Fresno tests were the most elaborate to include spatial arrangements between plugs within the plant line. Viral disease never materialized and thus did not confound the reported results. Plug population density studies were also conducted in Yolo County. In general, the populations in our tests mimicked commercial rates around 7,000 to 7,500 plugs per acre.

The earliest study demonstrated substantial yield gains of 10 to 15% by increasing to 2 or 3 plants per plug (Table 1). In this Colusa trial, 52.2 tons per acre was the baseline with single plants. As further tests were conducted, the results were both encouraging and substantial at times. However, results were also very mixed, both within and among locations. Results are not consistent with any particular variety.

At present, given the highly variable results, no recommendation is being made on the benefit of multiple plants per plug. There has also not been any pattern of influence on any particular fruit quality parameter.

Our plans are to continue the evaluations into 2006. Funding support has been provided by the California Tomato Research Institute for many of the tests.

Table 1. UC Farm Advisor trials, plants per plug comparisons, 2002-2005

	Location	Year	Variety	Plants per plug: single	double	triple	Statistical significance at 0.05
1	Colusa	2002	H 9492	52.2	57.0	59.9	yes
2	Colusa	2002-04	multiple	35.0	38.5	38.7	Ave. only
3	Colusa	2003 T3	H 9492	29.6	32.9	35.1	85%*
4	Colusa	2003 T3	Halley	26.6	31.7	27.9	NS
5	Fresno	2004 T1	Halley	22.5	28.6	28.3	yes
6	Fresno	2004 T1	AB 2	20.9	25.2	26.4	yes
7	Fresno	2005 T2	Halley	43.0	41.8	39.7	No
8	Fresno	2005 T2	AB 2	44.1	49.8	49.1	yes
9	Yolo	2003 T1	H 9492	32.4	33.9	-	No
10	Yolo	2003 T1	Halley	30.8	31.0	-	No
11	Yolo	2003 T2	AB 2	55.2	52.5	-	No
12	Yolo	2003 T2	AB 5	53.4	54.0	-	No
13	Yolo	2005 T3	Halley	46.4	45.0	-	No
14	Yolo	2005 T3	AB 2	43.2	45.0	-	No
	AVERAGE	2002-05	various	38.2	40.5	38.1	mixed

* 85% confidence level

FROST DAMAGE

While there are no local tomato transplants in the ground as of March 20th beyond backyard gardens and perhaps some limited specialty tomatoes, cold weather damage and frost is an early season concern in some years. It is likely our local grower-prescribed start date of March 15th as the earliest transplanting also developed around lessening occurrence of frost and cold weather events.

In early April, 1999, a 30°F frost for an hour or two occurred in some areas in the county with planting in full swing. Plant growth stage was mainly before layby or so, regardless of planting method. From this event, frost damage was clearly more extensive on transplants than on direct seeded seedlings. Moderately freezing conditions often appear to inflect damage differentially on plants of similar growth stage. In an attempt to measure impact of frost on yield, I flagged neighboring pairs of plants to follow to harvest in two commercial fields. Plants were selected with over 50% loss of leaves to compare with plants that appeared unaffected.

We lost a few additional plants that we initially thought would survive. Recovery time caused a delay in flowering and in many cases, vines were smaller even at the end of the season. In our Esparto field, stand loss was substantial. At harvest, frost-damaged plants yielded almost 4 times less marketable fruit compared to healthy plants, had more than twice as many immature fruit, and resulted in 5 times more fruit with blossom end rot (Table 2). In the Woodland field, where stand loss was minor, frost impact on fruit production remained substantial. Compared to its healthy neighboring plant, early-frosted plants set around half of the total number of fruit, produced 2.6 times less marketable yield and recovered slowly resulting in 1.6 times more immature fruit (Table 3). Fruit size was also smaller. The phrase 'what does not kill me, only makes me stronger', does not apparently apply to early frost-damage plants.

Bottom Line: While frost damage at an early growth stage may be substantial for transplants, it is likely the damage is spotty and not throughout the field. Should substantial stand loss occur and be widespread within a field, the assessment might tip more heavily toward unrecoverable loss. The results also throw caution to inching forward with earlier transplant schedules.

Table 2. Effect of moderate frost to transplant seedlings on processing tomato yield, Esparto area, 1999.

Plant Condition	lbs. red	% below color	% BER
Frosted	2.6	48	15
Healthy	10.1	22	3

Table 3. Effect of moderate frost to transplant seedlings on processing tomato yield, Woodland area, 1999

Plant Condition	lbs red	% below color	red (count)	Total Fruit (count)
Frosted	4.8	37	35	64
Healthy	12.6	23	86	121

This year, we've heard of frost damage occurring on transplants staged outside of the greenhouse while being held because of rain-delayed shipment to the field. Assessing frost-damaged plants for fitness in the field is a tough call outside of the extremes. The experience of University academics and practitioners is limited and the comments vary from "can tolerate a lot and recover" to that of marginally acceptable. Because of so many variables such as level below freezing point, duration, variety, temperatures pre and post, and field planting conditions to follow, predicting the end result is difficult.

For tomatoes, if the growing point of a young seedling is damaged, delays in recovery can result in substantial unevenness in fruit maturity. These plants should be culled.

Should plants be topped or hedged back to good growth? My limited experience with older plants suggest mechanical pruning might further delay recovery as well as impact yield if cut back severely.

Frost damage brings no good news or upside.

NITROGEN MANAGEMENT

For tomato growers, nitrogen management has been relatively straightforward. The norm has been to apply 120 to 150 lbs of nitrogen as a sidedress application at the layby growth stage. The consequence of a luxuriant supply of N has not resulted in a yield reduction, delayed harvest or out-of-control vine growth in canning tomatoes.

With an increase in cost of N, some growers may consider reducing nitrogen rates. Field tests conducted in the late 90's by UC Veg Crop Specialist Jeff Mitchell's graduate student Henry Krusekopf indicated that soil residual nitrogen at or above 16 ppm nitrate-N in the top foot prior to sidedressing was sufficient to produce maximum yields. No supplemental N was required. Most of the fields were in Fresno County's Westside, but a couple of the tests were in our area. Timing of the soil sample was in the spring sufficiently ahead of sidedress period to allow completion of lab work.

In N-depleted soils, an application of 75 pounds of N per acre provides the bulk of the yield gain for tomatoes. Higher rates of nitrogen provide incremental increases, but at a diminishing rate of return. Thus as N cost increases, the rate of N would tend to be reduced.

A practical grower-approach would be to sample a couple of fields to obtain soil lab reports specific to the field. If the soil tests are above 25 ppm, cut back from the normal N application rate to 75 lbs of applied N or so on part of your field and compare that to your normal application. If the levels are extremely high, 35 ppm or more, reduce the N to zero in some of the acres, half rate on the majority of the field, and the remainder will be a full normal rate. Of course, all of this involves extra adjustments and effort to assess the results in each particular field.

In fields where well water is used, checking nitrate-N levels may provide additional information on N availability. The conversion factor for calculating N applications from irrigation water is 2.7 x nitrate-N in parts per million = pounds of N per acre-foot of water. For example if lab result is 5 ppm of nitrate-N and 3 acre feet are applied per cropping season, then 40 lbs of N were delivered in the irrigation. It is unlikely all 40 pounds would be available to the crop because of run off and perhaps leaching.

Could we "walk the walk?" In 2005, we conducted two trials in commercial fields at a grower request. The previous crop at one site was following heavily fertilized bell peppers with 15-ppm nitrate-nitrogen in the springtime sample. The second site was following wheat in the crop rotation with 9 ppm. As part of our test, nitrogen was sidedressed with either 75 or 150 lbs of N and included a non-fertilized control.

At the site with high residual N, additional N boosted yields from 49.9 to 51.8 tons at the 75-oound N rate, a slight, but economic gain (Table 4). Following the wheat crop, with 9 ppm nitrate-N, sidedressing at the 75 lb rate was sufficient to maximize yields (Table 5). In the non-fertilized controls at the wheat site, plants appeared chlorotic and vine cover was marginal resulting in a high level of sun-damaged fruit from our hot 2005 summer. The pre-sidedressed soil sample program slightly underestimated the n application rate in one test and was on target in the second site.

Upshot: the pre-sidedressed nitrate soil sampling program provides some guidance on sidedressed N. application rates. Except for high residual N fields, fine-tuning N input is not precise nor economically without risk of sacrificing tomato crop yield.

Table 4. Pre-sidedressed N evaluation with 15-ppm nitrate-N, following bell peppers, Joe Muller and Sons, Woodland, 2005.

Sidedressed N rate (lbs/A)	Yield tons/A
None	49.9
75 lbs N	51.8
150 lbs N	51.3
LSD 5%	1.5
% C.V.	4

Table 5. Pre-sidedressed N evaluation with 9-ppm nitrate-N, following wheat, Joe Muller and Sons, Woodland, 2005.

Sidedressed N (lbs/A Urea)	Yield tons/A	% Sun
0	40.0	18
75	45.1	10
150	45.2	12
LSD (5%)	3.3	5.798
% C.V.	6	35

Submitted by Gene Miyao, Farm Advisor, Yolo, Solano & Sacramento counties

UNIVERSITY OF CALIFORNIA
COOPERATIVE EXTENSION
70 COTTONWOOD STREET
WOODLAND, CALIFORNIA 95695

TOMATO INFO NEWSLETTER
March 28, 2006