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14 March 2008
(vol. 48-1)

TOMATO INFO

IRRIGATION EFFICIENCY
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Irrigation Efficiency

While current wet weather conditions may belie the projected water delivery shortage from our Clear Lake irrigation distribution system in Yolo County, it is clear that dependable water availability is critical for our crop production.

Several factors have improved current water use efficiency in tomato production: buried drip irrigation systems and use of transplant seedlings. The drip systems obviously can deliver water more precisely and when buried, be less prone to surface evaporative losses. Whereas direct seeded fields often require several irrigations to emerge seedlings, a single irrigation following transplanting is the norm to establish the greenhouse-grown seedling in the field. Of course, timely rainfall can eliminate the need for irrigation during stand establishment, but Nature's delivery is not dependable. With direct seeding, efficiency might be gained by constructing soil caps over seed lines to reduce surface moisture loss and to eliminate irrigations that are needed only for wetting soil crusts to allow seedling emergence.

Other tomato production adjustments have also contributed to increased overall water use efficiency: higher yields to produce more tons of fruit per unit of water; early-maturity varieties, laser leveling of furrow surface slopes to increase irrigation uniformity, return discharge water systems; and careful soil management to reduce soil compaction in the furrow area.

As we reflect back several decades to the 1970's and 80's, growers were overwhelmingly concerned with Phytophthora root rot as the major limitation in tomato production. This root rot was an indicator of waterlogged soils from excessive irrigation and poor soil drainage conditions. Improved irrigation management has greatly reduced the occurrence and severity of Phytophthora.

How much water is needed for tomato production? Field research utilizing underground weigh scales (lysimeters) to help measure plant water use, demonstrates that tomatoes have an evapotranspirational requirement of about 24 acre-inches of water for our Central Valley. If irrigation efficiency were 80%, the water needs would be 30 acre-inches. Adjustments for seasonal weather conditions and specific planting schedules are needed. The water requirement is reduced by carry-over available soil moisture primarily from rainfall in our area.

When can tomato plants tolerate the most stress? Throttling back on irrigation during the fruit-bulking period and stopping irrigation during the fruit ripening stage has been widely practiced to balance sugars with yield, while attempting not to greatly reduce fruit tonnage. Field research supports this irrigation timing manipulation. While tomato plants can compensate, withholding irrigation that directly impacts stand establishment is ill advised. Fruit yield potential during the major flower-setting period through early fruit sizing is a water-stress sensitive time and should be avoided as well.

FUSARIUM WILT, RACE 3 RESISTANT FIELD TEST

Fusarium wilt, race 3 of tomato, is continuing to spread, especially in Yolo County (when compared to Solano or Sacramento counties but excluding Sutter Basin). While the rate of spread is generally slow from field to field and often even within fields, this soil-borne pathogen persists over several years. While there has not been a rigorous survey to document severity, the practice of cropping within 5 years back to tomatoes appears to sufficiently maintain the Fusarium population. In those clean fields, taking steps to prevent contaminated soil and especially infected plant tissue from being introduced is wise.

In fields with a history of Fusarium wilt, resistant varieties are valuable tools. A variety evaluation of race 3 resistant lines was conducted in 2007 in a commercial field of Don Beeman Farms with Salvador Duenas. The site was east of Woodland in an infested field out of tomato production since 2002. Varieties in the trial were 2 susceptible standards, AB 2 and H 9663, and 6 resistant entries submitted by various seed companies. Transplanting was completed on April 20 and harvested on August 20. The grower's planting and harvesting equipment and crew were provided.

Symptomatic diseased, yellow plants were counted beginning in early July, repeated later and a final tally made prior to harvest (table 1). About a month prior to harvest, number of diseased plants increased rapidly among the susceptible varieties, although AB 2 appeared less affected for a while. This delay in infection may partially explain why AB 2 performed well in spite of high infection level ahead of harvest. All the resistant lines had few if any infections from Fusarium.

Disease level was not uniformly distributed within the trial area. Compared to the blocks in the upper half of the trial, the lower half had 2 to 3 times the number of infected plants in the susceptible field variety in the perimeter rows of the trial.

Table 1. Infection level, Fusarium wilt, race 3, Don Beeman Farms, Elkhorn, 2007.

	Variety		Stand (Plants per 100')	3-Jul	27-Jul	19-Aug
				number of plants infected/100'		
1	AB 2	VFFP	103	6	42	55
2	CXD 221	VFFF3NP	104	0	1	0
3	CXD 242	VFFF3NP	103	0	0.3	0
4	CXD 246	VFFF3NP	102	0	1	1
5	Heinz 9663	VFFNP	103	19	61	54
6	HMX 4798	VFFF3NP	102	0	0	0
7	Susceptible	unknown	102	15	45	48
8	HMX 5883	VFFF3NP	102	1	0.3	2
9	PS 438	VFFF3P	103	0	1	0
	LSD 5%		NS	5	17	14
	% CV		1	71	70	54

Table 2. Yield, quality & cull-out, Fusarium wilt race 3, Don Beeman Farms, 2007

	Variety		Yield tons/A		Brix	PTAB color	pH	% pink	% green	% sun burn	% mold	% BER
1	CXD 242	VFFF3NP	50.3	a	4.65	23.5	4.42	7	8	1	1	1.0
2	AB 2	VFFP	48.3	ab	4.68	24.5	4.33	3	1	4	1	0.2
3	CXD 221	VFFF3NP	48.2	ab	5.03	26.8	4.41	4	6	1	1	0.3
4	HMX 4798	VFFF3NP	48.1	ab	4.83	24.3	4.42	4	5	0	0	0.2
5	PS 438	VFFF3P	42.9	abc	4.55	21.8	4.48	2	2	3	1	0.5
6	CXD 246	VFFF3NP	42.8	abc	4.60	22.5	4.50	3	7	2	3	1.0
7	Heinz 9663	VFFNP	40.7	bc	4.40	23.5	4.42	3	2	10	5	0.3
8	HMX 5883	VFFF3NP	36.2	c	4.48	24.5	4.46	3	2	3	3	1.3
9	Susceptible	unknown	35.2	c	4.58	23.8	4.50	1	3	8	1	0.0
	LSD 5%		8.3		NS	1.6	0.04	NS	3.7	4.3	3.0	NS
	% CV		13		7	4	1	74	63	83	119	207

Bottom Line: The Fusarium wilt race 3 resistant lines all held up well to the Fusarium. The popular susceptible AB 2, in spite of high disease, performed similarly to the best resistant lines. In fields with moderate incidence of disease, either AB2 or H 9663 could produce well. However, the increase in pathogen load at the end of the season would likely make future variety choices swing in favor of using resistant lines. In fields with severe losses with the previous tomato crop, use of resistant varieties is wise.

Ag Seeds and California Transplants provided assistance.

NITROGEN MANAGEMENT (copied with modification from March 2006)

With increased cost of nitrogen, some growers may consider reducing nitrogen rates. For canning 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 yield or fruit quality reductions, delayed harvest or out-of-control vine growth in canning tomatoes.

Field tests conducted in the late 1990's by UC Veg Crop Specialist Jeff Mitchell and 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 tomato 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 the sidedress period to allow completion of lab work.

In N-depleted soils, an application of around 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 after crop establishment to obtain soil lab reports specific to a field. If the soil tests are above 20 ppm (reported as nitrate-N), 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.

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.

Upshot: A pre-sidedressed nitrate soil sampling program provides some guidance on sidedressed N application rates. On exceptionally high residual N fields (35 ppm nitrate-N in the spring sampling period), it is very doubtful any additional N as a sidedress is needed. Applications above 200 pounds of N per acre would almost never be warranted for our area. Fine-tuning N input is neither precise nor economically without some risk as the soil sample must represent the scope of the field, including the low residual areas.

ROOT KNOT NEMATODES

For many recent years, nematode control in tomato production has simply been to use resistant varieties. By the late 1980's, field studies by UC nematologist Phil Roberts demonstrated that nematode resistance in tomatoes was as effective a tool in lowering nematode populations as some of our best nematicides. The Mi gene responsible for conferring resistance was the only commercial source of resistant in tomato and became successfully included in the majority of new cultivar releases. As an example, 90% of the top 50 varieties in California as listed by PTAB for 2007 are nematode resistant (although popular AB 2 and Halley are among the exceptions).

This repeated, widespread usage of nematode resistance doesn't fit into a long-term strategy of conserving the resistance. Research is on going to incorporate other sources of resistance to build a stronger multi-gene approach to protect both genes. However, field losses have surfaced with increased frequency with UC Davis lab-confirmed, resistance-breaking nematode populations from commercial fields. Locally, 6 fields with root knot damage on resistant varieties were confirmed through the Valerie Williamson lab at UCD. Five of the discoveries are in the general Woodland area and one is in Solano County. All have frequent rotation to tomatoes. Soils are all 'light' from a very fine sandy loam to a loam or silt loam.

Some strategies for such susceptible fields may be to soil sample to examine populations, try some nematicides especially in drip irrigated fields (because of effective delivery system) and plant early in the season to establish better root system ahead of more favorable warmer soils when root knot populations build. In most of these problem fields, only portions of the fields are affected. And perhaps if the problem is out of control, rotate out of tomatoes and host crops (most melons and peppers for example) for several years.

WORKER COMPENSATION BY EFFORT

At a recent ag labor management seminar in Woodland, UC Farm Advisor Greg Billikopf provided interesting advice on methods of improving worker productivity while raising the wages of productive workers.

"*The state pretended to pay the people; and the people pretended to work*." A Russian saying reflecting on their old labor system.

Universally, farm labors may well hold similar attitudes toward their jobs. Reflect on the common sight of a hand-weeding crew pacing as if a single unit through a field, regardless of the differences in worker capability and work effort required for any particular row. We were told that frequently the slowest person in the group sets the pace. The group thought process might be understood as, ‘why rush when we all get paid the same.’

I listened to Greg Billikopf explain, “when you pay on a per hour basis, the fastest workers are penalized and the slowest workers are rewarded.” Why would a highly capable worker want to exert great effort in that system and think it is fair? Table 3 shows a system that pays a minimum $7.25 per hour with a $0.055 per lbs. incentive bonus after achieving the minimum of 75 lbs. The last column (pay per effort) clearly shows the slowest workers are paid the most and the fastest workers increasingly get paid the least on an effort basis.

Table 3. Worker compensation for picking fruit by minimum hourly plus incentive bonus (with minimum 75 lb per hour requirement)

lbs/hr	hourly wage	bonus lbs	bonus $	income Total	pay per picking effort
20	$7.25	0	$0.00	$7.25	$0.36
25	$7.25	0	$0.00	$7.25	$0.29
30	$7.25	0	$0.00	$7.25	$0.24
35	$7.25	0	$0.00	$7.25	$0.21
40	$7.25	0	$0.00	$7.25	$0.18
45	$7.25	0	$0.00	$7.25	$0.16
50	$7.25	0	$0.00	$7.25	$0.15
55	$7.25	0	$0.00	$7.25	$0.13
60	$7.25	0	$0.00	$7.25	$0.12
65	$7.25	0	$0.00	$7.25	$0.11
70	$7.25	0	$0.00	$7.25	$0.10
75	$7.25	0	$0.00	$7.25	$0.10
80	$7.25	5	$0.28	$7.53	$0.09
85	$7.25	10	$0.55	$7.80	$0.09
90	$7.25	15	$0.83	$8.08	$0.09
95	$7.25	20	$1.10	$8.35	$0.09
100	$7.25	25	$1.38	$8.63	$0.09
105	$7.25	30	$1.65	$8.90	$0.08
110	$7.25	35	$1.93	$9.18	$0.08
115	$7.25	40	$2.20	$9.45	$0.08
120	$7.25	45	$2.48	$9.73	$0.08
125	$7.25	50	$2.75	$10.00	$0.08
130	$7.25	55	$3.03	$10.28	$0.08

How is quality maintained when speed becomes the major factor? The grower’s target should focus on meeting performance standards. Spot-checking to rate quality may be required. A below-performance grade could be reprimanded by differential lower pay rate or a reduction to the base pay for that day. If poor performance continued, implementing the 3-strikes rule maybe needed. The rules need to be fair and well understood at the beginning, perhaps best developed with group input. To achieve a win-win situation, the grower and worker should understand the targets.

Greg also warned against setting the piece-rate bar at some initially high financial level and then lowering the piece rate by self-justifying that your employee was making far too much money. The reward needs to be directly tied to the effort. Find that level of fairness that keeps the grower profitable, keeps the productive worker making more money than the norm and increases overall profitability of both. By tracking historical cost of the job under the various degrees of difficulty or favorable conditions, you’ll have a baseline to offer a piece rate pay scale.

The piece rate system would have been widely used had this system been easy to implement. For some growers, the challenge to improve productivity may motivate some changes in how individual workers or crews are paid for hand weeding, transplanting, moving sprinkler irrigation pipe, harvesting, etc.
Greg has a chapter on piece rate compensation that can be downloaded. http://www.cnr.berkeley.edu/ucce50/ag-labor/7labor/08.pdf He also has a web-based section on this subject at: http://www.cnr.berkeley.edu/ucce50/ag-labor/7research/7calag06.htm
If you are further interested, we can ask Advisor Greg Billikopf to provide another local seminar on crafting a wage rate plan. Greg is stationed in Modesto.

Submitted by,

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TOMATO INFO NEWSLETTER
March 14, 2008