

Preliminary Screening for Virus Resistance in Organic Field Grown Tomatoes

Jensen Uyeda, Ted Radovich, Jari Sugano, Koon-Hui Wang, Mike Melzner, and Linda Cox

Organic field grown tomato production is very challenging due to heavy pest pressure and restricted use of effective pesticides. The presence of three devastating viruses also contributes to the limited number of organic tomato producers. Viruses include tomato yellow leaf curl virus (TYLCV), tomato spotted wilt virus (TSWV), and pepper mottle virus (PepMoV) (Melzner et al., 2009 and 2012).

These three viruses can completely decimate commercial tomato operations without proper control strategies. Previous trials have shown the importance of screening and identifying resistant cultivars that can tolerate these viruses (Sugano et al., 2011). During these trials tomatoes were successfully grown under conventional practices.

In February 2012, a similar field trial was installed under organic practices at Poamoho Farms with six commercial cultivars reported to have resistance to TYLCV and TSWV (Table 1). 'Kewalo' has been shown to be susceptible to the virus and was selected as a susceptible control (Sugano et al., 2011). Four replications were installed, with six individual plants of each cultivar per replication.

Table 1. Tomato cultivars used in virus-resistance field trial.

Cultivar Name	Type	Seed Source	Characteristics
Pamella	Indeterminate	DP Seeds	Flattened globe shape, 180-220 grams
Sacramento	Indeterminate	DP Seeds	Flattened globe shape, 180-220 grams
Volante	Determinate	Sakata Seed	Deep oblate, large to extra-large
Tribute	Determinate	Sakata Seed	Globe, large to extra-large
Charger	Determinate	Sakata Seed	Deep oblate, extra-large
Kewalo	Determinate	UH CTAHR	6-8 oz, Matures in 75-80 days

Plants were seeded in January and transplanted in February 2012. Soil was amended with Hawaiian Earth Products compost (20 tons/acre) and Island Commodities tankage (15 tons/acre). Pests were managed using a combination of OMRI listed pesticides, including GF-120, Entrust, Nu Cop W50, and Trilogy.

Weekly harvests were recorded from April through June 2012. The cultivars selected for this evaluation include determinate and indeterminate plant types of large salad type tomatoes. At harvest, fruit were sorted and graded according to Hawaii Department of Agriculture's market standards for tomato. Data were analyzed using SAS and SigmaPlot.

An economic analysis was conducted using values from the trial to determine economic viability. Yield values are average yields per acre per crop across all six varieties. Input costs were estimated based on recommended application rates per acre per crop.

Results

Data indicate that 'Pamella' had significantly higher total marketable yield than 'Charger' and 'Kewalo', while 'Sacramento', 'Tribute' and 'Volante' produced intermediate yields (Figure 1). There were no significant differences in grade-A yields across all cultivars. However, indeterminate cultivars 'Pamella' and 'Sacramento' were numerically higher in comparison with the other cultivars. In informal flavor evaluations, growers and extension personnel rated all cultivars as acceptable, with 'Sacramento' identified as particularly desirable for flavor. Internal qualities of the cultivars are presented in Figure 2. Cost of production (Table 2) shows that at \$3.00 a pound, gross margins would be about \$28,000 per acre per crop.

Tissue blot assay

For each cultivar, all individual plants were sampled from each replication (n=12). These samples were evaluated for presence of TYLCV, TSWV and PepMoV. TYLCV was tested using a tissue blot immunoassay. Dark spots indicate the presence of the virus (Figure 3). TSWV and PepMoV were evaluated using ELISA (enzyme-linked immunosorbent assay).

All plants evaluated for TYLCV were positive for the virus (Figure 3). 'Charger', 'Tribute' and 'Volante' were strongly positive, while 'Pamella', 'Sacramento' and 'Kewalo' were slightly positive. Although all plants were found positive only 'Kewalo' showed severe symptoms in the field. This suggests that all plants except

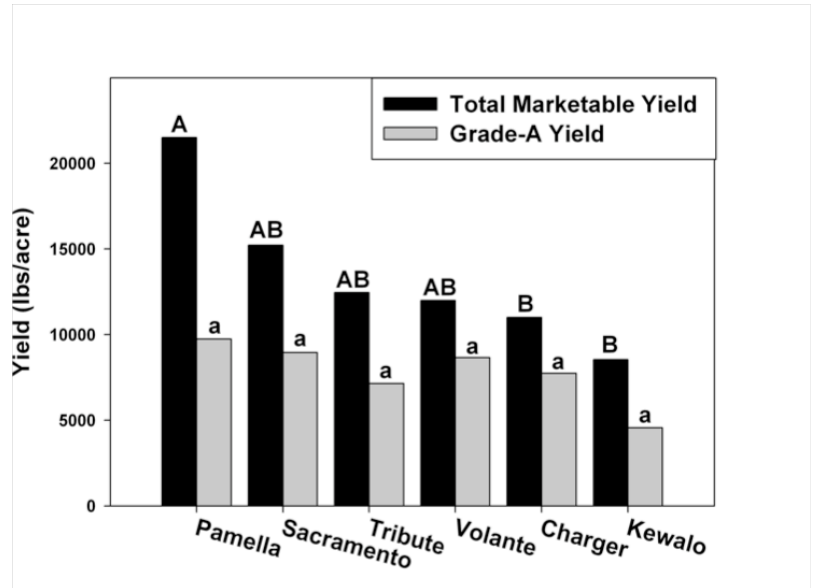


Figure 1. Estimated total marketable and grade-A yield per acre by cultivar. Means followed by the same letter are not statistically significant ($p < 0.05$).

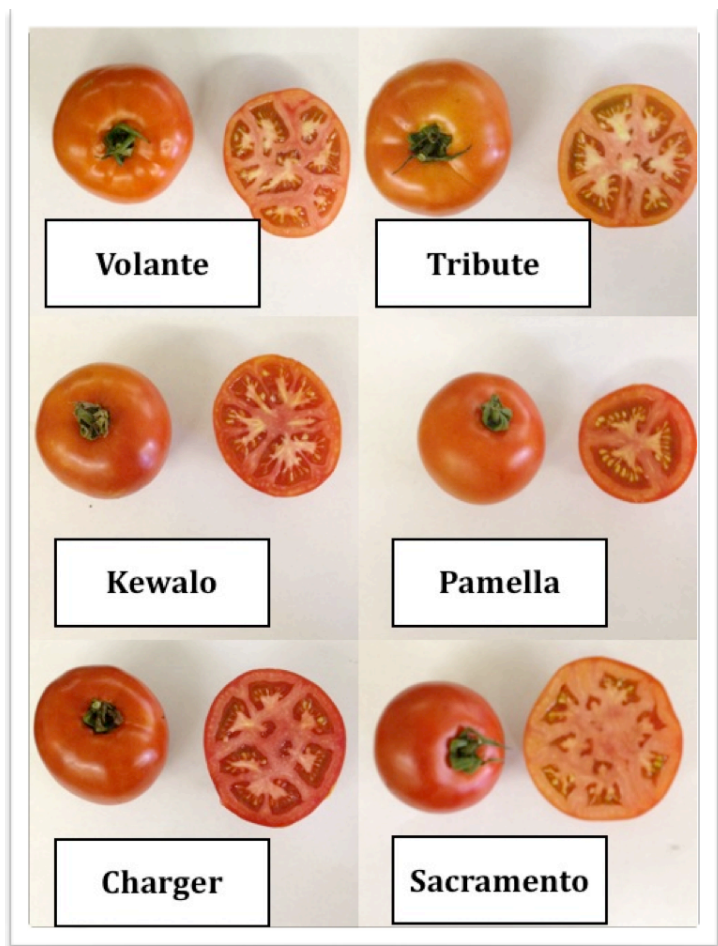


Figure 2. Top view and cross-section of different tomato cultivars.

Table 2. Example cost of production based on inputs and yields per acre per crop from the Poamoho Farms trial, 2012.

ORGANIC FIELD TOMATOES EXAMPLE					
Costs and gross margin per acre					
GROSS REVENUE PER ACRE	Quantity	Unit	\$/unit	Gross revenue	% of gross revenue
TYPICAL yields & prices	13456.00	pounds	\$3.00	\$40,368	100.00%
PRODUCTION COSTS (by activity)	Quantity	Unit	\$/unit	Cost	% of gross revenue
1 Land Preparation					
Fertilizer: Tankage	30,000.00	pounds	\$0.21	\$6,300	15.61%
Compost	26.70	cu yard	\$34.00	\$908	2.25%
Labor to prepare land	4.00	hours	\$7.98	\$32	0.08%
Total land preparation cost =				\$7,240	17.93%
2 Planting					
Tomato seeds	0.40	ounce	\$25.00	\$10	0.02%
Seedling trays	60.00	each	\$1.25	\$75	0.19%
Labor to raise & plant seedlings	3.00	hours	\$7.98	\$24	0.06%
Total planting cost =				\$109	0.27%
3 Pest Control					
Oroboost	0.75	gal	\$49.00	\$37	0.09%
Nu Cop 50wp	3.00	pound	\$4.60	\$14	0.03%
Trilogy	0.25	gal	\$105.40	\$26	0.07%
GF-120	0.25	gal	\$42.16	\$11	0.03%
Entrust	0.70	ounces	\$34.85	\$24	0.06%
Labor to apply pesticides	10.00	hours	\$7.98	\$80	0.20%
Total pest control cost =				\$192	0.47%
4 Irrigation					
Water	42.00	1000 gallons	\$2.00	\$84	0.21%
Labor to apply water	2.00	hours	\$7.98	\$16	0.04%
Total irrigation cost =				\$100	0.25%
5 Harvesting					
Labor to harvest	24.00	hours	\$7.98	\$192	0.47%
Boxes	0.00	each	\$0.75	\$0	0.00%
Total harvesting cost =				\$192	0.47%
6 Operating Overhead					
Operating interest	10.00%	annually		\$108	0.27%
Excise tax	0.50%	of gross revenue		\$202	0.50%
Commissions	5.00%	of gross revenue		\$2,018	5.00%
Management	5.00%	of gross revenue		\$2,018	5.00%
Office overhead	1.00%	of gross revenue		\$404	1.00%
Total operating overhead =				\$4,750	11.77%
TOTAL VARIABLE COSTS OF PRODUCTION PER ACRE =				\$12,582	31.17%
GROSS MARGIN PER ACRE(Gross revenue minus variable costs) =				\$27,786	68.83%

* This represents examples. Actual cost and revenues may differ.

'Kewalo' were tolerant to the virus. All plants tested for TSWV and PepMoV were negative for the viruses.

Conclusion

Although cultivars were susceptible to TYLCV, they varied in their tolerance to the virus. 'Pamella' and 'Sacramento' provided the highest numerical yields in this trial. Marketable yields were reduced by fruit fly damage resulting from inadequate application of GF-120. More frequent harvest of color break tomatoes is also expected to increase yields. The use of double resistant cultivars is recommended where both TYLCV and TSWV are present. If organically produced double resistant cultivars are not available

commercially, untreated conventionally grown seed may be used by certified organic growers. Growers must provide documentation of the unavailability of organic seed from three sources.

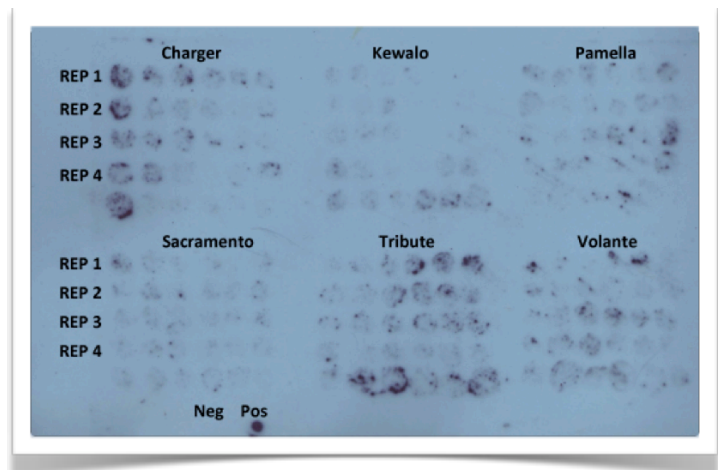


Figure 3. Tissue blot assay for TYLCV. April 2012.

References

- Melzner, M., D. Ogata, S. Fukuda, R. Shimabuku, W. Borth, D. Sether, and J. Hu. 2009. Tomato Yellow Leaf Curl. University of Hawai'i at Mānoa, College of Tropical Agriculture and Human Resources, Plant Disease publication PD-70. <http://www.ctahr.hawaii.edu/oc/freepubs/pdf/PD-70.pdf>
- Melzner, M., S. Tripathi, T. Matsumoto, L. Keith, J. Sugano, W. Borth, A. Weiczorek, D. Goncalves, and J. Hu. 2012. Tomato Spotted Wilt. University of Hawai'i at Mānoa, College of Tropical Agriculture and Human Resources, Plant Disease publication PD-81. <http://www.ctahr.hawaii.edu/oc/freepubs/pdf/PD-81.pdf>
- Sugano, J., M. Melzner, A. Pant, T. Radovich, S. Fukuda, S. Migita, and J. Uyeda. 2011. Field Evaluation of Tomato Yellow Leaf Curl Virus-Resistant Varieties for Commercial Production. University of Hawai'i at Mānoa, College of Tropical Agriculture and Human Resources, Plant Disease publication PD-78. <http://www.ctahr.hawaii.edu/oc/freepubs/pdf/PD-78.pdf>
- Valenzuela, H., R. Hamasaki, and T. Hori. 1993. Field Tomato Production Guidelines for Hawaii. University of Hawai'i at Mānoa, College of Tropical Agriculture and Human Resources, Research Extension Series 141. <http://www.ctahr.hawaii.edu/oc/freepubs/pdf/RES-141.pdf>

Acknowledgments

DP Seeds, Sakata Seed, and University of Hawaii CTAHR, Agriculture Diagnostic Service Center Seed lab for donation of seeds; Poamoho Farms for field and harvest support; Susan Migita and volunteers at Poamoho Research Station for harvest support.

Article content is the sole responsibility of the author. For more information about this article, contact Jensen Uyeda, email: juyeda@hawaii.edu.