Cornell CALS
College of Agriculture and Life Sciences

Cornell AgriTech
New York State Agricultural Experiment Station

Curriculum Vitae
Terence R. Bates, Ph.D.

Senior Research Associate,
School of Integrative Plant Science, Horticulture Section
Cornell Lake Erie Research and Extension Laboratory, Director
6592 West Main Road, Portland, New York, 14769
716-792-2800 ext. 207, trb7@cornell.edu

INTRODUCTION

Terry Bates is a Senior Research Associate and Director of the Cornell Lake Erie Research and Extension Laboratory. His program focuses on viticulture with an integrated systems approach to vine productivity, fruit quality, and farm profitability. Research interests and contributions include vine mineral nutrition and root biology to control vegetative growth, mechanized vineyard management for fruit quality and labor reduction, and Precision Viticulture to increase production efficiency. Terry was the lead PI on the "Efficient Vineyard" project, a UDSA-NIFA-Specialty Crop Research Initiative project in precision viticulture and is a co-PI on the "High-Resolution Vineyard Nutrient Management" SCRI project.

The Cornell Lake Erie Research and Extension Laboratory, a 50-acre research facility in Portland NY with current projects in juice grapes, wine grapes, hops, willow, and vegetables.

EDUCATION

Ph.D., Plant Physiology (1998) The Pennsylvania State University

Dissertation Research: The importance of root hairs in phosphorus acquisition and the mechanism of root hair elongation in phosphorus deficient *Arabidopsis thaliana* plants.

M.S., Horticulture (1994) The Pennsylvania State University

B.S., Biology; Minor, Science Education (1992) St. John Fisher College, Rochester, NY

PROFESSIONAL EXPERIENCE

Senior Research Associate and Cornell Lake Erie Research and Extension Laboratory Director ('09 - current)
Appointment: 40% Administration, 40% research, 20% Extension

Viticulture Research Associate IV, Cornell University ('98 – '09)
Responsible for viticulture research in the Lake Erie regional grape belt, which includes 30,000 acres of grape production in Western New York and Erie County, Pennsylvania

National Science Foundation Root Biology Fellow ('97)
Awarded a Doctoral Dissertation Grant and developed a technique using quantitative ratio fluorescent microscopy to measure cytoplasmic pH in growing root hair cells

Research Assistant, The Pennsylvania State University ('93-'97)
Designed and executed several studies on the mineral nutrition of *Arabidopsis thaliana* using a range of techniques including tissue culture, microscopy, image analysis, radioisotope labeling, and greenhouse culture

Technical Assistant, The Pennsylvania State University ('92-'93)

PROFESSIONAL ACTIVITIES

- Cornell Digital Agriculture Program Work Team (PWT) – Chair
- American Journal of Enology and Viticulture – Associate Editor
- Catalyst, Discovery into Practice – Associate Editor
- American Society for Enology and Viticulture – Eastern Section (member)
    - 2008 President
    - 2007 Conference Program Chair
    - 2005-2013 - Scholarship Committee Chair
- American Society of Enology and Viticulture – National (member)
    - By-Laws review committee
- American Society for Horticultural Science (member)
- Vineyard Lab Research Committee (Chair)
- Lake Erie Regional Grape Program Advisory Committee

HONORS AND AWARDS

- St. John Fisher College Science and Technology Hall of Fame (2017)
- American Society for Enology and Viticulture, Extension Distinction Award (2014 - Inaugural)
- New York Wine and Grape Foundation Research Award (2008) Individual
- New York Wine and Grape Foundation Research Award (2006) Group – Fredonia Vineyard Lab

GRANT ACTIVITY

Bates, T., VandenHeuvel, J., Russo, J., Meyers, J., (pending) Improving Regional and Block-Level Concord Crop Estimation. New York Wine and Grape Foundation. $38,258.

Russo, J., Martin, K., **Bates, T.** (2020-) Evaluating the Effects of Cropping levels on Bud Hardiness to Mitigate Risk in Lake Erie Grape Production for Vitis Labrusca, Vitis Vinifera, and Hybrid Cultivars. New York Wine and Grape Foundation. $20,806.

Gold, K., Lohman, R., Vanden Heuvel, J., Sun, Y., **Bates, T.** (2020-2021) Accelerating the application and adoption of remote sensing decision support in Northeastern viticulture. Cornell Initiative Digital Agriculture Research Innovation Fund. $150,000.

Keller, M., Zhand, Q., Skinkis, P., **Bates, T.,** Schreiner, P. (2020-2024) High-Resolution Vineyard Nutrient Management. USDA NIFA Specialty Crops Research Initiative. 9/1/20-8/31/24. $4,750,000.

Bates, T., Weigle, T. (2015-2019) Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Rate Management. CALS - College Of Ag. & Life Sciences, CALS Horticulture - Geneva, USDA, USDA (USDA-NIFA), 2015-51181-24393, Federal Government, Award, Award Signed By All Parties, $6,355,640.00.

Dresser, J., **Bates, T.** (2018-2019) Reducing the Prediction Error of Regional and Field Level Forecasts in Lake Erie Concord through the Integration of Precision Viticulture Technology. CALS - College Of Ag. & Life Sciences, CALS Horticulture - Geneva, NY WINE/GRAPE, NY WINE/GRAPE, Non-Profit Foundation, Award, Award Awaiting Feedback From, $32,911.00.

Martinson, T. E. and **T. Bates.** (2018-2021) Documenting performance of novel wine grape cultivars and clones and disseminating research-based information to Eastern Producers. Cornell Federal Formula Funding Initiative Integrated Research/Extension Project. $116,256.

Bates, T., Haggerty, L., Martin, K. (2015-2017) Variable rate mechanical shoot thinning to balance yield and fruit quality in New York Concord vineyards. CALS - College Of Ag. & Life Sciences, CALS Horticulture - Geneva, NY. New York Farm Viability Institute. $47,816.

Haggerty, L., **Bates, T.** (2015-2017) Using Cover Crops to Improve Soil Health and Vine Productivity in Intensely Managed 'Concord' Vineyards. CALS - College Of Ag. & Life Sciences, CALS CCE LEGP, NY FARM VIABILITY INST, NY FARM VIABILITY INST, OAR 15 014, Non-Profit Organization, Award, Award Closed, $45,130.00,

Bates, T. (2010-2018) Pilot Project on Canopy and Crop Estimation. CALS - College Of Ag. & Life Sciences, CALS Horticulture - Geneva, NGRA, NGRA, Non-Profit Organization, Award, Award Awaiting Closeout, $315,000.00.

Haggerty, L., Weigle, T., **Bates, T.** (2014-2015) Identify, Diagnose, and Manage Risk Zones in Commercial Vineyards Through the Extension of Sensor Technologies Research. CALS - College Of Ag. & Life Sciences, CALS CCE LEGP, U OF DELAWARE, U OF DELAWARE, 36283, University, Award, Award Closed, $41,703.00.

Bates, T. (2011-2021), "MATERIAL TRANSFER AGREEMENT: FIXED", CALS - College Of Ag. & Life Sciences, CALS Geneva CLEREL Uncategorized, BRAZIL, BRAZIL (EMBRAPA), Foreign Government, Award, Award Signed By All Parties.

Bates, T., Weigle, T., Martin, K. Taylor, J., Muza, A. (2012 – 2018). A System Approach to Concord Productivity and Fruit Quality in the Lake Erie Region. NY Wine/Grape Foundation. $330,319.

Loeb, G., Dunst, R., **Bates, T.**, Cousins, P. (2010 – 2012). Growing Phylloxera-Susceptible Grapes on Their Own Roots in Cool Climates: Costs and Benefits. NY Wine/Grape Foundation. $11,271.

Bates, T. (2009-2012). Evaluation of Vineyard Mechanization Options in Concord. NY Wine/Grape Foundation. $25,401

Bates, T., Creasap-Gee, J. (2009-2012). Spatial Measurement of Canopy, Yield, and JSS for Efficient Concord Production. NY Wine/Grape Foundation. $85,400.

Creasap-Gee, J., **Bates, T.** (2009). Web Resources for Cornell University's 'G.R.a.P.E. Pages'. NY Wine/Grape Foundation. $7,500.

Bates, T. (2002-2008). Improving Wine Grape Production in Acid Soils with Rootstocks and Soil Management. NY Wine/Grape Foundation. $153,840.

Cheng, L., **Bates, T.** (2007-2008). Enhancing and Synchronizing Grape Berry Maturation. NY Wine/Grape Foundation. $45.056.

Bates, T. (2007-2008). The Effect of Soil Type, Vine Size, and Crop Size on Concord. NY Wine/Grape Foundation. $21,236.

Bates, T., Cousins, P. (2000-2007). Evaluation of Rootstocks for Concord Grape in the Lake Erie Production Region. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $165,385.

Cheng, L. et al (2007). Develop a Protocol and a Database for Assessing Vineyard Soil Health to Improve Juice/Wine Quality and Vine Productivity. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $35,000.

Walter-Peterson, H., **Bates, T.** (2007). The Effect of Soil pH and Rootstock on the Wine Quality of Riesling and Traminette. NY Wine/Grape Foundation. $14,000.

Bates, T. (1999-2006). The Response of 'Concord' Grapevines to Soil pH. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $96,856.

Cheng, L., **Bates, T.** (2004-2006). Nitrogen Uptake, Partitioning and Utilization of Concord Grapevines. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $99,140.

Bates, T., Walter-Peterson, H. (2004-2006). Assessing Vineyard Variation and Applying Differential Management. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $37,047.

Cheng, L., **Bates, T.** (2005-2006). The Effect of Crop Load on Concord Juice Quality: Accumulation of Primary and Secondary Metabolites from Veraison to Harvest. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $25,000.

Goffinet, M., **Bates, T.** (2004-2005). Effect of Crop Load Adjustment on Bud Fruitfulness, Return Bloom, and Bud Cold Hardiness in Concord Grapevine. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $30,528.

Lakso, A., Goffinet, M., Cheng, L., **Bates, T.** (2003). Seasonal Balances and Distributions of Growth, Nutrients, and Carbohydrates in Mature Concord Grapevines. Hatch. $48,200.

Bates, T. (2002-2003). The Effect of Thinning Time, Thinning Level, and Vine Size on Concord Juice Quality. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $16,459.

Bates, T., Dunst, R. (2000-2003). Evaluation of Vertical Shoot Distribution on Canopy Shading, Yield, and Juice Quality of Concord and Niagara Grapevines. Kaplan Funds. $14,800.

Bates, T., Morris, J. (1999-2003).Total Vineyard Mechanization to Optimize Yield and Quality of Concord. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $136,873.

Bates, T., Howell, S., Wample, R. (1999-2002). Effect of Pruning, Training, Thinning, and Shoot Positioning on the Yield and Quality of 'Concord' Grapevines. USDA Viticulture Consortium East, NY Wine/Grape Foundation. $49,089.

REFEREED PUBLICATIONS

Taylor JA, **Bates T** (Accepted) Comparison of different vegetative indices for calibrating proximal canopy sensors to grapevine pruning weight. Am J Enol Vitic.

Bates T, Jakubowski R, Taylor JA. (2021) Evaluation of the Concord Crop Load Response for Current Commercial Production in New York. Am J Enol Vitic 72:1–11.

Guillaume S, **Bates T,** Lablee J, Betts T, Taylor J. (2020) Combining spatial data layers using fuzzy inference systems: Application to an agronomic case study. In 6th International Conference on Geographical Information Systems Theory, Applications and Management (GISTAM 2020). pp. 62–71. Science and Technology Publications, Lda.

Taylor J, Dresser J, Hickey C, Nuske S, **Bates T.** (2019) Considerations on spatial crop load mapping. Aust J Grape Wine Res. doi:10.1111/ajgw.12378.

Bates, T., J. Dresser, R. Eckstrom, G. Badr, T. Betts and J. Taylor, "Variable-rate mechanical crop adjustment for crop load balance in 'Concord' vineyards," (2018) IEEE IoT Vertical and Topical Summit on Agriculture - Tuscany (IOT Tuscany), Tuscany, 2018, pp. 1-4. doi: 10.1109/IOT-TUSCANY.2018.8373046.

Badr G, Hoffman JS, **Bates TR.** (2018) Effect of Cane Length on Concord and Niagara Grapevines. Am J Enol Vitic 4:ajev.2018.18019.

Badr G, **Bates TR.** (2018) Modelling "Concord" Berry Weight Dynamics. In 14th International Conference on Precision Agriculture. pp. 1–15. International Society of Precision Agriculture, Montreal, Quebec, Canada;

Taylor JA, Link K, Taft T, Jakubowski R, Joy P, Martin M, Hoffman JS, Jankowski J, **Bates TR.** (2017) A Protocol to Map Vine Size in Commercial Single High-Wire Trellis Vineyards Using "Off-the-Shelf" Proximal Canopy Sensing Systems. Catal Discov into Pract 2:35–47.

Bates TR. (2017) Mechanical crop control in New York "Concord" vineyards target desirable crop load levels. In Acta Horticulturae. pp. 259–264. International Society for Horticultural Science (ISHS), Leuven, Belgium;

Brillante L, Martínez-Luscher J, Yu R, Plank CM, Sanchez L, **Bates T**, Brenneman C, Oberholster A, Kurtural SK. (2017) Assessing Spatial Variability of Grape Skin Flavonoids at the Vineyard Scale Based on Plant Water Status Mapping. J Agric Food Chem 65:5255–5265.

Taylor JA, Sanchez L, Sams B, Haggerty L, Jakubowski R, Djafour S, **Bates TR.** (2016) Evaluation of a commercial grape yield monitor for use mid-season and at-harvest. J Int DES Sci LA VIGNE DU VIN 50:57–63.

Taylor, J.A. and **Bates, T.R.** (2013) Temporal and Spatial Relationships in Pruning Mass of Concord Vines. Aust. J. Grape Wine Res. 19(3) p401-408

Taylor, J.A. and **Bates, T.R.** (2013) A discussion on the significance associated with Pearson's correlation analysis in Precision Agriculture studies. Precision Agriculture. 14(5), p558-564.

Taylor, J.A., Nuske, S., Singh, S. Hoffman, J.S. and **Bates, T.R.** (2013) Temporal evolution of within-season vineyard canopy response from a proximal sensing system. Precision Agriculture '13. Proceedings of the 9th ECPA, Lleida, Spain, July 7-11, 2013. J.V. Stafford (ed.). Wageningen Academic Publishers.

Taylor, J.A. and **Bates, T.** (2012) A research note on sampling and estimating average pruning weights in Concord grapes. American Journal of Enology and Viticulture. 63(4), p559-563.

Grocholsky, B.; Nuske, S; Aasted, M; Achar, S; **Bates, T.** (2011). A camera and laser system for automatic vine balance assessment. ASABE Paper No. 1111651, American Society of Agricultural and Biological Engineers (ASABE). St. Joseph, Mich. ASABE.

Nuske, S.; Achar, S.; **Bates, T**.; Narasimhan, S.; Singh, S. (2011). Yield estimation in vineyards by visual grape detection. Proceedings of the 2011 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2011). San Francisco, CA.

Bates, T. and J. Morris. (2009) Mechanical cane pruning and crop adjustment decreases labor costs and maintains fruit quality in New York 'Concord' grape production. HortTechnology. 19 (2), 247-253.

Bates, T. & Wolf T. (2008) Vineyard Nutrient Management. Book Chapter In: Wine Grape Production Guide for Eastern North America. T. Wolf (Ed.). Natural Resource, Agriculture, and Engineering Service. Ithaca, New York.

Bates, T. (2008) Pruning level affects growth and yield of New York Concord on two training systems. American Journal of Enology and Viticulture. 59: 276-286.

Cheng, L, G. Guohai, & **T. Bates** (2004) Growth and fruiting of young 'Concord' grapevines in relation to reserve nitrogen and carbohydrates. J. Amer. Soc. Hort. Sci. 129(5), 660-666.

Bates, T, Dunst R, Taft T & Vercant M (2002) The Vegetative Response of 'Concord' Grapevines to soil pH. HortScience 37 (6), 890-893.

Bates, T, Dunst R & Joy P (2002) Seasonal Dry Matter, Starch, and Nutrient Distribution in 'Concord' Grapevine Roots. HortScience 37 (2), 313-316.

Bates, T, English-Loeb G, Dunst R, Taft T & Lakso A (2001) The interaction of phylloxera infection, rootstock and irrigation on young Concord grapevine growth. Vitis 40, 225-228.

Bates, T. & Lynch J (2001) Root hairs confer a competitive advantage under low phosphorus availability. Plant and Soil 236, 243-250.

Bates, T. & Lynch J (2000) The efficiency of *Arabidopsis thaliana* root hairs in phosphorus acquisition. American Journal of Botany 87, 964-970.

Bates, T. & Lynch J (2000) Plant growth and phosphorus accumulation of wildtype and two root hair mutants of *Arabidopsis thaliana*. American Journal of Botany 87, 958-963.

Bates, T. & Lynch J (1996) Stimulation of root hair elongation in *Arabidopsis thaliana* by low phosphorus availability. Plant, Cell, and Environment. 19, 547-554.

TECHNICAL/EXTENSION PUBLICATIONS

Bates T, Jakubowski R, Taylor J (2021) Measure and Manage Crop Load to Meet Your Vine Balance Targets. Appellation Cornell. Issue 44. March 2021. https://grapesandwine.cals.cornell.edu/newsletters/appellation-cornell/2021-newsletters/issue-44-march-2021/research-focus-1/

Bates T, Jakubowski R, Taft T, Sprague D, Joy A, Martin M, Ebert S. (2020) Variable-rate Mechanical Shoot Thinning in Concord Demonstrates the Practical Application of Precision Viticulture. Appellation Cornell. 2020-3. https://grapesandwine.cals.cornell.edu/sites/grapesandwine.cals.cornell.edu/files/shared/Research%20Focus2020-3.pdf

Bates, T., J. Dresser, R. Eckstrom, G. Badr, T. Betts and J. Taylor (2018). Sensors Provide Information to Guide Variable-Rate Mechanical Fruit Thinning and Prevent Overcropping of Concord Grapes. Appellation Cornell. Research Focus 2018-3. https://grapesandwine.cals.cornell.edu/sites/grapesandwine.cals.cornell.edu/files/shared/Research%20Focus%202018-3%20Aug.pdf.

Taylor, J.A., Nuske, S., Singh, S. Hoffman, J.S. and **Bates, T.** (2013)"Temporal evolution of within-season vineyard canopy response from a proximal sensing system." Submitted to the 9th European Conference on Precision Agriculture, Lleida, Spain, July 7-11, 2013.

Martinson, T., Walter-Peterson, H. C., Hoying, S. A., Wise, A., **Bates, T. R.,** Gerling, C. J. (2013). Around New York: Statewide Vineyard Crop Development update.. In Martinson, T. E. and C. Gerling (Ed.), Veraison to Harvest: Statewide Vineyard Crop Development Update (ed., vol. 7, pp. p1-2). Geneva NY: Cornell University.

Martinson, T., **Bates, T. R.** (2013). Grapes 101: Lessons from the big dig: dry matter, nitrogen uptake, and fertilizer efficiency. In Martinson, T. E. and C. Gerling (Ed.), Appellation Cornell (14th ed.). Geneva NY: Cornell University.

Taylor J.A. and **Bates, T.** (2012) Spatial Variation in Pruning Weight and Implications for Managing Vine Size in Concord Grapes. ASEV Eastern Section Conference, Technical Program, (Abstract only), Traverse City, Michigan July 16-19, 2012.

Martinson, T., Lakso, A. N., **Bates, T. R.** (2012). GRAPES 101. Bud Fruitfulness and Yield.. Appellation Cornell Newsletter (10th ed.). Ithaca, NY: Cornell's Viticulture and Enology Program. http://www.cals.cornell.edu/cals/grapesandwine/appellation-cornell/issue-10/grapes-101-bud-fruitfulness.cfm

Bates, T., Nuske, S., Grocholsky, B. (2011). Automating Measurements of Canopy and Fruit to Map Crop Load in Commercial Vineyards (vol. Research Focus 2011-4: Cornell Viticulture and Enology). Ithaca, NY: Appellation Cornell, Cornell University.

Jakubowski, R., Weigle, T. H., **Bates, T.**, Knight, E. (2011). Characterizing Grape Production in the Lake Erie Region through GIS Mapping. Lake Erie Regional Grape Program. Portland, NY.

Weigle, T. H., Carroll, J. E., Landers, A. J., Muza, A., **Bates, T.**, Cousins, P., Curtis, P. D., Dunst, R., Helms, M., Loeb, G. M., Hed, B., Martinson, T., Reisch, B. I., Senesac, A., Timer, J., Vanden Heuvel, J. E., Walter-Peterson, H. C., Wilcox, W. F., Wise, A. (2010). 2010 Production Guide for Organic Grapes. In Tim Weigle and Juliet Carroll (Ed.), *NYS IPM Publication No. 224*. Ithaca, New York USA: Cornell Cooperative Extension.

Bates, T. (2009) Dialing in vine size: Trials on four winegrape varieties in Lake Erie region. Wines & Vines. April, 50-53

Bates, T. and H. Walter-Peterson. (2008) Vineyard mechanization and site specific viticulture practices in New York. *In* Procceding for the Justin R. Morris Vineyard Mechanization Symposium. R. K. Striegler et al (Eds.), p. 53-64. University of Missouri, Columbia, MO.

Bates, T., B.I. Reisch, and H. Walter-Peterson. (2008) Improving wine grape production in acid soils with rootstocks and soil management. 58th Annual Finger Lakes Grape Growers' Conference, Waterloo, NY, March, 2008. p. 46-50.

Bates, T. (2007) Shaulis Viticulture and Eastern Viticulture. Wine East. Vol 34. No 5. January-February, 2007

Bates, T. (2006) Crop Load Management in western New York. Wine East. Vol 34. No 4. November-December, 10-19.

Lakso, A. Goffinet, **T. Bates**, T. Cheng, L. & Dunst, R. (2006) Seasonal Growth, dry matter, and carbohydrate development in mature 'Concord' grapevines. Poster Presentation. Proceedings of the Sixth International Cool Climate Symposium for Viticulture and Enology. 5-10 February, 2006, Christchurch, New Zealand.

Bates, T. (2006) Integrating Mechanization Practices and Hand Labor for Vineyard Production Efficiency. Proceedings of the Sixth International Cool Climate Symposium for Viticulture and Enology. 5-10 February, 2006, Christchurch, New Zealand.

Bates, T. (2005) Grapevine Root Biology and Rootstock Selection in the Eastern, U.S. Proceedings of the 20th Annual Mid-America Grape and Wine Conference. Southwest Missouri State University. Feb 4-8, 2005.

Bates, T. (2005) Soil pH, Nutrient Availability, and Vine Productivity. Proceedings of the 20th Annual Mid-America Grape and Wine Conference. Southwest Missouri State University. Feb 4-8, 2005.

Bates, T. (2005) Did Record Summer Heat Turn Fredonia into Napa? The New York Grapevine. Fall 2005. New York Wine and Grape Foundation.

Travis J, N Halbrendt, B Hed, J Ryder, E Anderson, B Jarjour, J Griggs & **T Bates** (2003) A Practical Guide to the Application of Compost in Vineyards. Penn State College of Agriculture. Department of Plant Pathology.

http://www.ppath.cas.psu.edu/EXTENSION/FRUITPATH/compostguide.pdf

Bates, T. (2003) Concord Crop Adjustment: Theory, Research, and Practice. Lake Erie Vineyard Notes, Summer 2003.

Bates, T. (2002) Purple Power. The New York Grapevine. Summer.

Bates, T. (2002) Looking Back at 'Looking Ahead' and Looking Ahead. . .Again. The New York Grapevine. Spring.

Bates T. (2001) More than one way to skin a grapevine. The New York Grapevine. Summer. 3-6.

Bates, T. (2000) Investigating Concord Grapevine Nutrition Through Soil pH. The New York Grapevine. Summer. 6-7.

Bates, T. & Lynch J. (1997) Cytoplasmic pH gradients in growing root hairs mediate tip growth rate. The Pennsylvania State University Root Biology Symposium.

Bates, T. & Lynch J. (1995) Stimulation of root hair elongation in Arabidopsis thaliana by low phosphorus availability. Plant Physiology Supplement 108:780.

INTERNET OUTREACH / SOFTWARE DEVELOPMENT

The Efficient Vineyard Website provides research-based information from the Cornell Lake Erie Research and Extension Laboratory. https://www.efficientvineyard.com/

2020 video summary of the Efficient Vineyard Project. https://www.efficientvineyard.com/overview

The "MyEfficientVineyard" or "MyEV" tool is a web-based software platform for commercial grape producers to upload, process, and visualize spatial data on their own vineyards. https://my.efficientvineyard.com/

2020-2021 Viticulture research posts and MyEV tutorials. https://www.efficientvineyard.com/blog

RESEARCH REPORTS

Bates, T., Kantor, G., Taylor, J., S., Weigle., Alston, J., (2016, 2017, 2018, 2019, 2020) Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management. Progress Report USDA-NIFA-SCRI Award no. 2015-51181-24393.

Bates, T., Dresser, J., Jakubowski, R., Joy, A., Sprague, D. (2018) Variable Rate Mechanical Shoot Thinning to Balance Yield and Fruit Quality in New York Concord Vineyards. Final Report. New York Farm Viability Institute.

Bates, T., Weigle, T., Haggerty, L., Martin, K., Muza, A., Loeb, G. (2017) A System Approach to Concord Productivity and Fruit Quality in the Lake Erie Production Region. Final Report. Lake Erie Processor Group and the New York Wine and Grape Foundation.

Bates, T., Kantor, G., Taylor, J., Kurtural, S., Weigle., Alston, J., (2017) Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management. Progress Report USDA-NIFA-SCRI Award no. 2015-51181-24393.

Bates, T., Nuske, S., Taylor, J., Kurtural, S., Weigle., Alston, J., (2016) Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management. Progress Report USDA-NIFA-SCRI Award no. 2015-51181-24393.

Bates, T., Nuske, S. (2014-2015) Pilot Project on Canopy and Crop Estimation: Automated Vineyard Canopy and Crop Measurement Project. Report to National Grape and Wine Initiative

Bates, T., Nuske, S. (2013) Spatial Vineyard Management for Production Efficiency, Environmental Sustainability, and Business Profitability. National Grape and Wine Initiative.

Bates, T., Creasap Gee, J. (2009-2011). Evaluation of Vineyard Mechanization Options in Concord. NYSAES, Geneva, NY: Viticulture Consortium - East.

Bates, T. (2009-2011). Spatial Measurement of Canopy, Yield, and Juice Soluble Solids for Efficient Concord Production.. NYSAES, Geneva, NY: Viticulture Consortium - East.

Bates, T. Reich, B. Walter-Peterson, H. and Dunst, R. (2008) Improving wine grape production on acid soils with rootstocks and soil management. Progress report. 2007 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Bates, T. (2008) The effect of soil type, vine size, and crop size on Concord. Progress report. 2007 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Bates, T. Lakso, A. and Dunst, R. (2008) The effect of crop size, soil moisture, and potassium availability on Concord nutrition and crop development. Final report. 2007 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Bates, T. and Walter-Peterson, H. (2007) Using precision agriculture tools to increase vineyard production efficiency. Progress report. 2006 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Bates, T. Lakso, A. and Dunst, R. (2007) The Response of 'Concord' Grapevines to Soil pH. Final report. 2006 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Cousins, P. and Bates, T. (2007) Evaluation of rootstocks for Concord and Niagara grapes in the Lake Erie production region. Final report. 2006 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Bates, T. and Morris, J. (2006) Total vineyard mechanization to optimize yield and quality of Concord grape production. Final report. 2005 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Goffinet, M. and Bates, T. (2006) Effects of Crop Load Adjustment on Bud Fruitfulness, Return Bloom, and Bud Cold Hardiness in Concord Grapevine. Final report. 2005 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Bates, T. (2005) The effect of thinning time, thinning level, and vine size on Concord juice quality. Final report. 2004 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Cheng, L. and Bates, T. (2005) Nitrogen uptake, partitioning and utilization of Concord grapevines. Final report. 2004 Viticulture Consortium East Research Reports, Cornell University, NYSAES.

Bates, T. (2004) Evaluation of vertical shoot distribution on canopy shading, yield, and juice quality of Concord and Niagara grapevines. Final report. 2003 Kaplan Fund Research Reports, Cornell University, NYSAES.

PRESENTATIONS

Bates, T. The MyEfficientVineyard software tool for spatial data processing in commercial vineyards. Cornell Recent Advances in Viticulture and Enology. (11/10/2020).

Bates, T. Vineyard Nutrition for Lake Erie Growers. Lake Erie Regional Grape Program Coffee Pot Meeting. (5/13/2020).

Martinson, T., Bates, T. Symposium Organizers. Nelson J. Shaulis Symposium on Digital Viticulture. Geneva, NY. (7/16 – 7/18/2019). https://blogs.cornell.edu/digitalviticulture/

Bates, T. Integrating Spatial Crop Load and Soil Mapping into Practical Management Tools. Nelson J. Shaulis Symposium on Digital Viticulture. Geneva, NY. (7/18/2019). ~100 U.S. grape industry attendees.
https://blogs.cornell.edu/digitalviticulture/2019/08/08/integrating-spatial-crop-load-and-soil-mapping-into-practical-management-tools-terry-bates/

Bates, T., Jakubowski, R., Dresser, J., Barrett, H., Ebert, S., Taft, t., Sprague, D., Joy, A., Taylor, J., Martin, M., Nelson J. Shaulis Symposium on Digital Viticulture. Field Demonstration. Branchport, NY. (7/17/2019). ~130 Eastern US grape industry attendees on the tour. https://blogs.cornell.edu/digitalviticulture/home/july-17-digital-viticulture-field-demonstrations/

Bates, T., Kantor, G., Taylor, J. "SCRI Project Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management." VESTA/Michigan Wine Collaborative Summit and Conference. Traverse City, MI. (6/6/2019). ~60 MI growers attended.

Bates, T., Barrett, H., Jakubowski, R. Variable-rate mechanical shoot thinning vineyard field demonstration #4. Don Tone's Farm, Branchport, NY (5/24/2019). ~25 NY growers attended.

Bates, T., Barrett, H., Jakubowski, R, Joy, A. Variable-rate mechanical shoot thinning vineyard field demonstration #3. Cornell Lake Erie Research and Extension Laboratory, Portland, NY. (5/21/2019). ~25 NY growers attended.

Bates, T., Barrett, H., Jakubowski, R. Variable-rate mechanical shoot thinning vineyard field demonstration #2. E&J Gallo Winery. Lodi, CA (4/23/2019). ~75 CA and WA growers attended.

Bates, T., Barrett, H., Joy, A. Variable-rate mechanical shoot thinning vineyard field demonstration #1. Scheid Family Vineyards. Salinas, CA (4/5/2019). ~35 CA growers attended.

Bates, T., Lake Erie Regional Grape Program Conference Presentation. "Vineyard soil health and nutrient availability." SUNY Fredonia, Fredonia, NY (3/13/2019).

Bates, T., Cornell AgriTech Advisory Council Meeting. "Cornell Digital Agriculture and the Efficient Vineyard Project." Geneva, NY. (12/29/2018).

Bates, T., Cornell Cooperative Extension Livingston County Annual Meeting. "The Future of Digital Agriculture in NY Vineyards." Mount Morris, NY. (11/13/2018).

Bates, T., Fresno State Grape Day. "Variable-Rate Vineyard Mechanization and Precision Viticulture." California State University, Fresno, CA. (8/7/2018).

Bates, T., American Society for Horticulture Science Conference. "SCRI Project Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management." Washington, DC. (7/30/2018).

Badr G, Bates TR. International Conference on Precision Agriculture. "Modelling 'Concord' Berry Weight Dynamics." International Society of Precision Agriculture, Montreal, Quebec, Canada. (6/27/2018).

Dresser, J., Ekstrom. R., Bates, T., American Society for Enology and Viticulture Conference. "Precision Midseason Yield Estimation of Lake Erie Concord." Monterey, CA. (6/19/2018).

Bates, T., Cornell Digital Agriculture Executive Extension Meeting presentation. "Current tools for Grape Producers from the Efficient Vineyard Project." Cornell University, Ithaca, NY. (6/14/2018).

Bates, T., IEEE IoT Topical Summit for Agriculture. "The USDA-NIFA-SCRI Efficient Vineyard Project." Tuscany, Italy. (5/9/2018).

Bates, T., Cornell Digital Agriculture Seminar. "Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management." Cornell University, Ithaca, NY. (4/16/2018).

Bates, T., Specialty Crop Research Initiative Project Meeting. "Implementation of spatial data into vineyard management practices." Carnegie Mellon University, Pittsburgh, PA. (3/29/2018).

Bates, T., Lake Erie Regional Grape Program Conference Presentation. "The Concord crop load model and precision viticulture." SUNY Fredonia, Fredonia, NY (3/14/2018).

Bates, T., Oregon State University Viticulture Seminar, "SCRI Project Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management." Corvallis, OR. (2/13/2018).

Bates, T. R., SCRI Efficient Vineyard Research Meeting, “Progress Report on the Efficient Vineyard SCRI Project”, Invited, National Grape and Wine Initiative, Sacramento CA. (June 8, 2017).

Bates, T. R., Unified Wine and Grape Symposium, “Spatial Crop Load Management”, Invited, American Society of Enology and Viticulture CAWG, Sacramento CA. (January 26, 2017).

Bates, T. R., SCRI Efficient Vineyard Research Meeting, “Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management.”, Invited, California Table Grape Commission, Delano CA. (January 5, 2017).

Bates, T. R., Washington State Grape Society Meeting, "Concord Fruit Thinning: Using Vine Biology and Mechanized Management to Address Market Demands in New York", Invited, Washington State University, Grandview, WA. (November 10, 2016).

Bates, T. R., Finger Lakes Community College Viticulture Class, "Concord Fruit Thinning: Using Vine Biology and Mechanized Management to Address Market Demands in New York", Invited, FLCC, Geneva, NY. (April 22, 2016).

Bates, T. R., E&J Gallo Technical Meeting, "Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management", Invited, E&J Gallo Winery, Modesto, CA. (April 12, 2016).

Bates, T. R., Nuske, S. (Author Only), Lake Erie Regional Grape Program Conference, "Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management", Invited, Cornell University, Fredonia, NY. (March 22, 2016).

Bates, T. R., Betts, T. (Presenter Only), Martin, K. (Presenter & Author), Business, Enology, and Viticulture Conference, "Practical Use of Spatial Vineyard Information", Invited, Cornell University, Rochester, NY. (March 5, 2016).

Bates, T. R., Unified Wine and Grape Symposium, "Industry of Tomorrow: Precision Viticulture", Invited, CAWG, Sacramento, CA. (January 28, 2016).

Bates, T. R., Unified Wine and Grape Symposium, "Vineyard Mechanization to Reduce Labor Costs", Invited, CAWG, Sacramento, CA. (January 27, 2016).

Bates, T. R., Steve, N., Weigle, T. H., Haggerty, L., Kaan, K., Julian, A., James, T., SCRI Precision Viticulture Advisory Meeting, "Precision Vineyard Management: Collecting and Interpreting Spatial Data for Variable Vineyard Management to Improve Production Efficiency and Product Quality", Accepted, SCRI, Sacramento, CA. (January 26, 2016).

Bates, T. R., NGWI Reporting Session, "Spatial Vineyard Measurement, Pilot Study Final Report", Invited, National Grape and Wine Initiative, Sacramento, CA. (January 25, 2016).

Bates, T. R., NYS Precision Ag Workgroup, "Precision Viticulture in New York", Accepted, New York Farm Viability Institute, Geneva, NY. (December 15, 2015).

Bates, T. R., Cornell Recent Advances in Viticulture and Enology, "Spatial ‘precision viticulture’ vineyard management", Accepted, Cornell Cooperative Extension, Ithaca, NY. (November 4, 2015).

Bates, T. R., Haggerty, L., American Society for Enology and Viticulture, Eastern Section Annual Meeting, "Overview of Grape Production and Research in the Lake Erie AVA", Invited, ASEV-ES, Dunkirk, NY. (July 23, 2015).

Bates, T. R., Finger Lakes Community College, "Western New York Grape Industry and Viticulture Research", Invited, Finger Lakes Community College, Geneva, NY. (May 5, 2015).

Bates, T. R., NGWI Reporting Meeting, "Spatial Crop Imaging in Grapes", Invited, National Grape and Wine Initiative, Portland, NY. (February 25, 2015).

Bates, T. R., NGWI Research Meeting, "Spatial vineyard measurement for variable rate management", Invited, National Grape and Wine Initiative, Davis, CA. (January 26, 2015).

Bates, T. R., American Vineyard Foundation Research Meeting, "Vineyard sensor technology", Invited, American Vineyard Foundation, Davis, CA. (January 22, 2015).

Bates, T. R., NGWI Research Meeting, "Spatial measurement of vineyard canopy and crop characteristics", Invited, National Grape and Wine Initiative, Napa, CA. (July 28, 2014).

Bates, T. R., Constellation Brands Annual Meeting, "Automated vineyard canopy and crop measurement", Invited, Constellation Brands, Sacramento, CA. (May 29, 2014).

Bates, T. R., ISHS Fruit Physiology Symposium, "Mechanical crop control in New York Concord vineyards target desirable crop load levels", Accepted, ISHS, Geneva, NY. (March 28, 2014).

Bates, T. R., Lake Erie Grape Grower Conference, "Mechanization for Vineyard Balance", Invited, Lake Erie Regional Grape Program, Fredonia, NY. (March 20, 2014).

Bates, T. R., B.E.V. NY 2014, "Soil pH and Vineyard Production", Invited, Finger Lakes Grape Program, Waterloo, NY. (March 1, 2014).

Bates, T. R., Fruit Thinning Field Day, "Concord Fruit Thinning Research", Lake Erie Regional Grape Program, North East, PA. (July 12, 2013).

Bates, T. R., Fruit Thinning Field Day, "Concord Fruit Thinning Research", Lake Erie Regional Grape Program, Fredonia and Portland, NY. (July 11, 2013).

Bates, T. R., Training your Customers: Effective Tasting Room Techniques, "Viticulture basics for the tasting room", Cornell Enology Extension Program, Portland, NY. (April 11, 2013).

Bates, T. R., Grape Expectations, "Wine grape nutrition under varying soil acidity", Rutgers Extension, New Jersey. (February 23, 2013).

Bates, T. R., Link, K. N., Viticulture 2013, "Characterizing the effect of location and crop load on Concord vine and fruit development", New York Wine and Grape Foundation, Rochester, NY. (February 8, 2013).

Bates, T. R., Taylor, J. A., Viticulture 2013, "Soil variation and vine size uniformity in Lake Erie Concord vineyards", New York Wine and Grape Foundation, Rochester, NY. (February 8, 2013).

Bates, T. R., Finger Lakes Grape Producers, "Spatial Vineyard Canopy and Crop Measurements", National Grape Co-op, Branchport, NY. (January 19, 2013).

Bates, T. R., Lake Erie Grape Producers, "Vineyard Nutrition Research", National Grape, Sheridan, NY. (January 17, 2013).

Bates, T., National Grape Co-op Grower Meetings, "Crop Load and Nutrition Research in Concord", National Grape Co-op, Welch's, Western, NY. (December 17, 2012).

Taylor, J. A., Bates, T. American Society for Enology and Viticulture - Eastern Section Annual Conference, "Spatial Variation in Pruning Weight and Implications for Managing Vine Size in Concord Grapes", American Society for Enology and Viticulture, Traverse City, MI. (July 17, 2012).

Bates, T., Nature Day, "Photosynthesis and Sweet Grapes", Westfield Academy and Central School, Brocton, NY. (June 7, 2012).

Bates, T., National Garden Club Annual Conference, "Grape and Wine Production in New York State", National Garden Club of America, Buffalo, NY. (May 19, 2012).

Bates, T., Cornell Viticulture Class, "Grape Production in the Lake Erie AVA", Cornell Horticulture, Ithaca, NY. (March 28, 2012).

Bates, T., Viticulture Class, "New Technology in Vineyard Management", Finger Lakes Community College, Geneva, NY. (March 28, 2012).

Bates, T., Taylor, J. A., Lake Erie Grape Grower Conference, "Spatial Crop Load Measurement in Concord", Lake Erie Regional Grape Program, Portland, NY. (March 8, 2012).

Bates, T., Finger Lakes Grape Conference, "Mechanization Options in Concord Production", Finger Lakes Grape Program, Waterloo, NY. (March 3, 2012).

Bates, T., Finger Lakes Grape Conference, "Vineyard Potassium Management", Finger Lakes Grape Program, Waterloo, NY. (March 3, 2012).

Bates, T., Ohio Grape and Wine Conference, "Spatial Measurement of Vine Canopy Growth and Vineyard Productivity", Ohio State, Columbus, Ohio. (February 20, 2012).

Bates, T., Vineyard Mechanization Workshop-Part 2, "Effect of mechanical pruning, shoot thinning, fruit thinning, and shoot positioning on Concord productivity", Lake Erie Regional Grape Program, Portland, NY. (December 14, 2011).

Bates, T., Lake Erie Summer Grower Conference, "Research overview at the Cornell Lake Erie Research and Extension Laboratory", Lake Erie Regional Grape Program, Portland, NY. (August 24, 2011).

Bates, T., National Grape and Wine Initiative, "Developing mobile sensors for vineyard management", NGWI, Modesto, CA. (August 3, 2011).

Bates, T., National Grape Co-op Grower Meeting, "Modeling fruit development for paper blending", Welchs', Westfield, NY. (July 26, 2011).

Bates, T., Vineyard Mechanization Workshop, "Advances in vineyard mechanized pruning and crop control", Lake Erie Regional Grape Program, Portland, NY. (July 21, 2011).

Bates, T., Pennsylvania Grape Conference, "Precision Viticulture and Spatial Crop Load Management", Pennsylvania Wine Association, State College, PA. (April 29, 2011).

Bates, T., Finger Lakes Viticulture Class, "Overview of grape production in western NY", Finger Lakes Community College, Geneva, NY. (April 27, 2011).

Bates, T., National Grape Co-op Grower Meeting, "The effect of the Lake Erie environment on grape production and fruit development", Welchs', Westfield, NY. (April 8, 2011).

Bates, T., Lake Erie Grape Growers' Conference, "Precision Viticulture in Concord Vineyards", Lake Erie Regional Grape Program, Fredonia, NY. (March 3, 2011).

Bates, T., Lake Erie Grape Growers' Conference, "Vineyard Nutrient Management", Lake Erie Regional Grape Program, Fredonia, NY. (March 3, 2011).

Bates, T., Finger Lakes Grape Growers' Conference, "Spatial Crop Load Management in Grape Vineyards", Finger Lake Grape Program, Waterloo, NY. (February 5, 2011).

Bates, T., Environmental Biology - Honors Class, "Environmental Impact of the Western NY Grape Industry", SUNY Fredonia, Fredonia, NY. (November 3, 2010).

Bates, T., CRAVE - Cornell Viticulture and Enology, "High Resolution Spatial Crop Load Management", Cornell, Ithaca, NY. (November 16, 2010).

Bates, T., National Grape and Wine Initiative Board Meeting, "Vineyard Canopy and Crop Estimation: Pilot Project Results", National Grape and Wine initiative, Charlottsville, Virginia. (October 25, 2010).

Bates, T., Welch's Technology Center Meeting, "Concord Production and Juice Quality", Welch's, Billerica, MA. (August 19, 2010).

Bates, T., Cornell Lake Erie Research and Extension Laboratory Field Day, "CLEREL Operation Overview and Current Viticulture Research", Lake Erie Regional Grape Program, Portland, NY. (July 21, 2010).

IN THE NEWS

Vineyard Measuring, Modeling and Management: An Overview of Remote Sensing.
Wine Business Monthly / By Richard Carey / March 2021
https://www.winebusiness.com/wbm/?go=getArticleSignIn&dataId=241886
As the Efficient Vineyard Project comes to a close, Cornell offers free platform to help growers get started with spatial data.
Good Fruit Grower / By Kate Prengaman / March 18, 2021
https://www.goodfruit.com/a-variable-rate-vineyard/

Drone imaging systems developed to help growers monitor grapevine nutrients.
FruitGrowers News / By Luke Auburn / January 28, 2021
https://fruitgrowersnews.com/news/drone-imaging-systems-developed-to-help-growers-monitor-grapevine-nutrients/

Flyby for fertilizer management: New $4.75 million grant supports High-Resolution Vineyard Nutrient Management project to develop sensor-based management strategies.
Good Fruit Grower / By Kate Prengaman / Dec 30, 2020
https://www.goodfruit.com/flyby-for-fertilizer-management/

Revealing the Virtues of Precision Viticulture: What You "C" is What You Get
Growing Produce / American Fruit Grower / By Thomas Skernivitz / November 3, 2020 / Cover Story
https://www.growingproduce.com/fruits/revealing-the-virtues-of-precision-viticulture/?fbclid=IwAR3vZTl0vgKYlVTeCdBZI1evwswXIRcAfqhljKsEm_X3Pkr-OxDyUmePLxs

New grant fuels better nutrient management in vineyards
Cornell Chronicle / By Erin Rodger / October 12, 2020
https://news.cornell.edu/stories/2020/10/new-grant-fuels-better-nutrient-management-vineyards

Seeing a future for crop estimation technology — Video / Growers put AI crop estimation to use in vineyards.
Good Fruit Grower / By Ross Courtney / Aug 4, 2020
https://www.goodfruit.com/seeing-a-future-for-crop-estimation-technology-video/

Outthinking technology: Digital Viticulture field day brings big-data tools down to the farm.
Good Fruit Grower / By Kate Prengaman / Sep 26, 2019
https://www.goodfruit.com/outthinking-technology/

Viticulture Goes Digital With Symposium and Tour
Growing Produce/American Fruit Grower / By Christina Herrick / July 22, 2019
https://www.growingproduce.com/fruits/viticulture-goes-digital-with-symposium-and-tour/#Tinsel/146494/9

Project Helps Grape Growers Use New Technology Effectively in Vineyards
Growing Produce/American Fruit Grower / By Christina Herrick / October 28, 2018
https://www.growingproduce.com/fruits/grapes/project-helps-grape-growers-use-new-technology-effectively-in-vineyards/

Tools for counting the crop: Combining low-tech crop load samples with high-tech maps could make vineyards more efficient.
Good Fruit Grower / By Kate Prengaman / Sep 20, 2017
https://www.goodfruit.com/tools-for-counting-the-crop/

The high-tech promise of hands-off: Mechanization researchers have seen quality improvements along with possibilities of cost savings.
Good Fruit Grower / By Kate Prengaman / Aug 29, 2017
https://www.goodfruit.com/the-high-tech-promise-of-hands-off/

Managing a variable vineyard: Research team aims to develop 'prescription map' for vineyards.
Good Fruit Grower / By Ross Courtney / Jan 16, 2017
https://www.goodfruit.com/managing-a-variable-vineyard/