# WEED SCIENCE





## WEED SCIENCE

Published six times a year by the Weed Science Society of America

#### William K. Vencill, Editor

The Weed Science Society of America publishes original research and scholarship in the form of peer-reviewed articles in three international journals. Weed Science is focused on understanding "why" phenomena occur in agricultural crops. As such, it focuses on fundamental research directly related to all aspects of weed science in agricultural systems. Weed Technology focuses on understanding "how" weeds are managed. As such, it is focused on more applied aspects concerning the management of weeds in agricultural systems. Invasive Plant Science and Management is a broad-based journal that focuses not only on fundamental and applied research on invasive plant biology, ecology, management, and restoration of invaded non-crop areas, but also on the many other aspects relevant to invasive species, including educational activities, policy issues, and case study reports. Topics for Weed Science include the biology and ecology of weeds in agricultural, forestry, aquatic, turf, recreational, rights-of-ways, and other settings; genetics of weeds and herbicide resistance; chemistry, physiology and molecular action of herbicides and plant growth regulators used to manage undesirable vegetation, and herbicide resistance; ecology of cropping and non-cropping systems as it relates to weed management; biological and ecological aspects of weed control tools including biological agents, herbicide resistant crops, etc.; effects of weed management on soil, air, and water. Symposia papers and reviews are accepted. Consult the editor for additional information.

#### **Associate Editors (Assignment Year)**

Muthukumar V Bagavathiannan, Texas A&M, College Station, TX 77843 (2015)

Carlene Chase, Horticultural Sciences Department, University of Florida, Gainesville, FL 32611 (2016)

**Bhagirath Singh Chauhan,** Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of Queensland, Queensland, Australia (2014)

Sharon Clay, South Dakota State University Plant Science Department, Brookings, SD 57007 (2002)

Adam Davis, USDA-ARS, Global Change and Photosynthesis Research, Urbana, IL 61801 (2007)

Franck E. Dayan, USDA-ARS-NPURU, National Center for Natural Products Research, University, MS 38677 (2003)

Anita Dille, Kansas State University, Department of Agronomy, Manhattan, KS 66506 (2013)

Timothy Grey, Department of Crop and Soil Science, University of Georgia, Tifton, GA 31793 (2009)

Marie Jasieniuk, Department of Plant Sciences, University of California, Davis, CA 95616 (2016)

Prashant Jha, Montana State University, Bozeman, MT 59717 (2017)

Ramon Leon, Department of Crop and Soil Sciences, North Carolina State University, Raleigh, NC 27695 (2016)

John L. Lindquist, Department of Agronomy, University of Nebraska, Lincoln, NE 68583-0817 (2002)

Sara Martin, Ag Canada, Ottawa, Canada (2018)

Viiav Nandula, Mississippi State University, Delta Research & Extension Center, Stoneville, MS 38776 (2008)

Chris Preston, Australian Weed Management, University of Adelaide, PMB1, Glen Osmond, SA 5064, Australia (2003)

Neha Rana, Monsanto, Chesterfield, MO 63005 (2017)

**Dean Riechers,** Department of Crop Sciences, University of Illinois, Urbana, IL 61801 (2011)

Hilary Sandler, University of Massachusetts-Amherst Cranberry Station, East Wareham, MA 02538 (2008)

Steven Seefeldt, USDA-ARS, University of Alaska, Fairbanks, AK 99775 (2011)

Patrick J. Tranel, Department of Crop Sciences, University of Illinois, 360 ERML, Urbana, IL 61801 (2002)

Martin M. Williams II, USDA-ARS Global Change and Photosynthesis Research, Urbana, IL 61801 (2008)

Tracy Candelaria, Managing Editor

#### Officers of the Weed Science Society of America

http://wssa.net/society/bod/

Weed Science (ISSN 0043-1745) is an official publication of the Weed Science Society of America, 12011 Tejon Street, Suite 700, Westminster, CO 80234 (720-977-7940). It contains refereed papers describing the results of research that elucidates the nature of phenomena relating to all aspects of weeds and their control. It is published bimonthly, one volume per year, six issues per year beginning in January.

Membership includes online access to *Weed Science, Weed Technology, Invasive Plant Science and Management*, and the online *WSSA Newsletter*. Dues should be sent to WSSA, 12011 Tejon Street, Suite 700, Westminster, CO 80234 no later than December 1 of each year. Membership in the society is on a calendar-year basis only.

New subscriptions and renewals begin with the first issue of the current volume. Please visit the *Weed Science* subscription page at https://www.cambridge.org/core/journals/weed-science/subscribe; Email: subscriptions\_newyork@cambridge.org in USA, journals@cambridge.org outside USA.

Weed Science publishes six times a year in January, March, May, July, September, and November. Annual institutional electronic subscription rates: US \$431.00; UK £300.00.

Please use Editorial Manager to access manuscript submissions (http://www.editorialmanager.com/ws). Authors are asked to pay \$65 per page as a portion of the cost of publication, plus an additional processing charge of \$55 per manuscript if none of the authors are WSSA members. The Editor can make exceptions in advance when justified.

The Weed Science Society of America fully subscribes to the belief that progress in science depends upon the sharing of ideas, information, and materials among qualified investigators. Authors of papers published in *Weed Science* are therefore encouraged, whenever practicable and when state and federal laws permit, to share genotypically unique, propagative materials they might possess with other workers in the area who request such materials for the purpose of scientific research.

Weed Science published by the Weed Science Society of America.
Copyright 2018 by the Weed Science Society of America.
All rights reserved. Reproduction in part or whole prohibited.

#### On the Cover:

Image of multiple herbicide-resistant Italian ryegrass population. This photo shows a prune orchard in Hamilton City, California, and it was taken in February 2016 one week after a paraquat application by the orchard manager. Photo by Caio Brunharo.



### Volume 66 Number 6 November–December 2018

#### REVIEW

Todd A. Gaines, Michael E. Foley, Stephen O. Duke, Münevver Doğramacı, James V. Anderson, David P. Horvath, Wun S. Chao and Nishanth Tharayil	681
RESEARCH ARTICLES	
Multiple Herbicide–Resistant Italian Ryegrass [Lolium perenne L. spp. multiflorum (Lam.) Husnot] in California Perennial Crops: Characterization, Mechanism of Resistance, and Chemical Management. Caio A. C. G. Brunharo and Bradley D. Hanson	696
Confirmation and Characterization of Non-target site Resistance to Fomesafen in Palmer amaranth (Amaranthus palmeri). Vijay K. Varanasi, Chad Brabham and Jason K. Norsworthy	702
Characterization of Acetolactate Synthase (ALS)-Inhibitor Resistance in Pennsylvania smartweed (Persicaria pensylvanica). Vijay K. Varanasi, Jason K. Norsworthy, Chad Brabham and Robert C. Scott	710
Extractable and Germinable Seedbank Methods Provide Different Quantifications of Weed Communities.  Theresa Reinhardt and Ramon G. Leon	715
Differential Germination Characteristics of Dicamba-Resistant Kochia ( <i>Bassia scoparia</i> ) Populations in Response to Temperature. <i>Vipan Kumar, Prashant Jha, Charlemagne A. Lim and Phillip W. Stahlman</i>	721
Competitiveness of Herbicide-Resistant Waterhemp ( <i>Amaranthus tuberculatus</i> ) with Soybean. <i>Thomas R. Butts</i> , <i>Bruno C. Vieira</i> , <i>Débora O. Latorre</i> , <i>Rodrigo Werle and Greg R. Kruger</i>	729
Evaluating Effect of Degree of Water Stress on Growth and Fecundity of Palmer amaranth ( <i>Amaranthus palmeri</i> ) Using Soil Moisture Sensors. <i>Parminder S. Chahal, Suat Irmak, Mithila Jugulam and Amit J. Jhala</i>	738
Role of Edamame ( <i>Glycine max</i> ) Seed Size in Early-Season Crop–Weed Interactions. Laura E. Crawford and Martin M. Williams II	746
Germination Ecology of Two Australian Populations of African turnipweed ( <i>Sisymbrium thellungii</i> ). <i>Gulshan Mahajan, Amar Matloob, Michael Walsh and Bhagirath S. Chauhan</i>	752
Efficacy of Halauxifen-Methyl on Glyphosate- Resistant Horseweed ( <i>Erigeron canadensis</i> ). <i>Cara L. McCauley,</i> William G. Johnson and Bryan G. Young	758
Management of Herbicide-Resistant Corn Poppy ( <i>Papaver rhoeas</i> ) under Different Tillage Systems Does Not Change the Frequency of Resistant Plants. <i>Joel Torra, Aritz Royo-Esnal, Jordi Rey-Caballero, Jordi Recasens and Marisa Salas</i> .	764
Persistence and Movement of Fomesafen in Florida Strawberry Production. <i>Thomas V. Reed,</i> Nathan S. Boyd, P. Christopher Wilson, Peter J. Dittmar and Shaun M. Sharpe	773
Application Timing and Degradation Rate of Sulfosulfuron in Soil Co-affect Control Efficacy of Egyptian broomrape ( <i>Phelipanche aegyptiaca</i> ) in Tomato.	780