Plant-Plant Allelopathic Interactions II

Udo Blum

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Laboratory Bioassays for Water-Soluble Compounds with an Emphasis on Phenolic Acids

Springer

Udo Blum
Raleigh
North Carolina
USA

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This volume is dedicated to researchers and their graduate students who are interested in studying plant-plant allelopathic interactions.

Preface

In a previous volume (Blum 2011) the author suggested that we could improve our understanding of plant-plant allelopathic interactions in the field by making laboratory bioassays more holistic. The comments and suggestions in that volume as to how to go about that were rudimentary at best. Reflections after the volume was published lead the author to conclude that a more detailed analysis of the factors making up laboratory bioassays was needed in the hope that such an analysis would provide clearer and more useful directions on how to design more holistic or more relevant laboratory bioassay systems. The more holistic being a theoretical goal and the more relevant being a more pragmatic goal.

More specifically this volume presents a detailed description and discussion of the underlying features, issues, and suppositions associated with seed and seedling laboratory bioassays presented in the earlier volume. It also continues the retrospective analysis of seed and seedling laboratory bioassays begun in the previous volume. It is, however, broader in scope and substance in that the information provided is relevant to all water-soluble compounds released to soil by putative allelopathic living plants and their litter and residues. It is ultimately an attempt to update and expand the practical guidelines for designing laboratory bioassays that have previously been provided in the literature with the hope that the designs of future seed and seedling laboratory bioassays will become more relevant to field systems. This volume like its predecessor does not provide a comprehensive review of the literature. The literature about designing and implementing laboratory bioassays of water-soluble allelopathic compounds is much too extensive for that. Standard references have been included to provide background and additional details.

Chapter 1 provides a general introduction to this volume, discusses the nature of plant-plant allelopathic interactions, describes the nature and sources of allelopathic compounds in soils, discusses the concepts of holism and reductionism as it relates to laboratory bioassays, provides a listing of benefits, limits, and common pit falls for laboratory bioassays, and answers or sets the stage for answering the following questions: (a) Why is it important to design laboratory bioassays that are more holistic or, stated in a more pragmatic way, more relevant to field environments? (b) What can be done to make laboratory bioassays more relevant to field environments? and (c) Is it always necessary to make laboratory bioassays relevant

to field environments? Chapter 2 describes and provides comments on the following basic features of laboratory bioassays: (a) biotic and physicochemical factors, (b) test materials, (c) measurements, hypotheses, experimental designs, and data analyses, and (d) basic information that should be provided for all laboratory bioassays. Chapter 3 discusses a number of issues and challenges associated with creating more relevant model laboratory bioassays including the following: treatment concentrations, mobility and transport, species density, symbiotic relationships, microorganisms, controls or references, and measurements among others. Chapter 4 describes a set of standard hypothetical laboratory bioassays that may be used to screen for stimulatory or inhibitory effects of identified putative allelopathic compounds, leachates, exudates, litter, residues, and soils. Comments regarding potential benefits and limitations of these bioassays are provided. Chapter 5 provides an abridged version of the known effects, the physicochemical and biotic factors that modify effects, and the modes of action of allelopathic compounds using phenolic acids as the model compound. Chapter 6 describes a number of standard laboratory bioassays for identifying and characterizing the modes of action by which identified putative allelopathic compounds, mixtures of allelopathic compounds, mixtures of organic and/or inorganic compounds and residues may stimulate or inhibit sensitive weed species. Five different approaches will be described: (a) bioassays for simple mixtures of identified putative allelopathic compounds, (b) bioassays for residue leachates plus or minus XAD-4 resin, (c) the application of regression analysis to data from residues and soil extract bioassays, (d) bioassays for determining the role of treatment surface area, and (e) using omics methods as tools to determine modes of action. Chapter 7 compares field systems with past and present laboratory bioassay systems, provides some thoughts on ways to minimize the impacts of atypical factors in seed and seedlings laboratory bioassays, points out which factors limit our ability to design field-relevant model systems, suggests future directions for laboratory and field research on plant-plant allelopathic interactions in a question format, and outlines the central tenets (i.e., opinions, doctrines, or principles) articulated in this volume.

Finally, this volume has been written specifically for researchers and their graduate students who are interested in studying plant-plant allelopathic interactions. The author hopes that this retrospective and at times critical analysis of past standard laboratory bioassays will provide a foundation for better and more field-relevant laboratory designs in the future.

Reference

Blum U (2011) Plant-plant allelopathic interactions. Phenolic acids, cover crops, and weed emergence. Springer Science and Business Media, Dordrecht

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Reference

Blum U (2011) Plant-plant allelopathic interactions: Phenolic acids, cover crops, and weed emergence. Springer Science and Business Media, Dordrecht.

Contents

Abbreviations

AIW	Average individual weight
AM	Arbuscular mycorrhizae
ATP	Adenosine triphosphate
BOA	Benzoxazolin-2-one
CFU	Colony-forming units
C/N	Carbon/Nitrogen ratio
DIBOA	2,4 dihydroxy-1,4-benzoxazin-3(4H)-one
ECM	Ectomycorrhizae
ED	Effective dose
EDTA	Ethylenediamine tetraacetic acid
FA	Ferulic acid
F-C	Folin-Ciocalteau
FER	Ferulic acid
GB	Glass beads
IPA compound	Identified putative allelopathic compound
MES	2(N-morpholino)-ethanesulfonic acid
NMR	Nuclear magnetic resonance
NPK	N, NO_3, NH_4, P and K unless otherwise indicated
PCO	*p*-Coumaric acid
*p*C-M	*p*-Coumaric acid and Methionine
*p*C-G	*p*-Coumaric acid and Glucose
PPFD	Photosynthetic Photon Flux Density
PVP	Polyvinylporrolidone
PVPP	Polyvinylpolyporrolidone
R	Reference
VA	Vanillic acid
XAD or XAD-4 resin	Amberlite XAD polymeric absorbent

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