Handbook of
Reference Methods for Plant Analysis

Edited by
Yash P. Kalra

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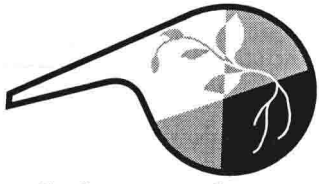

Soil and Plant Analysis Council, Inc.

CRC Press
Boca Raton Boston London New York Washington, D.C.

Library of Congress Cataloging-in-Publication Data

Catalog record is available from the Library of Congress.

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International Standard Book Number 1-57444-124-8
Printed in the United States of America 1 2 3 4 5 6 7 8 9 0

FOREWORD

The Soil and Plant Analysis Council, Inc. strives to promote reference methods for soil and plant analysis. In response to this mission, the Council has published since 1974 three editions of a *Handbook on Reference Methods for Soil Analysis*. However, a handbook on reference methods for plant analysis, to the best of my knowledge, is unavailable. In response to this, the *Plant Analysis Handbook* was created.

This *Handbook of Reference Methods for Plant Analysis* is an excellent resource of reference plant methods consolidated into one work. Plant analysis procedures are outlined into easy step-by-step procedures that are laboratory-ready for implementation. Plant laboratory preparation methods such as dry ashing and acid and microwave digestion are discussed in detail, as well as extraction techniques for analysis of readily soluble elements (petiole analysis) and quick test kits for field testing. Other chapters discuss quality assurance/quality control (QA/QC) programs and instrumentation procedures associated with plant analysis procedures.

The intent of this handbook is not to be an exhaustive overview of methods and modifications that exist, but is an attempt to consolidate the *time-tested* methods into one handbook in order to promote standardization of plant analysis procedures.

On behalf of the Soil and Plant Analysis Council, Inc., I want to express our appreciation to Yash Kalra, the authors, the reviewers, and the Council Headquarters staff for the time and effort spent in making this publication possible.

Byron Vaughan
President, 1994–1996

Board of Directors (1995–1996), left to right: J.B. Jones, Secretary-Treasurer, Micro-Macro Publishing; Byron Vaughan, President, Harris Laboratories; Denton Slovacek, HACH Co.; Bob Miller, University of California; Yash Kalra, Canadian Forestry Service; Paul Fixen, Potash & Phosphate Institute; Ann Wolf, Vice President, Pennsylvania State University; Ray Ward, Ward Laboratories; Bob Beck, Vice President, Cenex/Land O'Lakes.

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PREFACE

The first edition of the *Handbook on Reference Methods for Soil Analysis* was published by the Soil and Plant Analysis Council in 1974 and then revised in 1980 and 1992. This publication was well received and has proved to be a valuable reference. At the Board of Directors meeting in Seattle, WA in November 1994, it was decided to develop a publication on plant analysis to serve as a complement to the soil analysis handbook. An Editorial Committee was selected and I was asked to serve as Chair of this committee. Much of the planning of the handbook was done by the Editorial Committee during the Board of Directors' meeting in Kansas City, MO in March 1995.

The *Handbook of Reference Methods for Plant Analysis* continues the tradition established when the soil analysis handbook was published by providing laboratories with a standard reference book of analytical methods. This handbook is aimed at a broad audience. It should be a handy reference useful to plant scientists in production agriculture, forestry, horticulture, environmental sciences, and other related disciplines. The methods described are used internationally and have proved to be reliable analytical techniques. The book is designed in a step-by-step format to provide information on state-of-the-art methodology; the procedures are presented in such a way that they can be easily followed and used.

The handbook consists of 27 chapters prepared by 24 authors from Canada and the United States. Contributors are internationally acclaimed experts in their fields. Chapter 25 emphasizes the importance of quality control, with the hope that this will result in the generation of high quality analytical data. Appendix I provides information on the location and selection of appropriate plant material useful for analytical data quality control. This up-to-date compilation enhances the value of Chapter 26 on reference materials for data quality control.

I am indebted to the Council for giving me the opportunity to coordinate this project. I extend my sincere thanks to the members of the Editorial Committee for their cooperation. We are grateful to the authors and the reviewers and all others who contributed directly or indirectly to the publication of this handbook.

Support from the Canadian Forest Service and encouragement from Douglas G. Maynard are gratefully acknowledged. Publishing coordination was done by J. Benton Jones, Jr.

Yash P. Kalra
Editor

SOIL AND PLANT ANALYSIS COUNCIL, INC.

The Soil and Plant Analysis Council, Inc. (formerly the Council on Soil Testing and Plant Analysis) was formed in 1969 in the United States to:

- Promote uniform soil test and plant analysis methods, use, interpretation, and terminology
- Stimulate research on the calibration and use of soil testing and plant analysis
- Provide a forum and an information clearing house for those interested in soil testing and plant analysis
- Bring individuals and groups from industry, public institutions, and independent laboratories together to share information

The officers of the Council consist of a President, President-Elect, and Secretary-Treasurer. The presidency of the Council has been rotated between those who are in the public (usually at a state university) and those in the private sector. The President serves for 2 years. Membership in the Council is open to all. Council membership, including individual, laboratory, and cooperate members, has maintained at approximately 350, of whom 50 are from other than the United States.

Since its formation, the Council has engaged in soil sample exchanges, published proceedings of the Soil-Plant Analysts Workshops, and (co-)sponsored symposia and workshops on soil testing and plant analysis. The Council publishes a quarterly newsletter, *The Soil-Plant Analyst*. In 1974, the Council published the *Handbook on Reference Methods for Soil Testing,* which was revised in 1980. In 1992, a completely revised edition of the handbook was published with the title, *Handbook on Reference Methods for Soil Analysis.* In

1992, the Council published a *Registry of Soil and Plant Analysis Laboratories in the United States and Canada.*

The first Council-sponsored International Symposium on Soil Testing and Plant Analysis was held August 14–19, 1989, in Fresno, CA; the second in Orlando, FL, August 22–27, 1991; the third, August 14–19, 1993 in Olympia, WA; the fourth in Wageningen, The Netherlands, August 5–10, 1995; and the fifth in Bloomington, MN, August 7-11, 1997. The sixth International Symposium will be held in Brisbane, Australia, March 22-26, 1999. All four international symposia were attended by about 200 participants and organized in such a way as to provide maximum discussion and interaction among participants. The proceedings from the four international symposia have been published as special issues of the journal, *Communications in Soil Science and Plant Analysis*, published by Marcel Dekker, Inc., New York, and the proceedings of the fifth symposium will be published soon. Following the first international symposium, it was decided to proceed with these symposia every 2 years, at various locations outside the United States.

In July 1994, the Council initiated a Soil Proficiency Testing Program with 85 participants from both the public and private sectors in the United States and Canada. The program consists of five soil samples sent to participating laboratories in July and again in January. Laboratories are instructed as to what analytes are to be determined and a selection of methods provided. The Soil Proficiency Testing Program was continued for 1995–1996. The Plant Tissue Proficiency Testing program was initiated in July 1995, following the same procedure as that for the Soil Proficiency Testing Program. Five plant tissue samples were sent to participating laboratories in July 1995 and January 1996. Both proficiency testing programs were continued in 1997.

Those interested in all aspects of soil testing and plant analysis are invited to become a member of the Council and Laboratory Members to participate in the Proficiency Testing Programs. Further information can be obtained from the Council Headquarters, Georgia University Station, P.O. Box 2007, Athens, GA 30612-0007, Fax: (706) 613-7573.

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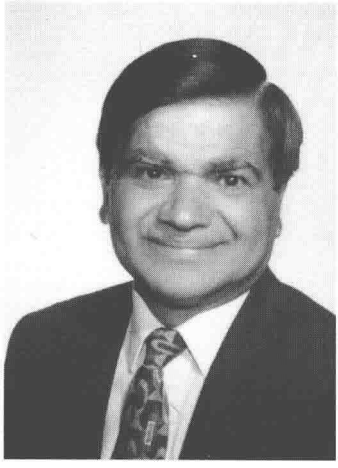

Yash P. Kalra is an analytical chemist with the Canadian Forest Service, Edmonton, Alberta. He has worked with this department for the last 30 years as head of the laboratory responsible for soil and plant analysis for the Northwest Region. His *Methods Manual for Forest Soil and Plant Analysis*, which he coauthored with Douglas G. Maynard in 1991, is widely used. He coordinated the first soil analysis collaborative study for methods validation by the Association of Official Analytical Chemists (AOAC) INTERNATIONAL. For this study, he received the Methods Committee Associate Referee of the Year Award in 1995. His pioneering work is being used as a model for the upcoming collaborative studies by the Soil Science Society of America and the AOAC INTERNATIONAL.

Yash is a member of the Board of Directors of the Soil and Plant Analysis Council, Inc. and was the 1993 recipient of the *J. Benton Jones, Jr. Award* given by the Council. He is a founder of the Group of Analytical Laboratories (GOAL), a co-founder of the Western Enviro-Agricultural Laboratory Association (WEALA), and has served as President of these two organizations and the Canadian Society of Soil Science. He is Editor, Environmental Sciences, *Journal of Forest Research (Japan),* and chair of the Methods Committee on Environmental Quality, AOAC INTERNATIONAL. Recently, he was appointed a member of the Coordination of Official Methods of Soil Analysis Committee (S889) of the Soil Science Society of America for the 1997–2000 term. He is a Fellow of the Indian Society of Soil Science and the AOAC INTERNATIONAL.

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