

Weed Science and Management



Editors

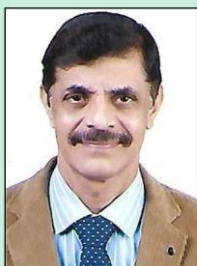
N.T. Yaduraju • A.R. Sharma • T.K. Das



**Indian Society of Weed Science, Jabalpur
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About the Editors



Dr. N.T. Yaduraju obtained M.Sc. from UAS, Bangalore and Ph.D. from Reading University, UK, and undertook research and teaching at the IARI, New Delhi (1976-2000). He is a highly acclaimed weed scientist. As Director, ICAR-Directorate of Weed Research, Jabalpur (2000-2005), he is known for developing world class facilities for weed science research and for providing leadership at the national level. He served as National Coordinator (2006-2010) of World Bank funded National Agricultural Innovation Project (NAIP) and facilitated development and implementation of several projects aimed at making ICAR/NARS a dynamic innovation system capable of responding to the present as well as the future needs. He has over 200 publications including research papers in reputed national and international journals. As President, Asian-Pacific Weed Science Society (2013-15), he is credited with organizing a highly successful 25th APWSS Conference at Hyderabad in 2015. He also served as the Vice-President, Indian Society of Agronomy (2010-11) and currently serving as the President, Indian Society of Weed Science (2013-2016). He has been honored with IARI Best Teacher Award, ISWS Fellow and ISWS Gold Medal for his contributions to weed science.

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Cover theme:

Weeds are and will continue to be major constraint for realizing high crop productivity. Conventional methods of weed control including manual weeding and bullock-drawn cultivator are found inadequate to check their menace. Recent developments in the low-dose high-potency herbicide molecules, zero-till cultivation, micro-irrigation with plastic mulching, and herbicide-tolerant crops are emerging as major innovations in weed management. The cover photos show the weed-infested wheat crop in the centre, with traditional and advanced technologies of weed management on the periphery.

Disclaimer:

The information contained in this book has been collected from all available sources in weed science. Every effort has been made to provide validated and authentic data in the book. However, the editors or the publishing societies do not assume any responsibility for the information published and the consequences arising as a result of their use.

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CONTENTS

Chapter	Title	Page No.
	<i>Foreword</i>	i
	<i>About the Publishing Societies</i>	ii
	<i>Preface</i>	iii-iv
	<i>About the Authors</i>	v-xi
1.	History and progress of weed science in India - <i>V.S. Rao</i>	1
2.	Weeds: Importance, characteristics and classification - <i>T.V. Ramachandra Prasad and M.T. Sanjay</i>	21
3.	Weed biology and ecology - <i>U.S. Walia, Makhan S. Bhullar and Mandeep Singh</i>	45
4.	Principles and methods of weed management - <i>Virender Kumar, Ram K. Malik, Ashok Yadav and Rajender S. Chhokar</i>	61
5.	Herbicide: History, classification, activity and selectivity - <i>T.K. Das and C.P. Nath</i>	89
6.	Herbicides: Formulations, adjuvants, labels, mixtures and application - <i>Vijay K. Nandula</i>	111
7.	Herbicide: Mode and mechanism of action and resistance - <i>Ramesh K. Singh and T.K. Das</i>	125
8.	Herbicide metabolism and residue analysis - <i>Shobha Sondhia</i>	145
9.	Weed management in major crops - <i>J.S. Mishra, A.N. Rao, V.P. Singh and Rakesh Kumar</i>	171
10.	Perennial weeds and their management - <i>B. Duary and P.C. Bhowmik</i>	195
11.	Aquatic weeds and their management - <i>C.T. Abraham and Meera V. Menon</i>	217
12.	Parasitic weeds and their management - <i>T.V. Ramachandra Prasad, C. Chinnusamy and T. Girija</i>	229
13.	Weed management in conservation agriculture systems - <i>A.R. Sharma, T.K. Das and U.K. Behera</i>	247
14.	Weed invasion and management - <i>I.C. Barua and J. Deka</i>	271
15.	Herbicide tolerant crops: Opportunities and challenges - <i>C. Chinnusamy, N.T. Yaduraju and Bhumesh Kumar</i>	293
16.	Weeds and their management under changing climate - <i>V.S.G.R. Naidu and Bhumesh Kumar</i>	311
17.	Information and communication technologies in weed management - <i>V.S.G.R. Naidu, H. Ravisankar and Sandeep Dhagat</i>	321
18.	Research needs for improving weed management - <i>Gulshan Mahajan, Vivek Kumar and Bhagirath S. Chauhan</i>	337
19.	Weed research methodologies - <i>T.K. Das, C.P. Nath and A.R. Sharma</i>	357
	Annexures - <i>T. Ramprakash, M.T. Sanjay and I.C. Barua</i>	375

FOREWORD




Weeds are the major biotic constraint in agricultural production. Among all the pests, weeds cause the highest loss in crop productivity of more than one-third. Besides, they are known to inflict indirect losses in terms of nutrient drain, increased cost of cultivation, increased pest incidences, decreased crop quality etc. Weeds are traditionally managed by manual removal or by mechanical means. However, these are no longer considered practical in view of the steep rise in labour cost. Besides many pro-poor welfare schemes implemented by the central and state governments, such as MNREGA have aggravated the situation of labour unavailability for manual weeding operations. Weed management through herbicides is getting popular with the farmers.

They find this technology simple, efficient and economical. However, there is inherent risk of irrational and injudicious use associated with all pesticides including herbicides. Over-reliance on herbicides leads to several problems including the development of herbicide-resistant weeds. The problem of herbicide resistance in *Phalaris minor* in wheat in north-west India is testimony to this phenomenon. It is well documented that integrated weed management approach involving different methods - specifically the cultural methods - is more sustainable. However, it is not being adopted by majority of the farmers for a variety of reasons.

The science of weed management has grown tremendously since the advent of 2,4-D in 1940s and availability of farm machinery for sowing, weeding, interculturing, spraying etc. Significant advances have been made in the development of low-dose high-potency herbicide molecules, weed management in arable and non-arable lands, zero-tillage based conservation agriculture, herbicide-tolerant crops, herbicide residue monitoring and mitigation, information and communication technologies, and others in pipeline like robots, microwaves and radiations, electrocution, and remote sensing for weed management. Weed science in India has also progressed considerably and a large volume of information has been generated related to weed management. Compilation and sharing of the knowledge on recent advances in weed management with all stakeholders is necessary for improving agricultural productivity. No such effort was made previously, and therefore, a beginning was urgently needed in this regard involving leading professional experts of the country and abroad.

Weed science and management has traditionally been a part of agronomy. However, it has to be appreciated that the knowledge from varied disciplines such as botany, entomology, pathology, microbiology, soil science, biotechnology, engineering etc. is needed to address the problem of weeds in a holistic way. A well-documented and updated resource covering all aspects related to weeds and weed management will provide the much needed knowledge to the students, teachers, researchers as well as extension personnel in agronomy. With this in view, the Indian Society of Agronomy in association with Indian Society of Weed Science decided to commission a book on the subject. I am very pleased to see that this publication has come out very nicely, which will certainly benefit all stakeholders. The editors have done an arduous job, which is indeed commendable. I am thankful to all the authors for their deep interest in the subject and for their valuable contributions.

22 November, 2016


(Gurbachan Singh)
President, ISA &
Chairman, ASRB

ABOUT THE PUBLISHING SOCIETIES



Indian Society of Weed Science (ISWS)

The Society was established in 1968 coinciding with the green revolution in the country. It has been registered under the Karnataka Societies Registration Act, 1960 with registration No. SOR/BLU/DR/518/08-09. Dr. R.S. Choudhary of Varanasi (Uttar Pradesh) was the first President and Dr. M.K. Moolani of Hisar (Haryana) was the first Secretary of the Society. Initially the headquarter of the Society was at CCS HAU, Hisar, which moved to UAS, Bangaluru (1980-1992) and then again to CCS HAU, Hisar (1993-2005). Following the establishment of National Research Centre for Weed Science, Jabalpur in 1989 (now named as ICAR-Directorate of Weed Research) and strengthening of infrastructure, the headquarter of the Society was finally shifted to Jabalpur in 2006. The mandate of the Society is: (i) to disseminate knowledge of weed management in its widest perspective, (ii) to encourage research, education and extension in the scientific and practical aspects of weed management, (iii) to provide suitable forum such as national and international symposia/seminars to diffuse scientific knowledge among scientists and facilitate personal contact among the members, and (iv) to publish journals, bulletins, books, newsletters, etc. for the advancement of weed science in the country.

The Society brings out various publications including the Indian Journal of Weed Science (quarterly), which is published continuously since 1969. The Society has organized various Conferences including the 8th Asian-Pacific Weed Science Society Conference in 1981 at UAS, Bengaluru, International Symposium at CCS HAU, Hisar in 1993, and 25th APWSS Conference at PJTSAU, Hyderabad in 2015. Presently, there are more than 1000 members of the Society including 895 life members.



Indian Society of Agronomy (ISA)

The beginning of the Indian Society of Agronomy can be traced in a letter issued in 1955 from Dr. H.R Arakeri, who later served as the first Patron of the Society (1974-1979). The headquarter of the Society was established at the Division of Agronomy, Indian Agricultural Research Institute, New Delhi. It was registered under the Societies Registration Act XXI of 1860 vide No. S 1109, dated 23 July 1957. Dr. P.S. Deshmukh, Hon'ble Union Agriculture Minister served as the first President of the Society. Presently, the Indian Society of Agronomy is one of the largest professional scientific bodies of agricultural scientists in India. The Society has 2750 life members, 102 annual members, 40 foreign members, and 98 institutional members. It has played a significant role in providing suitable forum for exchange of ideas, encouraging research and disseminating knowledge of Agronomy to the research workers. The Society has completed 50 years of its glorious existence and organized various National and International Symposia and Conferences, including the four International Agronomy Congresses at New Delhi during 1998, 2002, 2012 and 2016, respectively.

The Society has been bringing out various publications including the most coveted Indian Journal of Agronomy since 1956. Besides, the Society has conferred various awards and fellowships for outstanding achievements in the field of Agronomy.

PREFACE

Weeds are ubiquitous. These unwanted plants are a problem virtually in all ecosystems including agriculture, plantation crops, grasslands, forestry, game sanctuaries, water bodies, waste lands, public amenity areas, etc. Weeds therefore impact everyone including non-farmers and city dwellers. The loss caused by weeds in agriculture is enormous. They contribute as much as one-third of the total loss caused by all the agricultural pests. At a conservative estimate, 10-15% of the crop production is lost every year due to weeds amounting to well over Rs 100,000 crores. Sadly it goes unnoticed as the effect is mostly unseen, unlike with other pests where the damage is visible. Because of this, the farmer develops a fatalistic attitude towards weeds and gives them the last priority when it comes to their management. Manual and mechanical removal is the most predominant methods of weed management in India, although they are ineffective, particularly under adverse soil and weather conditions. Manual weeding is highly labour-intensive, involves a lot of drudgery and is unfortunately mostly done by women. Currently the farming is being predominantly practiced by old men and women, with youth simply taking no interest. They are moving towards urban areas in search of better jobs and different life style. Perhaps modernization of agriculture involving use of chemicals, machinery and other modern technologies may halt this trend. Management of weeds with the use of chemicals (herbicides) is one such technology which is simple, efficient and economical. More and more farmers are opting for herbicides mainly due to increased labour cost and the problem with their timely availability. Many pro-poor welfare schemes implemented by central and state governments, such as MNREGA have aggravated the situation. Manual weeding demands huge labour, up to 50 man-days for weeding one ha of crop area. At a conservative estimate a whopping 9 billion man-days of labour per annum is required if manual weeding is to be employed on a total cropped area of 180 M ha. This is going to be untenable. Experts opine that mechanization and other labour-saving technologies such as use of herbicides are to be promoted to make farming more sustainable and profitable.

Globally herbicides are the leading group of pesticides with 44% of the total consumption followed by the insecticides (22%) and fungicides (27%). In India, however, the insecticides dominate the scene, the share of herbicides being about 20%. Herbicide application is more common in crops such as wheat (44%), rice (31%), plantation crops like tea (10%), soybean (4%), and others (11%). All pesticides including the herbicides are toxic; hence, irrational and injudicious use cause damage to the users and the environment. Unlike other pesticides, herbicides by and large have lower toxicity (higher LD₅₀ values) and reported to leave no or very low levels of residues in the soil, crop produce and ground water. However, there are concerns of residual effect of herbicides on susceptible intercrops or succeeding crops and development of herbicide resistance in weeds. The development of herbicide- tolerant crops which enabled controlling of all weeds including perennial and parasitic weeds was considered as novel technology until several weeds developed resistance to the non-selective herbicide such as glyphosate. It is well documented that integrated weed management approach involving different methods - specifically the cultural methods - is ideal and more sustainable. However, it is not being adopted by majority of the farmers for a variety of reasons. It is with this objective this publication is being brought out. In this publication an effort is being made to update our knowledge relating to science and management of weeds by gathering the latest information available in national and international literature.

This book contains 19 chapters contributed by eminent weed scientists of the country and a few accomplished NRIs who made a mark abroad in this field. The chapters are contributed by virtually the Who's Who in weed science in India today. Besides providing basic and applied information on weeds and their management, the book also covers advanced subjects like conservation agriculture, herbicide tolerant crops, climate change, and information and communication technology in weed science. The book is primarily

aimed at post-graduate students majoring in agronomy with specialization in weed science for their M.Sc. and Ph.D. degree in India. A special feature of the book is inclusion of questions (subjective and objective) at the end of each chapter. Annexure at the end of the book provides the latest information on weed species and herbicides as available from authoritative sources. This has been done considering the requirements of the various competitive examinations like the Agricultural Research Service of the ICAR. It is a unique effort in the sense that the book has been published jointly by the two oldest professional societies in the field of agronomy and weed science.

Compilation of the available information on weed science, old and new, in a concise manner has been a monumental task. We are thankful to the identified lead authors of different chapters who carried out the assigned task exceedingly well and presented the available information in a systematic and scientific manner. Thanks are due to the associating authors who searched the literature and included the same in the book.

We are highly grateful to Dr. Gurbachan Singh, President, Indian Society of Agronomy and Chairman, Agricultural Scientists Recruitment Board, ICAR, who took the initiative and asked us to take up this task. We have put in our best efforts to bring out a quality publication and meet the prescribed deadline for the release of this book. It is hoped that this will benefit researchers, teachers, students, extension personnel, and all others involved in weeds and their management. We will certainly appreciate critical comments and suggestions from all our stakeholders, especially the students, for further improvement of this book.

22 November, 2016

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