

Sohan Singh Walia
Tamanpreet Kaur

Earthworms and Vermicomposting

Species, Procedures and Crop
Application

Earthworms and Vermicomposting

Sohan Singh Walia • Tamanpreet Kaur

Earthworms and Vermicomposting

Species, Procedures and Crop
Application



Springer

Sohan Singh Walia
School of Organic Farming
Punjab Agricultural University
Ludhiana, Punjab, India

Tamanpreet Kaur
School of Organic Farming
Punjab Agricultural University
Ludhiana, Punjab, India

ISBN 978-981-99-8952-2

ISBN 978-981-99-8953-9 (eBook)

<https://doi.org/10.1007/978-981-99-8953-9>

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2024

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd. The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Paper in this product is recyclable

Preface

Vermicomposting is a sustainable and eco-friendly practice that transforms organic waste into a valuable resource for gardening, agriculture, and environmental stewardship. In this book, we embark on a journey to explore the remarkable process of vermicomposting and its significance in today's world. Vermicomposting, often referred to as "worm composting," stands as a shining example of nature's recycling system at work. It harnesses the power of earthworms to convert kitchen waste, garden waste, and various organic materials into nutrient-rich worm castings—a natural fertilizer and soil conditioner of unparalleled quality.

As we delve deeper into the world of vermicomposting, you will discover its many facets, from the ecological benefits of reducing landfill waste to the practical advantages of enhancing soil fertility and structure. Whether you are a seasoned gardener seeking ways to enrich your plants or someone interested in minimizing your environmental footprint, vermicomposting offers a practical and rewarding solution.

Throughout this book, we will navigate the ins and outs of vermicomposting, from selecting the right worms to designing a suitable bin or system and from troubleshooting common issues to reaping the bountiful harvest of nutrient-dense castings. As we embark on this vermicomposting journey together, this book aims to provide you with a comprehensive understanding of the principles, techniques, and benefits of vermicomposting. Whether you are a seasoned gardener looking to enrich your soil naturally or a newcomer interested in sustainable waste management, you will find valuable insights within these pages.

Currently, there is a limited availability of reference books catering to the needs of students in this specialized area. This book presents the subject matter in a well-structured and coherent manner, aiming to enhance students' comprehension and ensure a consistent learning experience. We believe that this book will prove immensely valuable to students, teachers, and extension personnel alike.

This book is the result of a deep passion for vermicomposting and a commitment to sharing knowledge that empowers individuals and communities to make a positive impact on our planet. We hope you find inspiration within these pages and embark on your own vermicomposting adventure, contributing to a greener and more sustainable world.

We are open to receiving suggestions for further enhancing the content of this book. Your input and feedback are highly appreciated as they will help us continually improve and refine the material. Together, we can strive for excellence in this field of study.

Ludhiana, Punjab, India
Ludhiana, Punjab, India

Sohan Singh Walia
Tamanpreet Kaur

Contents

1	Earthworms and Vermicomposting	1
1.1	Introduction	1
1.1.1	Vermicomposting	2
1.2	Origin and Evolution	3
1.3	Distribution of Earthworm	3
1.4	Size of Earthworm	4
1.5	Food and Feeding Habits	5
	References	5
2	Anatomy of Earthworms	7
2.1	Body Structure	7
2.1.1	Earthworm Body	7
2.1.2	Shape, Size, and Color of Cocoons	15
3	Earthworms, Their Species, and Biological Features	17
3.1	Earthworm Species	21
3.1.1	Redhead Worm	21
3.1.2	Common Earthworm	22
3.1.3	Green Worm	23
3.1.4	European Night Crawler	24
3.1.5	Brandling Worm	24
3.1.6	Giant Gippsland Earthworm	25
3.1.7	Washington Giant Earthworm	27
3.1.8	Gray Worm	27
3.1.9	Composting Worm	28
3.1.10	African Night Crawler	28
3.2	Biological Features of Earthworm	30
3.3	The Morphology and Anatomy of the Earthworm Are Discussed Below	30
3.3.1	Anatomy of Earthworm	31
3.3.2	Digestive System	31
3.3.3	Circulatory System	31
3.3.4	Respiratory System	31
3.3.5	Excretory System	31

3.3.6 Nervous System	32
3.3.7 Sensory System	32
3.3.8 Reproductive System	32
3.3.9 Multiplication of Worms	32
3.3.10 Earthworm Sexuality	33
3.3.11 Ready for Reproduction	34
3.3.12 Copulation and Fertilization	34
3.3.13 No Partner Needed	34
References	36
4 Vermitechnology: History and Its Applications	37
4.1 History	38
4.2 Wastes Utilized in Vermitechnology	38
4.3 Earthworms Used in Vermitechnology	39
4.3.1 Earthworm Species Suitable for Waste Degradation	39
4.4 Role of Earthworms in Vermitechnology	40
4.4.1 Effects of Earthworms on	40
4.5 Applications of Vermitechnology	42
4.6 Issues Related to Vermitechnology	43
4.7 Vermitechnology in Other Countries	44
4.8 Vermitechnology in India	46
4.9 Vermitechnology in Northeast India	48
4.10 Recent Works Related to Vermitechnology	49
4.10.1 Aerobic Sponge Method Vermitechnology for Macro-Level Conversion of Organic Garbage	49
4.10.2 Treatment of Agricultural Wastes with Biogas: Vermitechnology	50
4.10.3 Assessment of Different Organic Supplements for Degradation of <i>Parthenium Hysterophorus</i> by Vermitechnology	50
4.10.4 Application of Vermitechnology in Aquaculture	50
4.10.5 Vermitechnology for Organic Waste Management and Sustainable Agriculture (Gopi 2017; Chattopadhyay 2017)	51
4.11 Future Prospects	51
References	51
5 Role of Earthworms in Vermicomposting	55
5.1 Earthworm Species Suitable for Vermicomposting	56
5.2 Organic Matter and Earthworms in the Soil	56
5.3 Soil Nitrogen and Earthworms	57
5.4 Soil Phosphorus and Earthworms	57
5.5 Heavy Metals and Vermicomposting	58
References	59

6	Different Sources of Vermicompost: Vermicomposting from Household Waste—Vermicomposting from Farm Waste	61
6.1	Different Sources of Vermicompost	61
6.2	Vermicomposting from Household Waste	64
6.2.1	Method	64
6.3	Vermicomposting from Farm Waste	64
6.3.1	Methods	64
6.4	Different Sources and Preparation of Vermicompost	67
	References	69
7	Preparation of Vermicompost	73
7.1	Introduction	73
7.2	Sequential Method of Composting	73
7.3	Mechanism of Earthworm Action	76
7.4	Vermicomposting Systems	77
7.4.1	Windrow System	77
7.4.2	Wedge System	78
7.4.3	Container System	78
7.4.4	Continuous Flow System	80
7.5	Maintaining Continuous Flow	81
7.6	Feeding Rates	81
7.7	Excessive Heating	82
7.8	Method for Preparation of Vermicompost from Paddy Straw/Waste Maize Silage	83
7.9	Processing: Time and Acceleration	83
7.10	Maturity and Stability	84
7.11	Composting v/s Vermicomposting	84
7.12	Acceleration Process	84
7.12.1	Organic Nutrients and Other Additives	84
7.12.2	Effective Micro-organisms (EM)	85
7.13	Domestic Waste Processing Systems	85
7.14	Points to Be Considered When Making Compost	85
	References	87
8	Influence of Vermicompost on Soil Health	89
8.1	Introduction	89
8.2	Influence of Physiochemical Properties of Soil	89
8.3	Influence of Vermicompost on Biological Properties of Soil	91
8.4	Modification in Physico-Chemical Characteristics of Feed Waste Through Vermicomposting	91
8.5	pH and Electrical Conductivity (EC)	91
8.6	Nitrogen	92
8.7	Organic Carbon and C:N Ratio	93
8.8	Phosphorus	94
8.9	Beneficial Role of Vermicompost in Fruit Crops	95

8.10	Beneficial Role of Vermicompost in Vegetable Crops	97
8.11	Nutrient Recovery from Kitchen Bio-Waste	98
8.12	Integration of Composting and Vermicomposting	99
8.13	Importance of Vermicompost	99
8.14	Environmental Applications of Vermicompost	100
	References	101
9	Harvesting of Vermicompost	109
9.1	Introduction	109
9.2	Vermicompost	109
9.2.1	Materials for Preparation of Vermicompost	110
9.2.2	The Five Essentials	112
9.2.3	Harvesting Vermicompost	112
9.2.4	Harvesting Earthworm	113
9.2.5	Storing and Packing of Vermicompost	115
9.2.6	Precautions During the Process	116
	Reference	116
10	By-Product and Value-Added Products	117
10.1	Vermiwash	117
10.1.1	Steps for Preparation	118
10.2	Vermicompost Tea	119
10.3	Vermimeal	119
10.4	Enriched Vermicompost	120
10.5	Pelleted Vermicompost	120
	References	121
11	Problems in Handling Vermicompost	123
11.1	Temperature	123
11.2	Aeration	124
11.3	Acidity (pH)	124
11.4	Pests and Diseases	124
11.5	Odor	127
12	Importance of Application of Vermicompost in Cereal, Fruit and Vegetable Crops	129
12.1	Rice Crop	130
12.2	Uses of Vermicompost in Urban Areas	132
12.3	Landfilling	132
12.4	Incineration	133
12.5	Animal Feed	133
	References	133
13	Beneficial Role of Vermicompost: Nutrient Content in Vermicompost and Success Stories	135
13.1	Beneficial Role of Vermicompost	136
13.2	Nutrient Content in Vermicompost	139

13.3	Success Stories.....	141
13.3.1	Success Story of Prateek Bajaj	141
13.3.2	Success Story of Karan Sikri (Kurukshestra's Young Farmer).....	142
13.3.3	Success Story of Bhikhari Mehta (Kumar et al. 2017)	143
13.3.4	Success Story of Ravuri Suresh Kumar (Devi and Kumar 2020).....	144
	References.....	145
14	Conclusion	147