Published 1988

Cropping Strategies for Efficient Use of Water and Nitrogen

Cover Design: Patricia Jeffson

American Society of Agronomy, Inc.
Crop Science Society of America, Inc.
Soil Science Society of America, Inc.
677 South Segoe Road, Madison, WI 53711 USA

Library of Congress Cataloging-in-Publication Data

Cropping strategies for efficient use of water and nitrogen: proceedings of a symposium sponsored by Divisions S-4, S-6, S-8, C-3, and A-6 of the Soil Science Society of America, Crop Science Society of America, and the American Society of Agronomy in Atlanta, GA, 30 Nov. and 1 Dec. 1987 / editor, W.L. Hargrove.
p. cm. — (ASA special publication; no. 51)
Includes bibliographies
ISBN 0-89118-097-4
1. Cropping systems. 2. Crops and water. 3. Crops and nitrogen. I. Hargrove, W.L. (William Leonard). II. Soil Science Society of America. III. Crop Science Society of America. IV. American Society of Agronomy. V. Series.
S1.A453 no. 51
[S602.5]
631 s—dc19 88-21878
[631.5'8] CIP

Printed in the United States of America

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ASA Special Publication Number 51

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Madison, Wisconsin, USA

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FOREWORD

Water and N are two factors that have a major influence on crop production. Water is provided by rainfall, and where rainfall is insufficient, supplemental irrigation is used. Similarly, N needs can be provided by using legumes and other N_2-fixing systems, or supplemented with N fertilizer and manures. Since crop production is at the beginning of most human food chains and is a essential human activity, water and N influence human health, welfare, and economics in critical ways. Therefore, it is important to understand the interaction of water and N in cropping systems, responses to these vital inputs, and ways of managing water and N most efficiently.

Cropping Strategies for Efficient Use of Water and Nitrogen deals with water and N management from several perspectives, including crop species, crop sequences, cultural practices, inputs, and environmental quality.

We greatly appreciate the contributions of W. L. Hargrove and B. G. Ellis, co-editors, and their editorial committee. We are also grateful to W. L. Hargrove, A. L. Black, and J. V. Mannering for organizing the symposium in which the papers that later were developed into chapters for this book were first presented. We wish to thank the authors for sharing their knowledge, experience, and insights on this subject.

This book is a valuable contribution to scientific, technological, and practical understanding of an important topic. We think you will find it informative and stimulating.

D. A. Holt, *president*
American Society of Agronomy

C. J. Nelson, *president*
Crop Science Society of America

D. R. Keeney, *president*
Soil Science Society of America

PREFACE

The very existence of the human race on this earth depends upon good management and wise stewardship of natural resources to produce food and fiber. The United States has been at the forefront of the science of increasing food and fiber production and as a result has achieved an abundance of food that is cheap, and a high standard of living. But, environmental problems, increasing public concern about degradation of groundwaters, and an economic dependency upon fossil fuels have also resulted. Concern for efficient use of N and water, while still protecting our environment, led to the development of a symposium at the 1987 Annual Meetings of the American Society of Agronomy at Atlanta, GA. The symposium was co-sponsored by Div. S-4, S-6, S-8, C-3, and A-6. Twelve papers were presented which address many factors that affect the efficiency of water and N use.

Cropping Stretegies for Efficient Use of Water and Nitrogen is the written publication from the papers that were presented at the symposium. Papers discuss the use of cropping systems to gain N_2 fixation and efficiency of utilization of this fixed N. Cropping systems, including rotations, multiple cropping, intercropping and specific cropping systems for low input agriculture as well as using specific cropping systems for reduced leaching of salts are topics included in the papers. The keen interest in groundwater quality and in reducing crop production costs while maintaining acceptable yield make the publication a timely contribution.

We, as members of the society, are indebted to the authors whose work has collected thoughts, concepts, and data that relate to this important topic. It is our hope that this will stimulate thinking about research that is essential for more efficient use of two of our most important resources, N and water, in our agricultural production systems. We wish to thank the reviewers who contributed suggestions for improvement of the manuscripts and for the many who stimulated discussion at the symposium. We also appreciate the excellent work of the ASA Headquarters staff in the publication process.

CONTRIBUTORS

R. W. Andrews	Editorial Research Assistant, Rodale Research Center, Kutztown, Pennsylvania
A. L. Black	USDA-ARS, Northern Great Plains Research Lab., Mandan, North Dakota
R. L. Blevins	Professor of Agronomy, Department of Agronomy, University of Kentucky, Lexington, Kentucky
S. J. Corak	Graduate Research Assistant, Department of Agronomy, University of Kentucky, Lexington, Kentucky
J. W. Doran	Soil Scientist, USDA-ARS, University of Nebraska, Lincoln, Nebraska
W. W. Frye	Professor of Agronomy, Department of Agronomy, University of Kentucky, Lexington, Kentucky
G. J. Gascho	Professor, Department of Agronomy, Coastal Plains Experiment Station, University of Georgia, Tifton, Georgia
A. D. Halvorson	Soil Scientist, USDA-ARS, Akron, Colorado
W. L. Hargrove	Associate Professor, Department of Agronomy, Georgia Agricultural Experiment Station, University of Georgia, Griffin, Georgia
O. B. Hesterman	Assistant Professor, Crop and Soil Sciences Department, Michigan State University, East Lansing, Michigan
J. E. Hook	Associate Professor, Agronomy Department, Coastal Plain Experiment Station, University of Georgia, Tifton, Georgia
R. R. Janke	Agronomy Coordinator, Rodale Research Center, Kutztown, Pennsylvania
D. L. Karlen	Soil Scientist, USDA-ARS, Department of Agronomy, Iowa State University, Ames, Iowa
G. W. Langdale	USDA-ARS, Southern Piedmont Conservation Research Center, Watkinsville, Georgia
J. V. Mannering	Professor, Department of Agronomy, Purdue University, West Lafayette, Indiana
D. B. Mengel	Professor of Agronomy, Department of Agronomy, Purdue University, West Lafayette, Indiana
R. I. Papendick	Soil Scientist, USDA-ARS, Land Management and Water Conservation, Washington State University, Pullman, Washington
S. E. Peters	Research Agronomist, Rodale Research Center, Kutztown, Pennsylvania
Francis J. Pierce	Assistant Professor, Department of Crop and Soil Sciences, Michigan State University, East Lansing, Michigan

J. F. Power	Research Leader, USDA-ARS, University of Nebraska, Lincoln, Nebraska
J. K. Radke	Research Soil Scientist, USDA-ARS, Rodale Research Center, Kutztown, Pennsylvania
Charles W. Rice	Assistant Professor, Department of Agronomy, Kansas State University, Manhattan, Kansas
E. J. Sadler	Soil Scientist, USDA-ARS, Coastal Plains Soil and Water Conservation Research Center, Florence, South Carolina
James S. Schepers	Soil Scientist, USDA-ARS, University of Nebraska, Lincoln, Nebraska
M. S. Smith	Professor of Agronomy, Department of Agronomy, University of Kentucky, Lexington, Kentucky
R. E. Sojka	Soil Scientist, USDA-ARS, Snake River Soil and Water Management Research Unit, Kimberly, Idaho
P. W. Unger	Soil Scientist, USDA-ARS, Conservation and Production Research Lab., Bushland, Texas
J. J. Varco	Assistant Professor of Agronomy, Department of Agronomy, Mississippi State University, Mississippi State
M. G. Wagger	Assistant Professor, Department of Crop Science, North Carolina State University, Raleigh, North Carolina

Conversion Factors for SI and non-SI Units

Conversion Factors for SI and non-SI Units

To convert Column 1 into Column 2, multiply by	Column 1 SI Unit	Column 2 non-SI Unit	To convert Column 2 into Column 1 multiply by
	Length		
0.621	kilometer, km (10^3 m)	mile, mi	1.609
1.094	meter, m	yard, yd	0.914
3.28	meter, m	foot, ft	0.304
1.0	micrometer, μm (10^{-6} m)	micron, μ	1.0
3.94×10^{-2}	millimeter, mm (10^{-3} m)	inch, in	25.4
10	nanometer, nm (10^{-9} m)	Angstrom, Å	0.1
	Area		
2.47	hectare, ha	acre	0.405
247	square kilometer, km^2 (10^3 m)^2	acre	4.05×10^{-3}
0.386	square kilometer, km^2 (10^3 m)^2	square mile, mi^2	2.590
2.47×10^{-4}	square meter, m^2	acre	4.05×10^3
10.76	square meter, m^2	square foot, ft^2	9.29×10^{-2}
1.55×10^{-3}	square millimeter, mm^2 (10^{-6} m)^2	square inch, in^2	645
	Volume		
9.73×10^{-3}	cubic meter, m^3	acre-inch	102.8
35.3	cubic meter, m^3	cubic foot, ft^3	2.83×10^{-2}
6.10×10^4	cubic meter, m^3	cubic inch, in^3	1.64×10^{-5}
2.84×10^{-2}	liter, L (10^{-3} m^3)	bushel, bu	35.24
1.057	liter, L (10^{-3} m^3)	quart (liquid), qt	0.946
3.53×10^{-2}	liter, L (10^{-3} m^3)	cubic foot, ft^3	28.3
0.265	liter, L (10^{-3} m^3)	gallon	3.78
33.78	liter, L (10^{-3} m^3)	ounce (fluid), oz	2.96×10^{-2}
2.11	liter, L (10^{-3} m^3)	pint (fluid), pt	0.473

Mass

2.20×10^{-3}	gram, g (10^{-3} kg)	pound, lb	454
3.52×10^{-2}	gram, g (10^{-3} kg)	ounce (avdp), oz	28.4
2.205	kilogram, kg	pound, lb	0.454
0.01	kilogram, kg	quintal (metric), q	100
1.10×10^{-3}	kilogram, kg	ton (2000 lb), ton	907
1.102	megagram, Mg (tonne)	ton (U.S.), ton	0.907
1.102	tonne, t	ton (U.S.), ton	0.907

Yield and Rate

0.893	kilogram per hectare, kg ha^{-1}	pound per acre, lb $acre^{-1}$	1.12
7.77×10^{-2}	kilogram per cubic meter, kg m^{-3}	pound per bushel, lb bu^{-1}	12.87
1.49×10^{-2}	kilogram per hectare, kg ha^{-1}	bushel per acre, 60 lb	67.19
1.59×10^{-2}	kilogram per hectare, kg ha^{-1}	bushel per acre, 56 lb	62.71
1.86×10^{-2}	kilogram per hectare, kg ha^{-1}	bushel per acre, 48 lb	53.75
0.107	liter per hectare, L ha^{-1}	gallon per acre	9.35
893	tonnes per hectare, t ha^{-1}	pound per acre, lb $acre^{-1}$	1.12×10^{-3}
893	megagram per hectare, Mg ha^{-1}	pound per acre, lb $acre^{-1}$	1.12×10^{-3}
0.446	megagram per hectare, Mg ha^{-1}	ton (2000 lb) per acre, ton $acre^{-1}$	2.24
2.24	meter per second, m s^{-1}	mile per hour	0.447

Specific Surface

10	square meter per kilogram, m^2 kg^{-1}	square centimeter per gram, cm^2 g^{-1}	0.1
1 000	square meter per kilogram, m^2 kg^{-1}	square millimeter per gram, mm^2 g^{-1}	0.001

Pressure

9.90	megapascal, MPa (10^6 Pa)	atmosphere	0.101
10	megapascal, MPa (10^6 Pa)	bar	0.1
1.00	megagram per cubic meter, Mg m^{-3}	gram per cubic centimeter, g cm^{-3}	1.00
2.09×10^{-2}	pascal, Pa	pound per square foot, lb ft^{-2}	47.9
1.45×10^{-4}	pascal, Pa	pound per square inch, lb in^{-2}	6.90×10^3

continued on next page

Conversion Factors for SI and non-SI Units

To convert Column 1 into Column 2, multiply by	Column 1 SI Unit	Column 2 non-SI Unit	To convert Column 2 into Column 1 multiply by
		Temperature	
1.00 (K − 273)	Kelvin, K	Celsius, °C	1.00 (°C + 273)
(9/5 °C) + 32	Celsius, °C	Fahrenheit, °F	5/9 (°F −32)
		Energy, Work, Quantity of Heat	
9.52×10^{-4}	joule, J	British thermal unit, Btu	1.05×10^{3}
0.239	joule, J	calorie, cal	4.19
10^{7}	joule, J	erg	10^{-7}
0.735	joule, J	foot-pound	1.36
2.387×10^{-5}	joule per square meter, J m^{-2}	calorie per square centimeter (langley)	4.19×10^{4}
10^{5}	newton, N	dyne	10^{-5}
1.43×10^{-3}	watt per square meter, W m^{-2}	calorie per square centimeter minute (irradiance), cal cm^{-2} min^{-1}	698
		Transpiration and Photosynthesis	
3.60×10^{-2}	milligram per square meter second, mg m^{-2} s^{-1}	gram per square decimeter hour, g dm^{-2} h^{-1}	27.8
5.56×10^{-3}	milligram (H_2O) per square meter second, mg m^{-2} s^{-1}	micromole (H_2O) per square centimeter second, μmol cm^{-2} s^{-1}	180
10^{-4}	milligram per square meter second, mg m^{-2} s^{-1}	milligram per square centimeter second, mg cm^{-2} s^{-1}	10^{4}
35.97	milligram per square meter second, mg m^{-2} s^{-1}	milligram per square decimeter hour, mg dm^{-2} h^{-1}	2.78×10^{-2}
		Plane Angle	
57.3	radian, rad	degrees (angle), °	1.75×10^{-2}

Electrical Conductivity, Electricity, and Magnetism

10	siemen per meter, S m^{-1}	millimho per centimeter, mmho cm^{-1}	0.1
10^4	tesla, T	gauss, G	10^{-4}

Water Measurement

9.73×10^{-3}	cubic meter, m^3	acre-inches, acre-in	102.8
9.81×10^{-3}	cubic meter per hour, $m^3\ h^{-1}$	cubic feet per second, $ft^3\ s^{-1}$	101.9
4.40	cubic meter per hour, $m^3\ h^{-1}$	U.S. gallons per minute, gal min^{-1}	0.227
8.11	hectare-meters, ha-m	acre-feet, acre-ft	0.123
97.28	hectare-meters, ha-m	acre-inches, acre-in	1.03×10^{-2}
8.1×10^{-2}	hectare-centimeters, ha-cm	acre-feet, acre-ft	12.33

Concentrations

1	centimole per kilogram, cmol kg^{-1} (ion exchange capacity)	milliequivalents per 100 grams, meq 100 g^{-1}	1
0.1	gram per kilogram, g kg^{-1}	percent, %	10
1	milligram per kilogram, mg kg^{-1}	parts per million, ppm	1

Radioactivity

2.7×10^{-11}	bequerel, Bq	curie, Ci	3.7×10^{10}
2.7×10^{-2}	bequerel per kilogram, Bq kg^{-1}	picocurie per gram, pCi g^{-1}	37
100	gray, Gy (absorbed dose)	rad, rd	0.01
100	sievert, Sv (equivalent dose)	rem (roentgen equivalent man)	0.01

Plant Nutrient Conversion

	Elemental	*Oxide*	
2.29	P	P_2O_5	0.437
1.20	K	K_2O	0.830
1.39	Ca	CaO	0.715
1.66	Mg	MgO	0.602