

Grass Tetany

ASA Special Publication Number 35

Proceedings of a symposium sponsored by Divisions C-1, C-2, and C-6 of the Crop Science Society of America.

The papers were presented during the annual meetings in Los Angeles, California, November 13–18, 1978.

Symposium Organizer

David L. Grunes

Co-Editors

Victor V. Rendig

David L. Grunes

Editor-in-Chief

Matthias Stelly

Managing Editor

David M. Kral

Assistant Editor

Judith H. Nauseef

1979

Published by the

**AMERICAN SOCIETY OF AGRONOMY
CROP SCIENCE SOCIETY OF AMERICA
SOIL SCIENCE SOCIETY OF AMERICA**

677 South Segoe Road
Madison, Wisconsin 53711

Copyright 1979 by the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, Inc.
ALL RIGHTS RESERVED UNDER THE U.S. COPYRIGHT LAW OF 1978 (P.L. 94-553). Any and all uses beyond the limitations of the "fair use" provision of the law require written permission from the publisher(s) and/or the author(s); not applicable to contributions prepared by officers or employees of the U.S. Government as part of their official duties.

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

Library of Congress Catalog Card Number: 78-73561
Standard Book Number: 0-89118-056-7

Printed in the United States of America

Contents

Foreword	
J. W. Pendleton, V. A. Johnson, and P. F. Pratt	vii
Preface	
Victor V. Rendig and David L. Grunes	ix
1 Clinical, Mineral, and Endocrine Interrelationships in Hypomagnesemic Tetany	
E. T. Littledike and P. S. Cox	
Introduction	1
Classification of Hypomagnesemic Tetany	2
Diet or Other Management Factors	2
Chemical Changes in Blood	4
Clinical Course.	5
Gastrointestinal Mechanisms of Magnesium Homeostasis.	5
Sites of Magnesium Absorption	5
Rumen, Reticulum, Omasum, and Abomasum	5
Intestine	6
Factors Influencing Absorption.	8
Other Minerals.	8
Microbial Influences	8
Amount of Feed and Magnesium Ingested	9
Availability of Magnesium	12
Endogenous Losses of Magnesium	13
Magnesium Homeostasis in Body	13
Blood	13
Endocrine Factors.	15
Vitamin Factors.	21
Other Factors.	21
Bone.	21
Mammary Gland	22
Kidney.	23
Cerebrospinal Fluid	25
Interrelationships of Blood and Cerebrospinal Fluid.	25
Magnesium Concentrations in the Cerebrospinal Fluid	30
Plasma and Cerebrospinal Fluid Magnesium Exchange	30
Comparison of Hypomagnesemic Tetany to Postparturient Hypocalcemia	33
Treatment.	35

	Physiopathology	36
	Pathology	36
	Cardiovascular Changes	37
	Other Changes	37
	Summary	38
	Literature Cited	39
2	Animal Nutrition Aspects of Grass Tetany	
	J. P. Fonenot	
	Introduction	51
	Description of Grass Tetany	52
	Signs	52
	Animals Affected	52
	Forage Regimens	52
	Cause(s) of Disturbances	53
	Dietary Magnesium Requirement	53
	Dietary Factors Affecting Magnesium Utilization	54
	Site of Magnesium Absorption	54
	Potassium	54
	Nitrogen	56
	Combination of Nitrogen and Potassium	57
	Calcium and Phosphorus	57
	Organic Acids	58
	Higher Fatty Acids	58
	Readily Available Carbohydrates	59
	Prevention of Grass Tetany	59
	Literature Cited	59
3	Plant Breeding, Selection, and Species in Relation to Grass Tetany	
	D. A. Sleper	
	Introduction	63
	Species	64
	Genetic Variation	68
	Selection	70
	Additional Concerns and Research Needs for the Forage Breeder	72
	Literature Cited	75
4	Influence of Soil, Liming, Magnesium, Potassium, and Nitrogen on Magnesium Composition of Plants	
	Roscoe Ellis, Jr.	
	Introduction	79
	Soil Relationships	79
	General Discussion	79
	Parent Materials	80
	Clay Minerals	81

Relationships of Mg Determinations in Soils to Uptake of	
Mg by Plants	81
General Discussion	81
Methods for Determining Mg in Soils	83
Exchangeable Mg	83
Percentage of Soil Exchange Capacity Saturated	
with Mg	84
Cation Activities and Activity Ratios	84
Nonexchangeable Mg	85
Conclusions	86
Effects of Soil Amendments and Fertilization Practices on	
Uptake of Mg by Plants	87
Fertilization with Mg	87
Liming Acid Soils	88
Influence of K on Uptake of Mg by Plants	89
Influence of N on Uptake of Mg by Plants	89
Summary and Conclusions	90
Literature Cited	91

5 Tetany Hazard of Grass as Affected by Fertilization with Nitrogen, Potassium, or Poultry Litter and Methods of Grass Tetany Prevention

S. R. Wilkinson and J. A. Stuedemann

Introduction	93
Pasture Fertilization	94
Forage Availability	95
Soil Chemical Composition	95
Plant Chemical Composition	96
Poultry Litter Fertilization and Plant Chemical	
Composition	98
Broiler Litter Pasture Fertilization	99
Magnesium Supplementation	103
Magnesium Sources	104
Methods of Direct Oral Magnesium Supplementation	105
Mineral Mixes	105
Palatable Mineral Mixes	106
Loose Concentrates	106
High Magnesium Blocks or Liquids	107
Magnesium in Drinking Water	107
Dosing with Magnesium Bullets or Soluble Mg Salts	108
Foliar Application of Magnesium	109
Pasture Fertilization with Magnesium to Prevent Grass	
Tetany	113
Fertilization Practices to Alleviate or Reduce	
Hypomagnesemia and Grass Tetany	114
Summary of Supplementation Methods	115
Research Needs	116
Literature Cited	117

**6 Soil-Climate-Plant Relationships in the Etiology of
Grass Tetany**

H. F. Mayland and D. L. Grunes

Introduction	123
Soil Factors	124
Estimating Soil Magnesium Availability	124
Magnesium Fertilization	124
Soil Calcium and pH	126
Aluminum	127
Liming	128
Soil Potassium Competition	129
Nitrogen Fertilization	130
Climate Factors	134
Temperature Influences	135
Light Intensity Effects	137
Seasonal Changes	138
Soil Oxygen Influences	140
Soil Water Effects on Mineral Uptake	140
Plant Factors Affecting Mg Availability to Animals	143
Forage Nitrogen	143
Forage Carbohydrates	144
Higher Fatty Acids (HFA)	147
Organic Acids	151
Metabolism and Concentration in Forages	151
Organic Acid Effects on Dietary Magnesium Availability	154
Cell Wall and Other Cell Constituents	155
Miscellaneous Complexing Factors	155
Histamine	155
Aluminum	156
Sodium vs. Potassium	157
Phosphorus	157
Magnesium Distribution in Forage Tissue	158
Chlorophyll Magnesium	158
C ₃ vs. C ₄ Grasses	159
Plant Species: Magnesium Uptake and Availability	160
Estimating the Grass Tetany Hazard	162
Research Needs	165
Literature Cited	167

Foreword

Grass tetany is a complex animal metabolic disorder that is influenced by soil properties, fertilizer practices, forage species and mineral composition, season of the year, temperature, and animal species, breed, and age. The disorder is a major problem of grazing cattle and sheep in the temperate regions of the world. Serious outbreaks have occurred in one-fourth of the states of the United States where losses in affected cattle herds have been as high as 20%. Improved control of grass tetany would result in significant economic benefits to livestock producers and increased production of high quality animal protein to aid the nutritional needs of a rapidly growing world population.

The American Society of Agronomy, the Crop Science Society of America, and the Soil Science Society of America are pleased to sponsor this special publication of the proceedings of a 1977 symposium on grass tetany. The authors are outstanding animal, plant, and soil scientists who have examined in depth the role and interactions of animals, plants, and soils in causing grass tetany. Research needs and opportunities for improved control of this serious metabolic disorder of cattle and sheep through application of existing research information are considered. Useful new research information from numerous and diverse sources is brought together in the publication.

J. W. Pendleton, President
American Society of Agronomy

V. A. Johnson, President
Crop Science Society of America

P. F. Pratt, President
Soil Science Society of America

Preface

Grass tetany is a serious problem of grazing animals in the United States and in many other parts of the world, and costly losses have occurred. In the most common form of the disorder, diagnosis indicates an insufficiency of magnesium—thus hypomagnesemic tetany—but many soil, plant, and animal factors are contributory. Effective methods of treatment have been developed, but, at least in some cases, if these procedures are not initiated soon after onset of symptoms, affected animals will not recover. This is especially a problem with grazing beef cattle, where the first indication that grass tetany is occurring may be finding dead animals. Thus, there is a need for developing a better understanding of all aspects of the disorder, so that through better management practices the likelihood of its occurrence will be minimized.

The six papers in this special publication were presented at a symposium held on 17 Nov. 1977 at the ASA annual meetings in Los Angeles. The symposium was organized by Dr. David L. Grunes in response to a request from Dr. Marcus Zuber.

We expect *Grass Tetany* to serve as a valuable reference source for both teachers and researchers. We know of no other publication which deals in such detail with soil, plant, and animal aspects of this very important animal disorder. Because many of the factors involved are interactive, some overlap between papers is unavoidable, and, rather than detracting from the publication, is a positive attribute. To have the many contributory factors viewed from the vantage point of different specialties adds to the value of the presentation. The authors were asked to indicate the needs for future research, and the comments they provided in response to this request should offer direction to those who may wish to seek greater insight and new knowledge about grass tetany.

ACKNOWLEDGMENTS

Many people, both members and nonmembers of ASA, contributed to preparing this special publication. The presentations and cooperation of the authors was outstanding. Those who reviewed the manuscripts did so with thoroughness and promptness, and we are deeply grateful to them. They were C. B. Ammerman, University of Florida, Gainesville; R. C. Buckner, USDA, Lexington, Ky.; R. G. Burau, University of California, Davis; R. B. Bushnell, University of California, Davis; C. B. Elkins, USDA, Auburn, Ala.; R. Ellis, Jr., Kansas State University, Manhattan; J. P. Fontenot, Virginia Polytechnic Institute and State University.

ty, Blacksburg; R. R. Hill, Jr., USDA, University Park, Pa.; L. R. Hossner, Texas A & M, College Station; W. A. House, USDA, Ithaca, N.Y.; A. W. Hovin, University of Minnesota, St. Paul; E. O. McLean, Ohio State University, Columbus; J. K. Miller, U.S. Department of Energy, Oak Ridge, Tenn.; M. C. Neathery, University of Georgia, Athens; and R. L. Reid, West Virginia University, Morgantown. Ms. Judy Nauseef and others in the ASA office who may have assisted her contributed much to the quality of the publication by providing skilled editorial polishing and reference checking. Appreciation is expressed for the able and cheerful assistance of the office staff in the Department of Land, Air and Water Resources, University of California, Davis, in particular Ms. Lois Sapp and Ms. Jeannie Jenkins.

Victor V. Rendig
David L. Grunes
Co-Editors