

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

THE EFFECT OF SOME MEDIA COMPONENTS
ON THE MICRONUTRIENT COMPOSITION
OF SOME CONTAINER - GROWN PLANTS.

A thesis presented in partial fulfilment
of the requirements for the degree of
Master in Horticultural Science
at Massey University.

Colin Bruce Christie
1976

In 1860 Sachs made the following statement:

"I published the results of experiments which demonstrated that land plants are capable of absorbing their nutritive matters out of watery solutions, without the aid of soil, and that it is possible in this way not only to maintain plants alive and growing for a long period of time, as had long been known, but also to bring about a vigorous increase in their organic substance, and even the production of seed capable of germination."

Julius von Sachs
Lectures on the Physiology of Plants
Clarendon Press, Oxford, England. 1887

ABSTRACT

Plants were grown in a range of soilless growing media made from peat, perlite and pumice.

Plant samples and media extracts were analysed by atomic absorption spectrophotometry.

All media components used proved to be sufficiently reactive with respect to micronutrients to modify nutrient levels in plant foliage. This is supported by differences in micronutrient extractability and sorption by media components.

The use of fritted trace elements did not prevent the appearance of Fe chlorosis, but did increase the foliar level of some micronutrients.

The results show some nutritional differences between peats from different sources. Differences in mineral uptake associated with perlite and pumice were also observed. These differences may explain why iron chlorosis may be induced in plants grown in perlite based substrates and not in pumice based substrates.

<u>TABLE OF CONTENTS</u>		page number
	Acknowledgements	v.
	List of Figures	vi.
	List of Plates	vii.
	List of Tables	ix.
	Introduction	1
Chapter I	Literature Review	2
	Introduction	2
	(1) Container growing media	3
	(2) The ideal substrate	14
	(3) Micronutrient problems in soilless growing media	21
	(4) Inertness of media components	25
	(5) Rationale for experimental work	28
Chapter 2	Materials and Methods	31
	(1) Plant Materials and Propagation Methods	31
	(2) Media Components	32
	(3) Preparation of Growing Medium	33
	(4) Maintenance of Growing Conditions	34
	(5) Experimental Design	35
	(6) Sampling	35
	(7) Preparation of Samples for Analysis	36
	(8) Preliminary investigation of some chemical properties of the media components	38
	(9) Analytical Method	39
	(10) Photographic record	41
Chapter 3	Experimental Section	42
	Preliminary work	42
	Experiment one	44
	Discussion	49
	Experiment two	53
	Discussion	64
	Experiment three	70
	Discussion	90
	Experiment four	97
	Discussion	116
Chapter 4	General Discussion and Summary	127
	Appendix I	136
	Appendix II	140
	Bibliography	151

ACKNOWLEDGEMENTS

I owe my most sincere thanks to my supervisor Mr M. Richards for the initial suggestion of the topic. Mr Richards' considerable and most valuable assistance in the experimental work and in the preparation of the thesis has been of inestimable value.

I would like to express my appreciation to Dr M.A. Turner, Dr G.G. Pritchard and Mr P.E.H. Gregg for their assistance and useful discussions during the course of this work.

My thanks are also due to Dr R.D. Reeves, who freely gave of his time to teach me the basic principles of atomic absorption spectroscopy use.

Thanks are also due to Dr M.A. Nichols, who willingly assisted in the statistical manipulation of the data.

I am grateful to J.N. Anderson and Son, Napier, who kindly donated the stock Chrysanthemum 'Nob Hill' plants, Smiths Soil Industries, Auckland for samples of FTE 36 and Sierra Chemical Co., California for samples of FTE 503.

I am much indebted to Mr Lex Rennes for the estimation of phosphate levels and to Mr G. McSweeny of Fertilizer Manufacturers Research Association for doing some fluorine analyses at short notice.

I would also acknowledge the debt I owe to a host of colleagues and friends, especially Mr Stuart Tustin, for encouragement and assistance most generously given.

Finally, it is a pleasure to acknowledge the unfailing helpfulness and patience of those who have assisted in the preparation of this manuscript for publication.

<u>List of Figures</u>	following page
Figure 1. Influence of medium and level of Frit 503 on the concentration of micronutrients in <u>Chrysanthemum</u> 'Nob Hill'	49
Figure 2. Influence of growing medium, nitrogen source and level of Frit 36 on the concentration of micronutrients in <u>Chrysanthemum</u> 'Nob Hill'	64
Figure 3. Influence of growing medium, nitrogen source and level of Frit 36 on EDTA-extractable micronutrients	65
Figure 4. Influence of growing medium and level of Frit 36 on the concentration of micronutrients in <u>Chrysanthemum</u> 'Nob Hill'	90
Figure 5. Influence of growing medium and level of Frit 36 on the concentration of micronutrients in <u>Sorghum</u> 'RS610'	91
Figure 6. Influence of growing medium and level of Frit 36 on the concentration of micronutrients in Chinese Cabbage	92
Figure 7. Influence of growing medium and level of Frit 36 on EDTA-extractable micronutrients	93
Figure 8. Influence of medium and Frit source on the concentration of micronutrients in <u>Chrysanthemum</u> 'Nob Hill'	116
Figure 9. Influence of medium and Frit source on the concentration of micronutrients in <u>Sorghum</u> 'RS610'	117
Figure 10. Influence of medium and Frit source on EDTA-extractable micronutrients.	118

<u>List of Plates</u>	following page
<u>Plate 1.</u> First maturing <u>Chrysanthemum</u> 'Nob Hill' flowers grown in (i) Irish peat-pumice, (ii) Irish peat-perlite.	41
<u>Plate 2.</u> Later maturing <u>Chrysanthemum</u> 'Nob Hill' flowers grown in (i) Irish peat-pumice, (ii) Irish peat-perlite showing boron deficiency symptoms.	43
<u>Plate 3.</u> Foliage of <u>Chrysanthemum</u> 'Nob Hill' plants grown in (i) New Zealand peat-pumice or New Zealand peat-perlite, (ii) Irish peat-pumice or Irish peat-perlite, without added Frit.	44
<u>Plate 4.</u> Foliage of <u>Chrysanthemum</u> 'Nob Hill' plants grown in (i) New Zealand peat-pumice or New Zealand peat-perlite, (ii) Irish peat-pumice or Irish peat-perlite, with added FTE 503.	48
<u>Plate 5.</u> Foliage of <u>Chrysanthemum</u> 'Nob Hill' plants grown in New Zealand peat-pumice (A+B) and New Zealand peat-perlite (C+D), with an OS nitrogen source (B+D) or SCU nitrogen source (A+C), and with (2) or without (0) added Frit 36.	54
<u>Plate 6.</u> Foliage of <u>Chrysanthemum</u> 'Nob Hill' plants grown in New Zealand peat-pumice (top row) and New Zealand peat-perlite (bottom row) with Frit 36 added to the medium at 0, 100, 200, 300, and 400 g/m ³ (left to right).	54
<u>Plate 7.</u> Foliage sections of <u>Sorghum</u> 'RS610' plants grown in (i) New Zealand peat-pumice and (ii) New Zealand peat-perlite with Frit 36 added to the growing medium at 0, 100, 200, 300, and 400 g/m ³ (left to right).	76
<u>Plate 8</u> Foliage of Chinese Cabbage plants grown in (i) New Zealand peat-pumice and (ii) in New Zealand peat-perlite with Frit 36 added to the growing medium at 0, 100, 200, 300, and 400 g/m ³ (left to right).	81
<u>Plate 9.</u> Foliage of <u>Chrysanthemum</u> 'Nob Hill' plants grown in (i) pumice and (ii) perlite with (A) No Frit added, (B) Frit 503 added, or (C) Frit 36 added to the growing medium	98
<u>Plate 10.</u> Foliage sections of <u>Sorghum</u> 'RS610' plants grown in (i) pumice and (ii) perlite with (A) No Frit added, (B) Frit 503 added, or (C) Frit 36 added to the growing medium	105

	following page
<u>Plate 11.</u> Foliage sections of <u>Sorghum</u> 'RS610' plants grown in perlite with Frit 503 (top) and Frit 36 (bottom), following localised application of FeSO_4 .	120
<u>Plate 12.</u> Foliage sections of <u>Sorghum</u> 'RS610' plants grown in New Zealand peat pumice (left) and New Zealand peat-perlite (right) following application of fluoride to the medium.	120

<u>LIST OF TABLES</u>		page No.
Table 1	Standard nutrient supplement per 10 litres of growing medium	33
Table 2	Micrograms of copper per gram of dried <u>Chrysanthemum</u> foliage	45
Table 3	Micrograms of Zinc per gram of dried <u>Chrysanthemum</u> foliage	46
Table 4	Micrograms of Manganese per gram of dried <u>Chrysanthemum</u> foliage	47
Table 5	Micrograms of Iron per gram of dried <u>Chrysanthemum</u> foliage	48
Table 6	Micrograms of Copper per gram of dried <u>Chrysanthemum</u> foliage	55
Table 7	Micrograms of Zinc per gram of dried <u>Chrysanthemum</u> foliage	56
Table 8	Micrograms of Manganese per gram of dried <u>Chrysanthemum</u> foliage	57
Table 9	Micrograms of Iron per gram of dried <u>Chrysanthemum</u> foliage	59
Table 10	Micrograms of EDTA-extractable Copper per gram of growing medium	60
Table 11	Micrograms of EDTA-extractable Zinc per gram of growing medium	61
Table 12	Micrograms of EDTA-extractable Manganese per gram of growing medium	62
Table 13	Micrograms of EDTA-extractable Iron per gram of growing medium	63
Table 14	Micrograms of Copper per gram of dried <u>Chrysanthemum</u> foliage	71
Table 15	Micrograms of Zinc per gram of dried <u>Chrysanthemum</u> foliage	72
Table 16	Micrograms of Manganese per gram of dried <u>Chrysanthemum</u> foliage	73
Table 17	Micrograms of Iron per gram of dried <u>Chrysanthemum</u> foliage	74
Table 18	Microgram of Aluminium per gram of dried <u>Chrysanthemum</u> foliage	75
Table 19	Microgram of Copper per gram of dried <u>Sorghum</u> foliage	77
Table 20	Microgram of Zinc per gram of dried <u>Sorghum</u> foliage	78
Table 21	Micrograms of Manganese per gram of dried <u>Sorghum</u> foliage	79

		page No.
Table 22	Micrograms of Iron per gram of dried <u>Sorghum</u> foliage	80
Table 23	Micrograms of Copper per gram of dried Chinese Cabbage	82
Table 24	Micrograms of Zinc per gram of dried Chinese Cabbage	83
Table 25	Micrograms of Manganese per gram of dried Chinese Cabbage	84
Table 26	Micrograms of Iron per gram of dried Chinese Cabbage	85
Table 27	Micrograms of EDTA-extractable Copper per gram of growing medium	86
Table 28	Micrograms of EDTA-extractable Zinc per gram of growing medium	87
Table 29	Micrograms of EDTA-extractable Manganese per gram of growing medium	88
Table 30	Micrograms of EDTA-extractable Iron per gram of growing medium	89
Table 31	Micrograms of Copper per gram of dried <u>Chrysanthemum</u> foliage	99
Table 32	Micrograms of Zinc per gram of dried <u>Chrysanthemum</u> foliage	100
Table 33	Micrograms of Manganese per gram of dried <u>Chrysanthemum</u> foliage	101
Table 34	Micrograms of Iron per gram of dried <u>Chrysanthemum</u> foliage	102
Table 35	Micrograms of Aluminium per gram of dried <u>Chrysanthemum</u> foliage	103
Table 36	Micrograms of Copper per gram of dried <u>Sorghum</u> foliage	106
Table 37	Micrograms of Zinc per gram of dried <u>Sorghum</u> foliage	107
Table 38	Micrograms of Manganese per gram of dried <u>Sorghum</u> foliage	108
Table 39	Micrograms of Iron per gram of dried <u>Sorghum</u> foliage	109
Table 40	Micrograms of Aluminium per gram of dried <u>Sorghum</u> foliage	110
Table 41	Micrograms of EDTA-extractable Copper per gram of growing medium	111
Table 42	Micrograms of EDTA-extractable Zinc per gram of growing medium	112

	page No.
Table 43 Micrograms of EDTA-extractable Manganese per gram of growing medium	113
Table 44 Micrograms of EDTA-extractable Iron per gram of growing medium	114
Table 45 Micrograms of EDTA-extractable Aluminium per gram growing medium	115
Table 46 Mechanical analysis of media components	136
Table 47 Cation exchange capacity of media components	136
Table 48 Extractable nutrients	137
Table 49 Micronutrient sorption	137
Table 50 2N HCl soluble micronutrients (mg/Kg) in fertilizers used	137
Table 51 Nutrient supplement (g/l) as used in Experiment 2	138
Table 52 Fluoride levels in media components and plants	138
Table 53 Micrograms of bicarbonate extractable Phosphate per gram of growing medium	138

Introduction

The omission of soil from the growing medium has generally produced a substrate more satisfactory for plant growth with current cultural practices.

However, observant growers have noted that when a range of soilless media are similarly fertilized and compared they will often yield large differences in plant growth response.

Leaving soil out of the medium has reduced many problems of management, but it has introduced some others that require investigation.

Foliar chlorosis and delayed flowering in some plants may be increased when grown in peat-perlite mixtures, this problem occurs less frequently in peat-sand or peat-pumice mixtures.

The addition of a relatively small proportion of soil to the growing media may reduce the variation in plant growth response observed between different media, and may even prove beneficial in some situations.

Experience on growers' properties suggests the media may be altering the availability of some micronutrients.