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**THE INFLUENCE OF ZINC AND COPPER FERTILIZER
APPLICATION ON ZINC, COPPER AND CADMIUM
CONCENTRATION IN MIXED PASTURE**

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the degree of Master of Applied Science in Soil Science at
Massey University, Palmerston North, New Zealand.**

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ABSTRACT

There has been considerable debate about the accumulation of cadmium (Cd) in agricultural soils and its subsequent uptake by pasture plants due to phosphate fertilizer application. Ruminants grazing pastures absorb a small fraction of this Cd, and some of this is subsequently accumulated in the liver and kidney. Although tissue accumulation of Cd in grazing livestock is generally small ($< 1 \text{ mg Cd kg}^{-1}$ fresh tissue), but any reduction in plant uptake is beneficial in reducing such accumulation further, especially in the kidneys. Uptake of Cd by pasture may be affected by the concentration of other nutrient cations, such as zinc (Zn) and copper (Cu). In addition, since Zn and Cu are complexed by the same metal binding protein (metallothionein) as Cd, a change in the ratio of these nutrients in pasture may also reduce Cd accumulation rates by interfering with Cd accumulation.

In order to assess the effects of Zn and Cu on Cd uptake by pasture, a field experiment was conducted, using three pairs of pasture plots with low ($0.2 \text{ mg Cd kg}^{-1}$) and high ($0.6 \text{ mg Cd kg}^{-1}$) background Cd status. Twelve sub-plots (1.44 m^2) were laid out in each plot and increasing levels of Zn (0, 5, 15 and 40 kg ha^{-1}) and Cu (0, 2, 5 and 10 kg ha^{-1}) were added as $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ and $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ respectively. Pasture samples were collected at regular intervals and analysed for dry matter yield, botanical composition and Zn, Cu and Cd uptake. Soil samples were extracted with 0.01M CaCl_2 and 0.1M HCl solution to measure the plant available Zn, Cu and Cd.

It was found that the plots with a high background Cd status in the soil resulted in a higher Cd concentration in mixed pasture ($0.22 \text{ mg Cd kg}^{-1} \text{ DM}$) than those with a low background Cd status ($0.10 \text{ mg Cd kg}^{-1} \text{ DM}$) at the first harvest (after 73 days). The Cd concentration in the mixed pasture was higher during the summer (December) period than in the early spring (September).

Application of Zn fertilizer increased the Zn concentration in pasture from 37 to $150 \text{ mg kg}^{-1} \text{ DM}$ at the first harvest. Excessive amounts of Zn lead to a decrease in DM yield. The growth of pasture was controlled principally by the amount of plant available Zn,

which depended on the amount of both added Zn and added Cu. The effect of the added Cu was to increase the toxicity of the added Zn.

Application Cu fertilizer increased the Cu levels from 9 to 16 mg kg⁻¹ DM at the first harvest. The Cu concentration in pasture continued to decrease with time following the addition of fertilizers. The legumes are more tolerant of Cu than grass. The Cu concentration in harvest 4 (after 159 days) ranged from 6.9 to 7.0 mg kg⁻¹ DM in grass and 8.9 to 9.9 mg kg⁻¹ DM in legumes.

The Cd concentration in the pasture decreased with increasing Zn concentration in the pasture at the first harvest. The effect of Zn on Cd uptake was more pronounced on plots with a high background Cd status in the soil. The effect of Zn on Cd concentration depends on the external Zn concentration levels.

There was no consistent effect of Cu concentration on Cd concentration. The effect of the addition of Cu and Zn in fertilizer was to lower the Cd:Cu and Cd:Zn ratios in the herbage.

There was a good relationship between soil available Zn as extracted by 0.1M HCl and Zn concentration in the herbage. A similar observation was obtained for Cu. But there was no consistent relationship between 0.01M CaCl₂ extractable Cd and the Cd concentration in pasture.

The results indicated that pasture and soil analysis for Cd and Zn may provide useful guides to situations where Cd concentrations in pasture may be decreased by Zn applications.

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TABLE OF CONTENTS

	Page
ABSTRACT	i
ACKNOWLEDGMENTS	iii
TABLE OF CONTENTS	v
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF APPENDICES	xiv
 CHAPTER ONE: 	
INTRODUCTION	
1.1 Background	1
1.2 Objective	2
 CHAPTER TWO: 	
REVIEW OF LITERATURE	
2.1 Introduction	3
2.2 Sources of cadmium	3
2.2.1 Cadmium in fertilizer	4
2.2.2 Cadmium in sewage sludge	6
2.3 Availability of soil cadmium	7
2.4 Cadmium in plants	8
2.5 Cadmium in farm animals	10

2.6	Factors influencing the accumulation of Cd in plants, soil and animals	12
2.6.1	Plant uptake of fertilizer Cd from soil	12
2.6.1.1	Time of contact and form of Cd	12
2.6.1.2	Effect of fertilizer application	13
2.6.1.3	CEC and soil organic matter effects	15
2.6.1.4	Effect of Zn and Cu on Cd concentration in plants, soil and animals	17
2.6.1.4.1	Zinc and Cd interactions	17
2.6.1.4.2	Copper and Cd interaction	19
2.6.1.4.3	Copper and Zn interaction	19
2.6.1.5	Effect of soil pH and liming on Cd concentration	20
2.7	Effect of plant species on Cd concentration	23
2.8	Factors that influence the uptake of Cd in animals and humans	24
2.9	Seasonal influences on DM yield, concentration of Zn, Cu and Cd	26
2.9.1	Effect on growth rate, botanical composition and DM yield	26
2.9.2	Effect on Cu concentration	28
2.9.3	Effect on Zn concentration	29
2.9.4	Effect on Cd concentration	30
2.10	Effect of Zn and Cu fertilizers on Zn and Cu concentration	30
2.10.1	Effect on Cu concentration	30
2.10.2	Effect on Zn concentration	32
2.11	Toxicity effect	33
2.11.1	Toxicity effect of Cu	33
2.11.2	Toxicity effect of Zn	33

CHAPTER THREE:
MATERIALS AND METHODS

3.1	Location and fertilizer management	35
3.2	Fertilizer treatment	37
3.3	Field preparation	37
3.4	Experimental design	38
3.5	Fertilizer rate and application	38
3.6	Collection of soil and pasture samples	39
	3.6.1 Soil sampling	39
	3.6.2 Pasture sampling	39
3.7	Botanical composition	40
3.8	Soil and herbage sample preparation	40
	3.8.1 Initial soil for chemical analysis	40
	3.8.2 Soil samples for pseudo-total Cd analysis	40
	3.8.3 Soil samples for available Zn, Cu and Cd analysis	41
	3.8.3.1 0.01M CaCl ₂	41
	3.8.3.2 0.1M HCl	41
	3.8.4 Pasture samples for Zn, Cu and Cd analysis	41
3.9	Chemical analysis	42
3.10	Statistical analysis of analytical data	42

**CHAPTER FOUR:
RESULTS AND DISCUSSION**

4.1	Reliability of the data in pasture and soil samples	43
4.2	Initial chemical properties	44
4.2.1	Initial soil chemical properties	44
4.2.2	Initial pasture chemical composition	46
4.3	Dry matter yield of pasture	47
4.3.1	Dry matter yield of mixed pasture	47
4.3.1.1	Effect of treatment	47
4.3.1.2	Effect of Cu level	49
4.3.1.3	Effect of Zn level	51
4.3.1.4	Effect of background Cd	52
4.3.2	Dry matter yield of pasture species	53
4.3.2.1	Effect of treatment	53
4.3.2.2	Effect of Cu level	53
4.3.2.3	Effect of Zn level	54
4.3.2.4	Effect of background Cd	56
4.4	Pasture growth rate	57
4.4.1	Growth rates in mixed pasture	57
4.4.1.1	Effect of treatment	57
4.4.1.2	Effect of Cu level	58
4.4.1.3	Effect of Zn level	58
4.4.1.4	Effect of background Cd	61

4.4.2	Growth rates of pasture species	61
4.4.2.1	Effect of treatment	61
4.4.2.2	Effect of Cu level	62
4.4.2.3	Effect of Zn level	63
4.4.2.4	Effect of background Cd	64
4.5	Botanical composition	65
4.6	Copper content	67
4.6.1	Copper content in mixed pasture	67
4.6.1.1	Effect of treatment	67
4.6.1.2	Effect of Cu level	68
4.6.1.3	Effect of Zn level	70
4.6.1.4	Effect of background Cd	71
4.6.2	Copper content in pasture species	72
4.6.2.1	Effect of treatment	72
4.6.2.2	Effect of Cu level	72
4.6.2.3	Effect of Zn level	74
4.6.2.4	Effect of background Cd	75
4.7	Zinc content	75
4.7.1	Zinc content in mixed pasture	75
4.7.1.1	Effect of treatment	75
4.7.1.2	Effect of Cu level	75
4.7.1.3	Effect of Zn level	76
4.7.1.4	Effect of background Cd	77

4.8	Cadmium content	78
4.8.1	Cadmium content in mixed pasture	78
4.8.1.1	Effect of treatment	78
4.8.1.2	Effect of Cu level	79
4.8.1.3	Effect of Zn level	82
4.8.1.4	Effect of background Cd	87
4.8.2	Cadmium content in pasture species	88
4.8.2.1	Effect of treatment	88
4.8.2.2	Effect of Cu level	89
4.8.2.3	Effect of Zn level	90
4.8.2.4	Effect of background Cd	91
4.9	Seasonal influences on dry matter yield, Cu, Zn and Cd concentrations in pasture	92
4.9.1	Effect on DM yield	92
4.9.2	Effect on Cu	93
4.9.3	Effect on Zn	94
4.9.4	Effect on Cd	95
4.10	Available Cu, Zn and Cd content in soil	96
4.10.1	Available Cu	96
4.10.2	Available Zn	99
4.10.3	Available Cd	100
4.11	Total Cd concentration in soil	104
	CONCLUSIONS	105
	REFERENCES	108
	APPENDICES	128

LIST OF TABLES

Table 2.1	Concentration of cadmium in sewage sludge.	7
Table 2.2	Cadmium concentration in some plants.	10
Table 2.3	Effect of different P sources on Cd concentrations in plants.	15
Table 2.4	Dry weight and Cd concentration of oat shoots and exchangeable soil Cd as affected by soil cation exchange capacity.	17
Table 2.5	Effect of soil pH on the Cd concentration in different crops.	22
Table 2.6	Cadmium concentration in liver and kidney samples of cattle and sheep in various countries.	26
Table 2.7	Annual herbage yields and seasonality of yields of ryegrass-clover pastures.	27
Table 2.8	Effect of season on Zn concentration of annual pastures in SW Australia.	29
Table 3.1	Treatment combinations of the field experiment.	37
Table 4.1	Initial soil chemical properties.	45
Table 4.2	Chemical composition of the initial mixed pastures	46
Table 4.3	Botanical composition of the mixed pasture.	66
Table 4.4	Available soil Cu, Zn and Cd concentrations.	98
Table 4.5	Total Cd concentration in soil after 73 days from fertilizer application.	102

LIST OF FIGURES

Fig. 2.1	The relationship between Cd and P contents of phosphatic fertilizers (Williams and David, 1973).	6
Fig. 3.1	Experimental layout in the field.	36
Fig. 4.1	Effect of Cu levels on DM yield of mixed pasture.	48
Fig. 4.2	Effect of Zn levels on DM yield of mixed pasture.	50
Fig. 4.3	Effect of background Cd status on DM yield of mixed pasture.	52
Fig. 4.4	Effect of Cu levels on DM yield of pasture species.	54
Fig. 4.5	Effect of Zn levels on DM yield of pasture species.	55
Fig. 4.6	Effect of background Cd status on DM yield of pasture species.	56
Fig. 4.7	Effect of Cu levels on pasture growth rates of mixed pasture.	59
Fig. 4.8	Effect of Zn levels on pasture growth rates of mixed pasture.	60
Fig. 4.9	Effect of background Cd status on pasture growth rates of mixed pasture.	61
Fig. 4.10	Effect of Cu levels on growth rates of pasture species.	62
Fig. 4.11	Effect of Zn levels on growth rates of pasture species.	63
Fig. 4.12	Effect of background Cd status on growth rates of pasture species.	64
Fig. 4.13	Effect of Cu levels on Cu concentration in mixed pasture.	69
Fig. 4.14	Effect of Zn levels on Cu concentration in mixed pasture.	70
Fig. 4.15	Effect of background Cd status on Cu concentration of mixed pasture.	71
Fig. 4.16	Effect of Cu levels on Cu concentration in pasture species.	73
Fig. 4.17	Effect of Zn levels on Cu concentration in pasture species.	74
Fig. 4.18	Effect of Cu levels on Zn concentration in mixed pasture.	76
Fig. 4.19	Effect of Zn levels on Zn concentration in mixed pasture.	77

Fig. 4.20	Effect of background Cd status on Zn concentration in mixed pasture.	78
Fig. 4.21	Effect of Cu levels on Cd concentration in mixed pasture.	80
Fig. 4.22	Effect of Cu concentration on Cd:Cu ratio.	81
Fig. 4.23	Relationship between pasture Zn concentration and pasture Cd concentration.	82
Fig. 4.24	Effect of Zn levels on Cd concentration in mixed pasture	83
Fig. 4.25	Effect of Zn concentration on Cd:Zn ratio.	84
Fig. 4.26	Effect of Zn+Cu concentration on Cd:(Zn+Cu) ratio.	84
Fig. 4.27	Effect of background Cd status on Cd concentration in mixed pasture.	87
Fig. 4.28	Effect of Cu levels on Cd concentration in pasture species.	89
Fig. 4.29	Effect of Zn levels on Cd concentration in pasture species.	90
Fig. 4.30	Effect of background Cd status on Cd concentration in pasture species.	91
Fig. 4.31	Effect of days following the addition of fertilizers on DM yield.	92
Fig. 4.32	Effect of days following the addition of fertilizers on Cu concentration in mixed pasture.	94
Fig. 4.33	Effect of days following the addition of fertilizers on Cd concentration in background Cd status.	95
Fig. 4.34	Relationship between available soil Cu and pasture Cu in harvest 1.	97
Fig. 4.35	Relationship between available soil Zn and pasture Zn in harvest 1.	99
Fig. 4.36	Relationship between available soil Cd and pasture Cd in harvest 1.	101
Fig. 4.37	Relationship between total soil Cd content and available soil Cd.	103

LIST OF APPENDICES

Appendix 1	Rates of Zn and Cu fertilizer additions in the field experiment.	128
Appendix 2	Dry matter yield of pasture at different harvests.	129
Appendix 3	Growth rates of pasture for different harvests.	130
Appendix 4	Copper concentrations in pasture for different harvests.	131
Appendix 5	Zinc concentrations in pasture for different harvests.	132
Appendix 6	Cadmium concentrations in pasture for different harvests.	133