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FIELD AND LABORATORY STUDIES
OF THE MOVEMENT AND REACTIONS
OF PHOSPHORUS IN SOILS

A thesis presented in partial fulfilment of
the requirements for the degree of
Doctor of Philosophy in Soil Science
at Massey University

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1978

ABSTRACT

Low and stable concentrations of phosphorus (P) forms and sediment were obtained in stream flow from two small, adjacent, scrub-covered, and minimally-disturbed catchments near Palmerston North, New Zealand. In contrast, higher and irregular concentrations and loadings were obtained following land clearing, P fertilizer application, and the establishment of grazed pasture. The need for intensive stream sampling, as well as complete hydrograph data in order to obtain reliable information on stream loadings, is emphasised.

High and fluctuating concentrations of P forms and sediment were obtained following the change in land use. A high proportion of the P and sediment loss occurred in the storm runoff component of stream flow. The estimated losses of fertilizer P in stream flow (approximately 1% of that added) were very small from an agronomic standpoint but they represent large proportional increases in the loadings of P forms in stream flow.

The high amounts of water-extractable P present in the soils of the catchment (field soils), immediately following the aerial application of fertilizer P, declined rapidly to lower, more stable values. This pattern of decline for field soils was replicated using small pots established in the field (pot soils) and containing fertilized soil representative of the catchments. Close correlations were obtained between water-extractable P in the upper 1cm of field and pot soils, and mean dissolved inorganic P (DIP) concentrations in the surface runoff component of stream flow in closely-following storms. The possibility of predicting DIP losses in

surface runoff from soils using a water-extraction technique is thus indicated.

The decrease with time in the amounts of water-extractable P observed after superphosphate addition to field and pot soils was reproduced in the laboratory. This relationship validated the use of laboratory studies to examine the rate and extent of interaction of fertilizer P occurring in field soils and to predict the potential movement of fertilizer P from soils to waters.

The decline in water-extractable P closely paralleled the decrease in plant uptake of P with time following fertilizer P addition to two contrasting soils. This suggested that water extraction may be a useful soil-testing procedure for predicting P availability to plants, as well as the movement of P in surface runoff from soils.

The rate of decline in water-extractable P in a given soil was proportional to both the amount of P added and the amount initially extractable immediately following P addition. This suggests that the rate and extent of P sorption in a soil is directly related to soil solution P concentration. Differences were obtained, however, between three contrasting soils in the relative rate and extent of P sorption.

A kinetic model based on the Langmuir equation was developed to simulate the decline in water-extractability of P added to three soils. Three populations of sites were assumed and the appropriate sorption maxima and binding energy constants were derived from sorption isotherm studies. The model provided a satisfactory prediction of the fate of different amounts of fertilizer P. It is probable that the further development of this model would provide a useful basis for predicting the fate of P added to soils and the potential movement of added P in surface-runoff waters.

ACKNOWLEDGEMENTS

I would like to express my gratitude to a number of people without whose help and support this thesis would never have eventuated. In particular I would like to thank:

My supervisor, Professor Keith Syers, to whom I am deeply indebted for his bouyant enthusiasm, encouragement, and friendship. Further to this, his rigorous standards of scientific thoroughness and presentation, while sometimes trying, have been highly rewarding.

Mr. Russell Tillman, to whom I am particularly grateful for his friendship, patience, and continual assistance during the planning, execution and presentation of this study.

Other members of the Department of Soil Science staff, both teaching and technical, and my colleagues who provided assistance and good humour.

Julie, for her patience over the long duration of the study and her forbearance of difficulties.

Dianne, for producing first-class typescript.

The University Grants Committee for a post-graduate scholarship for three years.

The Faculty of Agricultural and Horticultural Science, Massey University, for a Massey post-graduate scholarship.

The Waikato Valley Authority for time and encouragement to complete this thesis.

TABLE OF CONTENTS

	Page
ABSTRACT	i
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF FIGURES	ix
LIST OF TABLES	xvi

CHAPTER 1

REVIEW OF LITERATURE	1
1.1 Importance of Phosphorus Forms and Concentrations in Surface Waters	1
1.2 Factors Influencing Phosphorus Enrichment of Surface Waters	4
1.2.1 Natural or background phosphorus concentrations	4
1.2.2 Urban land use	7
1.2.3 Rural land use	8
1.2.3.1 Forestry	8
1.2.3.2 Livestock farming	10
1.2.3.3 Cropping	11
1.2.3.4 Fertilizer	13
1.2.4 Relative importance of factors influencing the phosphorus enrichment of waters	16
1.3 Movement of Phosphorus from Soils to Surface Waters	17
1.3.1 Sources of water and phosphorus	17
1.3.1.1 Surface runoff	19
1.3.1.2 Subsurface runoff	20
1.3.2 Potential influence of changes in land use on phosphorus movement to water	21
1.4 Forms and Reactions of Phosphorus in Soils	23
1.4.1 Organic phosphorus in soils	23

1.4.2	Inorganic phosphorus in soils	25
1.4.2.1	Primary inorganic phosphorus	25
1.4.2.2	Secondary inorganic phosphorus	26
1.5	Modelling the Reactions and Reaction Rates of Phosphorus Added to Soils and the Movement of Phosphorus from Soils. . .	29
1.5.1	Reactions	29
1.5.1.1	Isotherm resolution of data	29
1.5.1.2	Reaction mechanisms	31
1.5.2	Reaction rates	35
1.5.3	Prediction of phosphorus movement from soils and catchments to water	41
1.6	General Conclusions and Research Needs	44

CHAPTER 2

GENERAL MATERIALS AND METHODOLOGY	47
2.1 Description of the Catchments	47
2.1.1 Topography, geology, and soils	47
2.1.2 Vegetation and land clearing	50
2.2 Monitoring Equipment	52
2.3 Sample Collection	56
2.3.1 Water samples	56
2.3.2 Soil samples	56
2.4 Analytical Procedures	57
2.5 Data Processing	57

CHAPTER 3

MOVEMENT OF WATER, SEDIMENT, AND PHOSPHORUS FORMS FROM TWO SMALL, ADJACENT CATCHMENTS UNDER CHANGING LAND USE	59
3.1 Introduction	59
3.2 Materials and Methods	61

3.3	Results and Discussion	64
3.3.1	Flow-concentration relationships	64
3.3.2	Sources of water, sediment, and phosphorus forms	70
3.3.3	Impact of land clearing and changing land use on sediment and phosphorus movement	74
3.3.3.1	Movement of sediment and particulate phosphorus	74
3.3.3.2	Movement of dissolved inorganic and organic phosphorus	85
3.3.4	Influence of phosphorus fertilizer on the movement of phosphorus forms from the catchments	95
3.4	General Discussion	106

CHAPTER 4

FATE OF APPLIED PHOSPHORUS ADDED TO SOILS AND MOVEMENT IN RUNOFF WATER		112
4.1	Introduction	112
4.2	Materials and Methods	113
4.2.1	Preliminary investigation	114
4.2.2	Detailed investigation	117
4.2.3	Supplementary study	119
4.3	Results and Discussion	120
4.3.1	Changes in water-extractable phosphorus in soil from fertilized and control field sites within the catchments	120
4.3.2	Changes in water-extractable phosphorus in soil from fertilized and control pots in the field	130
4.3.2.1	Treatment differences and phosphorus movement from the upper lcm	130
4.3.2.2	Relationships between water-extractable phosphorus data obtained for soils from fertilized field sites and pots	134
4.3.2.3	Regeneration of the water-extractable phosphorus pool in soils	136

4.3.3	Relationships between mean dissolved inorganic phosphorus concentrations in surface runoff and water-extractable phosphorus values obtained for soils from fertilized field sites and pots	143
4.4	General Discussion	150

CHAPTER 5

THE RATE AND EXTENT OF PHOSPHORUS

	REACTIONS IN SOILS	159
5.1	Introduction	159
5.2	Materials and Methods	161
5.2.1	Comparison of extraction techniques to estimate labile phosphorus in soils	161
5.2.2	Soils used in subsequent laboratory studies	161
5.2.3	Preliminary laboratory studies of the decline in water-extractable phosphorus following phosphorus addition to one soil	162
5.2.4	Laboratory and glasshouse studies of the decline in water-extractable and plant-available phosphorus in contrasting soils following phosphorus addition	164
5.2.5	Comparisons between solid and liquid additions of phosphorus to soils	165
5.2.6	Detailed studies of the decline in water-extractable phosphorus in soils	166
5.3	Results and Discussion	171
5.3.1	Comparison of extraction techniques	171
5.3.2	Decline in water-extractable phosphorus following phosphorus addition to one soil	171

5.3.3	Decline in water-extractable and plant- available phosphorus in contrasting soils following phosphorus addition	175
5.3.3.1	Characteristics of the decline in water-extractable phosphorus in soils of contrasting phosphorus sorption properties	175
5.3.3.2	Decline in water-extractability of phosphorus in soil and the availability of phosphorus to plants	179
5.3.4	Influence of solid or dissolved phosphorus addition to soil on the decline in water- extractable phosphorus	188
5.3.5	Detailed studies of the decline in water- extractable phosphorus in soils and an approach to modelling soil phosphorus reactions	192
5.4	General Discussion	207
SUMMARY AND CONCLUSIONS		216
BIBLIOGRAPHY		219
APPENDICES		238

LIST OF FIGURES

	Page
FIGURE 2.1 Map of the North Island of New Zealand showing the general location of the study area in the inset	48
2.2 Map of the study area (from inset on Fig. 2.1) showing location of catchments (circle), local drainage networks, and indicating topography . . .	49
2.3 Vertical aerial photography of the two catchments before (A) and after (B) clearing	51
2.4 Vertical aerial photograph of the two catchments showing cleared slopes and debris deposition following clearing	53
2.5 Ground photograph in the 22-ha catchment after clearing showing soil surface disturbances, steepness of slopes, and debris in stream channel	54
2.6 H-S flume and Stevens F-type flow recorder operating on the stream draining the 6-ha catchment	55
3.1 Components of a stream hydrograph	63
3.2 Variation in flow and concentrations of PP and sediment in storm discharge from the 22-ha catchment during the storm event of 24-25/6/1974 before land clearing	65
3.3 Variation in flow and concentrations of PP and sediment in storm discharge from the 22-ha catchment during the storm event of 26/5/1975 after land clearing	66
3.4 Variation in mean concentrations of sediment and PP in the storm discharge of successive storm events throughout 1974, 1975 and 1976 for the 22-ha catchment	67
3.5 Variations in mean concentrations of sediment and PP in storm discharge of successive storm events throughout 1974 and 1975 for the 6-ha catchment	68

FIGURE 3.6	Variation in flow and concentrations of DIP and DOP in storm discharge from the 22-ha catchment during the storm event of 24-25/6/1974 before land clearing	69
3.7	Variation in flow and concentrations of DIP and DOP in storm discharge from the 22-ha catchment during the storm event of 26/5/1975 after land clearing	71
3.8	Variation in mean concentrations of DIP and DOP in the storm discharge of successive storm events throughout 1974, 1975, and 1976 for the 22-ha catchment	87
3.9	Variation in mean concentrations of DIP and DOP in the storm discharge of successive storm events throughout 1974 and 1975 for the 6-ha catchment	88
3.10	Influence of fertilizer P application on the variation in mean concentrations of DIP (A) and PP (B) in the storm discharge of successive storm events from two adjacent catchments, both of which were fertilized in 1975 but only one of which was fertilized in 1976	97
3.11	Regression between mean concentrations of DIP in storm flow from the 22-ha and 6-ha catchments in 1975 (both catchments fertilized) and in 1976 (6-ha catchment only fertilized)	99
3.12	Regression between mean PP and sediment concentrations in storm flow from the 6-ha catchment (A) and the 22-ha catchment (B) in 1976 following fertilizer addition to the 6-ha catchment only	105
4.1	Plan of the two catchments showing the location of 6 sites for soil sampling in 1975 (A, B, C, D, E, and F) and the three transect lines for placement of pots to estimate the mean superphosphate application rates in the catchments	115
4.2	Transverse section of the three transect lines shown in Fig. 4.1 showing the location of pots placed in the catchments to estimate the application rate of superphosphate	116

FIGURE 4.3	Decline in water-extractable P in soils with time following fertilizer P addition at three fertilized sites and from three control sites in 1975	124
4.4	Decline in water-extractable P in soils with time following fertilizer P addition at three fertilized sites and from three control sites in the 6-ha catchment only in 1976	126
4.5	Decline in water-extractable P in soils with time following fertilizer P addition at three fertilized sites in the 6-ha catchment only in 1976 and three fertilized sites in both catchments in 1975	127
4.6	Relative water-extractability of P, expressed as a proportion of the initial extraction value, with time following fertilizer P addition at three fertilized sites in the 6-ha catchment only in 1976 and three fertilized sites in both catchments in 1975	129
4.7	Decline in water-extractable P with time, following fertilizer P addition, in soil from field pots	131
4.8	Relative water-extractability of P, expressed as a proportion of the initial extraction value, with time following fertilizer P addition to soil in field pots	133
4.9	Field pots involving "divided" soil treatments showing condition at time of fertilizer placement and after 40 days in the field	135
4.10	Decline in water-extractable P with time, following fertilizer P addition, in soil from fertilized sites in the field and pots in the field	137
4.11	Regression between water-extractable P in soil from fertilized field sites (B) and from surface 2-cm pot treatment (A). All data for the 6-ha catchment in 1976	138

FIGURE 4.12	Regression between water-extractable P in soil from fertilized field sites (B) and from mixed pot treatment (A). All data for the 6-ha catchment in 1976	139
4.13	Regression between DIP concentrations in the leachates from 20 pots (mixed treatment after 7 months in the field) obtained by successive leachings	142
4.14	Relationship between mean DIP concentrations in the surface runoff component of storm flow from the two catchments and water-extractable P in soil from fertilized field sites in 1975	144
4.15	Regression between mean DIP concentrations in the surface runoff component of selected storm flow and water-extractable P in soil from fertilized field sites in 1975	146
4.16	Relationship between mean DIP concentrations in the surface runoff components of storm flow from the 6-ha catchment and water-extractable P in soil from fertilized field sites in the 6-ha catchment in 1976	147
4.17	Regression between mean DIP concentrations in the surface runoff component of storm flow from the 6-ha catchment and water-extractable P in soil from fertilized field sites in the 6-ha catchment in 1976	148
4.18	Regression between mean DIP concentrations in the surface runoff component of storm flow and water-extractable P in soil from fertilized field sites in the 6-ha catchment, combining 1975 and 1976 data	149
4.19	Regression between mean DIP concentrations in the surface runoff component of storm flow from the 6-ha catchment in 1976 and water-extractable P in soil from surface 2-cm pot treatments	152
4.20	Regression between mean DIP concentrations in the surface runoff component of storm flow from the 6-ha catchment in 1976 and water-extractable P in soil from the mixed pot treatments	153

FIGURE 5.1	Regression between water-extractable P values obtained in two sequential water extractions (each of 1 hour duration at a soil:solution ratio of 1:40) (B) and in one water extraction (17 hours duration and at a soil:solution ratio of 1:400) (A)	172
5.2	Decline in water-extractable P (two 1-hour extractions at a soil:solution ratio of 1:40) with time from soil incubated in pots following fertilizer P addition	173
5.3	Relative water extractability of P, expressed as a proportion of the initial extraction value, with time following P addition at three rates	174
5.4	Decline in water-extractable P in catchment field soils and in incubation pots of the same soil following fertilizer P addition	177
5.5	Decline in water-extractable P from Pahiatua and Egmont soils with time following incubation and fertilizer P addition	178
5.6	Decline in water-extractable P from Pahiatua soil with time following incubation and fertilizer P addition	180
5.7	Decline in water-extractable P with time following fertilizer P addition and incubation of Egmont soil	181
5.8	Decline in recovery of P from Pahiatua soil with time following superphosphate addition and incubation	183
5.9	Regression between plant uptake of P from Pahiatua soil following superphosphate addition and incubation, and amounts of extractable P	184
5.10	Decline in recovery of P from Egmont soil with time following superphosphate addition and incubation	185
5.11	Regression between plant uptake of P from Egmont soil samples following superphosphate addition and incubation, and amounts of extractable P	186

FIGURE 5.12	Regression between plant uptake of P from Pahiatua and Egmont soils following superphosphate addition and incubation, and extractable P	187
5.13	Decline in recovery of P from Pahiatua soil with time following rock phosphate addition and incubation	189
5.14	Decline in recovery of P from Egmont soil with time following rock phosphate addition and incubation	190
5.15	Decline in water-extractable P from Pahiatua soil with time following fertilizer P addition at $75 \mu\text{g P g}^{-1}$ in solid and liquid forms	193
5.16	Decline in water-extractable P from Pahiatua soil following fertilizer P addition and incubation	194
5.17	Decline in water-extractable P with time from Pahiatua soil following fertilizer P addition and incubation at three rates of addition	195
5.18	Decline in water-extractable P with time from Dannevirke soil following fertilizer P addition and incubation at two rates of addition	196
5.19	Decline in water-extractable P with time from Egmont soil following fertilizer P addition and incubation	197
5.20	Decline in relative water extractability of P, expressed as a proportion of the extraction value obtained after 40 hours, with time following fertilizer P addition and incubation	199
5.21	Schematic representation of the proposed reaction mechanisms involved in P sorption and desorption	205
5.22	Predicted (---) and measured (—) decline in the amounts of water-extractable P in Pahiatua (a), Dannevirke (b), and Egmont (c) soils with time after fertilizer P addition	206

FIGURE 5.23	Predicted (---) and measured (—) decline in the amounts of water-extractable P in Pahiatua soil with time after fertilizer P addition at rates of $150 \mu\text{g P g}^{-1}$ (a) and $75 \mu\text{g P g}^{-1}$ (b)	208
5.24	Predicted (---) and measured (—) decline in the amounts of water-extractable P in Dannevirke soil with time after fertilizer P addition at rates of $150 \mu\text{g P g}^{-1}$ (a) and $75 \mu\text{g P g}^{-1}$ (b)	209
5.25	Predicted (---) and actual (—) decline in the amounts of water-extractable P in Egmont soil with time after fertilizer P addition at rates of $150 \mu\text{g P g}^{-1}$ (a) and $75 \mu\text{g P g}^{-1}$ (b)	210

LIST OF TABLES

	Page
TABLE 3.1 Flow from the 22-ha and 6-ha catchments for the years 1974, 1975, and 1976, showing total annual outputs of four forms of flow	72
3.2 Discharge of water, sediment, particulate P (PP), and total P (TP), from the two catchments in annual stream flow before land clearing (1974) and following clearing and fertilizer application (1975 and 1976) . .	77
3.3 Discharge of water, sediment, particulate P (PP) and total P (TP) from the two catchments in annual stream flow within storm events before land clearing (1974) and following clearing and fertilizer application (1975 and 1976)	80
3.4 Discharge of water, sediment, particulate P (PP) and total P (TP) from the two catchments in annual storm flow before land clearing (1974) and following clearing and fertilizer application (1975 and 1976) . .	82
3.5 Discharge of water, sediment, particulate P (PP), and total P (TP) from the two catchments in annual subsurface flow before land clearing (1974), and following clearing and fertilizer application (1975 and 1976)	84
3.6 Discharge of water, dissolved inorganic P (DIP), dissolved organic P (DOP), and total P (TP) from the two catchments in annual stream flow before land clearing (1974) and following clearing and fertilizer application (1975 and 1976)	90
3.7 Discharge of water, dissolved inorganic P (DIP), dissolved organic P (DOP), and total P (TP) from the two catchments in annual stream flow within storm events before land clearing (1974) and following clearing and fertilizer application (1975 and 1976) . .	92
3.8 Discharge of water, dissolved inorganic P (DIP), dissolved organic P (DOP), and total P (TP) from the two catchments in annual storm flow before land clearing (1974) and following clearing and fertilizer application (1975 and 1976)	94
3.9 Discharge of water, dissolved inorganic P (DIP), dissolved organic P (DOP), and total P (TP) from the two catchments in annual subsurface flow before land clearing (1974) and following clearing and fertilizer application (1975 and 1976)	96

TABLE 3.10	Mean concentrations of particulate P (PP) and sediment, and amounts of PP associated with sediment in annual storm flow from the 22-ha and 6-ha catchments in 1974 (before clearing) and in 1975 and 1976 (following clearing and fertilizer application)	102
3.11	Losses of P forms and sediment from fertilized (6-ha) and unfertilized (22-ha) catchments in 1976 showing losses per hectare, proportions of P forms lost, and mean concentrations in annual storm discharge	103
4.1	Application rate of fertilizer P at the soil surface obtained from sampling containers surrounding six potential soil-sampling sites in the preliminary investigation of 1975	121
4.2	Amounts of water-extractable P in soils from sites A, C and F (Fig. 4.1) and control sites on 24/3/1975 (before fertilizer application) and at various times after fertilizer was applied on 5/4/1975	123
4.3	Regression analyses between amounts of water-extractable P in soils and mean DIP concentrations in the surface runoff component of stream flow for the two catchments during the two years of study	151
5.1	Background data for three soils used in laboratory studies	163
5.2	Correlation coefficients between plant uptake of P after 50 days growth in Pahiatua and Egmont soils fertilized with superphosphate and rock phosphate, and amounts of water-extractable P and Olsen-extractable P	191
5.3	Amounts of total "native" P, determined using ^{32}P , and the amounts of P present in each region, calculated from solution P concentrations at equilibrium with no P addition and the Langmuir equation for each region	200
5.4	Sorption constants describing the three (I, II, and III) regions of P sorption for three soils; K and b are the equilibrium constant of reaction and the sorption maximum, respectively, for a particular region	201