

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.

LABORATORY STUDY ON THE
FATE AND REACTIVITY OF PHOSPHATE
ADDED TO YELLOW BROWN PUMICE SOILS.

Thesis

presented at Massey University of
Manawatu in part fulfilment of the
requirements for the Degree of Master
of Agricultural Science.

LIBRARY
MASSEY UNIVERSITY OF MANAWATU
PALMERSTON NORTH, N.Z.

By

Hong-hee Chuah.

- 1965 -

37183

1965

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION	1
II. REVIEW OF LITERATURE	3
The mechanism of phosphate retention	3
The fractionation of soil phosphorus	10
The isotopic exchange kinetic methods	15
III. MATERIALS	21
IV. METHODS	24
1. Preparation of soil samples	24
2. Colorimetric determination of phosphate	24
3. Fractionation procedures to determine iron-, aluminium-, calcium-, and organically-bound phosphate	24
4. Phosphate extraction procedure using anion exchange resin	28
5. Procedure for laboratory addition of phosphate	28
6. Isotopic exchange kinetic procedure for exchangeable soil phosphate	29
7. Assessment of microbial population	40
V. RESULTS AND DISCUSSION	43
1. Forms of phosphate in the untreated soils	43
2. The fate of the added phosphate	44
3. Truog's reagent extractable phosphate and anion exchange resin extractable phosphate	52
4. Radio-isotope exchange kinetics on Tirau silt loam (Topsoil)	53
VI. CONCLUSION	66
VII. SUMMARY	67
ACKNOWLEDGEMENTS	
REFERENCE	
APPENDICES	

LIST OF TABLES.

<u>TABLE</u>	<u>PAGE</u>
1. Description of soil	22
2. Soil chemistry	23
3. Forms of phosphate in the untreated soils.....	44
4. Effect of time on the redistribution of added soluble phosphate in Taupo sandy silt	46
5. Effect of time on the redistribution of added soluble phosphate in Ngaroma sandy loam.....	47
6. Effect of time on the redistribution of added soluble phosphate in Kaingaroa loamy sand	48
7. Effect of time on the redistribution of added soluble phosphate in Tirau silt loam.....	49
8. Effect of ether-toluene on microbial population	50
9. Radio-isotope exchange kinetics on Tirau silt loam ...	55

LIST OF PLATES AND FIGURES.

<u>PLATE</u>		<u>PAGE</u>
I	Counting equipment	37A
II	Circulatory apparatus	37B
 <u>FIGURES</u>		
I	Radio-isotope exchange kinetics on Tirau silt loam (no P treatment).....	56
II	Radio-isotope exchange kinetics on Tirau silt loam (P treatment for 6 months).....	57
III	Radio-isotope exchange kinetics on Tirau silt loam (P treatment for 10 months).....	58
IV	Radio-isotope exchange kinetics on Tirau silt loam (P treatment, no ether-toluene added).....	59

I. INTRODUCTION

Volcanic ash blankets almost two-thirds of the North Island (Baumgart 1954). Of the volcanic ash soils, rather more than one third are classified as yellow brown pumice soils (Baumgart 1954) derived from rhyolitic pumiceous ash having clay fractions made up principally of allophane (Fieldes and Taylor 1961). This mineral shows a considerable capacity for fixing phosphate (Jackman 1951). Yellow brown pumice soils present an interesting field of research for the soil scientist, since they are among the most dynamic of soils - their equilibrium with the environment is quite unstable (Baumgart 1954). An attempt is being made in New Zealand to bring the yellow brown pumice soils to a high level of production through both foresting and agriculture. Phosphate topdressing is essential for establishment and maintenance of improved pastures. It appears from the results of Jackman (1955) that a substantial proportion of fertilizer phosphate becomes converted to organic forms and accumulates as such. He has shown also that these soils in the virgin state contain a high proportion of their total phosphorus in the organic form.

Less information is available on the trend of inorganic fixation of phosphate in these soils and the laboratory studies reported herein, were undertaken with a view to elucidating these trends. In particular, in

information was sought on the relative significance of aluminium-, iron- and calcium-binding of phosphate as influenced by time of contact between added phosphate and soil, and on changes in the solubility and exchange-ability of phosphate occurring throughout the time of contact.

To these ends use was made of

- (a) The phosphate fractionation procedures developed by Fife (Fife 1959a,b; 1962; 1963; priv. comm.),
- (b) Truog's procedure for the determination of available phosphate (Truog 1930),
- (c) An anion exchange resin technique (Saunders and Metelerkamp 1962, Cooke and Hislop 1963, Saunders 1964, Fife and Spedding priv. comm.)
- (d) A radio-isotopic exchange procedure (Furkert) 1962, Shao 1963, Spedding priv. comm.).