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INVESTIGATIONS ON GROWTH AND P UPTAKE CHARACTERISTICS OF MAIZE AND SWEET CORN AS INFLUENCED BY SOIL P STATUS

A thesis presented in partial fulfilment of the requirements for the degree of

Doctor of Philosophy (PhD)

(Plant & Soil Science)

Institute of Natural Resources
Massey University
Palmerston North, New Zealand

Tehseen Aslam
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This thesis is dedicated to my family and teachers,
all of them supported a lot and expected from me to fulfil this task one day.
ABSTRACT

Despite being different cultivars of the same plant species (*Zea mays* L.), maize and sweet corn have contrasting P fertiliser recommendations in New Zealand, that are reflected in different target Olsen P values of 10-15 mg P/kg soil for optimum maize growth and 26-35 mg P/kg soil for optimum sweet corn growth. Three key hypotheses were developed in this study to explain why these differences may exist: i) maize and sweet corn differ in their responsiveness to P fertiliser i.e. maize is more internally P efficient and requires less P than sweet corn to grow, ii) both cultivars differ in external P efficiency i.e. their ability to take P up from soil iii) both cultivars differ in external P efficiency because they have different root system structure.

Two field experiments evaluated the growth and yield responses of maize and sweet to different rates of P fertiliser application. The first experiment was conducted in Hawke’s Bay (2001-02) and second in the Manawatu (2002-03) with P application rates of 0, 100 and 200 kg P/ha in the Hawke’s Bay and 0, 15 and 70 kg P/ha in the Manawatu. Both experiments were conducted on soils of low available P status. The Olsen P test values of 13 mg P/kg soil in the Hawke’s Bay and 11 mg P/kg soil in the Manawatu were far below the recommended values for sweet corn (25-35 mg P/kg soil).

In both experiments and across all P treatments maize produced significantly higher dry matter yields than sweet corn during all sampling stages. In the Hawke’s Bay experiment at 100 days after sowing (DAS), the maize (87719 plants/ha, 20.9 t/ha) produced 43% more dry matter than sweet corn (71124 plants/ha, 14.6 t/ha), whereas, in the Manawatu experiment (140 DAS), maize (71124 plants/ha, 15.2 t/ha) had a 39% higher dry matter yield than sweet corn (71124 plants/ha, 10.9 t/ha). In both the field experiments, the sweet corn fresh cob yield of 27 and 28 t/ha in the Hawke’s Bay and the Manawatu regions and maize grain yields of 16 and 10 t/ha, respectively, were within the range of the reported commercial yields for each region.

In both experiments, the P fertiliser application raised the soil P status (Olsen P test values) but caused no significant increases in either maize or sweet corn yields (total dry matter, sweet corn fresh cob or maize grain). Commercially viable yields of both
cultivars were able to be achieved without P fertiliser application with Olsen P soil test in the range of 10-15 mg P/kg soil.

Sweet corn reached harvestable maturity at 115 DAS in the Hawke’s Bay and 140 DAS in the Manawatu experiments. By this time maize had produced 4-6 t/ha more total dry matter yield than sweet corn, yet maize and sweet corn had achieved similar total P uptake (32-37 kg P/ha at 100 DAS in the Hawke’s Bay and 18-19 kg P/ha at 140 DAS in the Manawatu). At silking (after 75 DAS in the Hawke’s Bay and approximately 110 DAS in the Manawatu), both cultivar’s total leaf P concentrations (0.21-0.25%) were within the sufficiency range values for maize crops in New Zealand (0.18-0.33 %). Maize, however was more internally P efficient growing more dry matter per unit P taken up, which was more noticeable in the drier season. Fertiliser P application increased P uptake with both cultivars under moist conditions in the Hawke’s Bay experiment (2001-02). However, the dry conditions in the Manawatu (2002-03) limited P uptake as well as restricted dry matter yields with both cultivars. Further, there were no significant differences between maize and sweet corn P uptake efficiency (kg P/kg root) despite significant differences in the root system structure (biomass) for both cultivars at all stages, which lead to different temporal patterns of P uptake.

The lack of maize yield response to fertiliser P in both field experiments is consistent with the New Zealand recommendations for growing a maize grain crop (because soil Olsen P was in the range of 10-15 mg P/kg). However, the lack of sweet corn yield response in both field experiments does not support the New Zealand recommendations for growing sweet corn (which assume optimal Olsen P values are 26-35 mg P/kg).
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Tehseen Aslam
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter/Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td></td>
<td>i</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td></td>
<td>iii</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td></td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td></td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td></td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF PLATES</td>
<td></td>
<td>xvi</td>
</tr>
<tr>
<td>APPENDICES</td>
<td></td>
<td>xvii</td>
</tr>
<tr>
<td>CHAPTER 1</td>
<td>GENERAL INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1.1 Maize and its types</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1.2 Fertiliser P recommendations for maize and sweet corn in New Zealand</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1.3 Aim of the study</td>
<td>4</td>
</tr>
<tr>
<td>CHAPTER 2</td>
<td>LITERATURE REVIEW</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2.1 Introduction</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2.2 Role of P in plant</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2.2.1 Soil P</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>2.3 Methods of assessing nutrient P availability</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>2.3.1 Soil P testing</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>2.3.2 Plant P analysis</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>2.4 Maize and sweet corn growth, development and nutrient requirements</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>2.4.1 Growth and development stages</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>2.4.2 Climatic requirements</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2.4.2.1 Temperature</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2.4.2.2 Water availability</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>2.4.3 Nitrogen (N) and Phosphorus (P)</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>2.4.3.1 N requirements and uptake</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>2.4.3.2 P requirements and uptake</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>2.4.4 Nutrient P use efficiency</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>2.5 Maize and sweet corn fertiliser P response studies</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>2.5.1 Maize P response studies</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>2.5.2 Sweet corn P response studies</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>2.6 Maize and sweet corn root systems and P uptake</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>2.6.1 P uptake and root system characteristics</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>2.6.2 Role of mycorrhiza fungi in P uptake</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>2.6.3 Root growth and development of maize and sweet corn</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>2.6.4 Fertiliser P response studies on maize roots</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>2.7 Techniques for measuring root systems</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>2.7.1 Profile wall technique</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>2.7.2 Soil coring technique</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>2.7.3 Need for technique development</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>2.8 Conclusions</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>2.9 Study hypotheses</td>
<td>45</td>
</tr>
</tbody>
</table>
# CHAPTER 3 MAIZE AND SWEET CORN GROWTH AND YIELD RESPONSES TO FERTILISER P IN THE HAWKE’S AND MANAWATU

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Introduction</td>
<td>46</td>
</tr>
<tr>
<td>3.2</td>
<td>Materials and Methods</td>
<td>47</td>
</tr>
<tr>
<td>3.2.1</td>
<td>Site descriptions of two field experiments</td>
<td>47</td>
</tr>
<tr>
<td>3.2.2</td>
<td>Experimental design and treatments</td>
<td>50</td>
</tr>
<tr>
<td>3.2.3</td>
<td>Field operations (Land preparation, fertiliser, planting &amp; thinning)</td>
<td>50</td>
</tr>
<tr>
<td>3.2.4</td>
<td>Weather observations</td>
<td>53</td>
</tr>
<tr>
<td>3.2.5</td>
<td>Soil sampling and analyses</td>
<td>53</td>
</tr>
<tr>
<td>3.2.5.1</td>
<td>Soil texture and soil dry bulk density</td>
<td>53</td>
</tr>
<tr>
<td>3.2.5.2</td>
<td>Soil water content</td>
<td>54</td>
</tr>
<tr>
<td>3.2.5.3</td>
<td>Soil chemical analysis (pre-plant and during crop growth)</td>
<td>54</td>
</tr>
<tr>
<td>3.2.5.4</td>
<td>Determination of sodium bicarbonate extractable phosphate (Olsen P)</td>
<td>55</td>
</tr>
<tr>
<td>3.2.5.5</td>
<td>Determination of nitrate-N and ammonium-N in dry soil</td>
<td>55</td>
</tr>
<tr>
<td>3.2.6</td>
<td>Crop growth measurements</td>
<td>56</td>
</tr>
<tr>
<td>3.2.6.1</td>
<td>Plant dry matter yield</td>
<td>56</td>
</tr>
<tr>
<td>3.2.6.2</td>
<td>Sweet corn fresh cob yield</td>
<td>56</td>
</tr>
<tr>
<td>3.2.6.3</td>
<td>Maize grain yield</td>
<td>57</td>
</tr>
<tr>
<td>3.2.6.4</td>
<td>Root growth measurements</td>
<td>57</td>
</tr>
<tr>
<td>3.2.7</td>
<td>Statistical analyses</td>
<td>57</td>
</tr>
<tr>
<td>3.3</td>
<td>Results</td>
<td>58</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Hawke’s Bay field experiment season 2001-02</td>
<td>58</td>
</tr>
<tr>
<td>3.3.1.1</td>
<td>Growing degree days and climatic conditions</td>
<td>58</td>
</tr>
<tr>
<td>3.3.1.2</td>
<td>Soil texture and dry bulk density</td>
<td>59</td>
</tr>
<tr>
<td>3.3.1.3</td>
<td>Soil water content</td>
<td>60</td>
</tr>
<tr>
<td>3.3.1.4</td>
<td>Soil Olsen P depth distribution and status</td>
<td>62</td>
</tr>
<tr>
<td>3.3.1.5</td>
<td>Maize and sweet corn dry matter yields</td>
<td>64</td>
</tr>
<tr>
<td>3.3.1.6</td>
<td>Sweet corn fresh cob yield</td>
<td>66</td>
</tr>
<tr>
<td>3.3.1.7</td>
<td>Maize grain and dry matter yields and harvest index</td>
<td>66</td>
</tr>
<tr>
<td>3.3.1.8</td>
<td>Application of “Maize and Sweet corn Calculators”</td>
<td>66</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Manawatu field experiment season 2002-03</td>
<td>68</td>
</tr>
<tr>
<td>3.3.2.1</td>
<td>Growing degree days and climatic conditions</td>
<td>68</td>
</tr>
<tr>
<td>3.3.2.2</td>
<td>Soil water content</td>
<td>70</td>
</tr>
<tr>
<td>3.3.2.3</td>
<td>Soil Olsen P depth distribution and status</td>
<td>72</td>
</tr>
<tr>
<td>3.3.2.4</td>
<td>Soil mineral N content</td>
<td>74</td>
</tr>
<tr>
<td>3.3.2.5</td>
<td>Maize and sweet corn dry matter yields</td>
<td>76</td>
</tr>
<tr>
<td>3.3.2.6</td>
<td>Sweet corn fresh cob yield</td>
<td>80</td>
</tr>
<tr>
<td>3.3.2.7</td>
<td>Maize grain and dry matter yields and harvest index</td>
<td>80</td>
</tr>
<tr>
<td>3.3.2.8</td>
<td>Maize and sweet corn height</td>
<td>80</td>
</tr>
<tr>
<td>3.3.2.9</td>
<td>Application of “Maize and Sweet corn Calculators”</td>
<td>82</td>
</tr>
<tr>
<td>3.4</td>
<td>Discussion</td>
<td>83</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Cultivars differences in total dry matter yield</td>
<td>83</td>
</tr>
<tr>
<td>3.4.2</td>
<td>Dry matter yield response to soil and fertiliser P</td>
<td>83</td>
</tr>
<tr>
<td>3.4.3</td>
<td>Sweet corn fresh cob yield and response to P fertiliser</td>
<td>85</td>
</tr>
<tr>
<td>3.4.4</td>
<td>Maize grain yield and response to P fertiliser</td>
<td>85</td>
</tr>
</tbody>
</table>
3.4.5 Soil P status response to fertiliser P application and crop growth ............................................. 86
3.4.6 Other yield limiting factors for/during crop growth ................................................................. 88
  3.4.6.1 Adequate solar radiation ........................................................................................................ 89
  3.4.6.2 Adequate soil water content .................................................................................................. 92
  3.4.6.3 Adequate soil physical conditions .......................................................................................... 93
  3.4.6.4 Adequate soil N status/requirement ...................................................................................... 94
  3.4.6.5 Adequate availability of other nutrients ................................................................................ 95
3.5 Conclusions .................................................................................................................................. 96

CHAPTER 4
P UPTAKE AND P USE EFFICIENCY OF MAIZE AND SWEET CORN IN THE HAWKE’S BAY AND MANAWATU FIELD EXPERIMENTS .............................................................. 97
  4.1 Introduction ................................................................................................................................ 97
  4.2 Materials and Methods ................................................................................................................ 98
    4.2.1 Plant tissue phosphorus (P) and nitrogen (N) content .......................................................... 98
    4.2.2 Phosphorus use efficiency ....................................................................................................... 99
    4.2.3 Statistical analyses .................................................................................................................. 99
  4.3 Results .......................................................................................................................................... 100
    4.3.1 Hawke’s Bay field experiment season 2001-02 .................................................................... 100
      4.3.1.1 P uptake at 33, 75 and 100 DAS ...................................................................................... 100
      4.3.1.2 Plant tissue P concentration .............................................................................................. 102
      4.3.1.3 Phosphorus use efficiency at 33, 75 and 100 DAS ............................................................ 103
    4.3.2 Manawatu field experiment season 2002-03 ....................................................................... 104
      4.3.2.1 P uptake at 80, 110 and 140 DAS ................................................................................... 104
      4.3.2.2 Plant tissue P concentration .............................................................................................. 106
      4.3.2.3 Phosphorus use efficiency at 80, 110 and 140 DAS .......................................................... 107
      4.3.2.4 N uptake at 80, 110 and 140 DAS ................................................................................... 108
      4.3.2.5 Plant tissue N concentration .............................................................................................. 110
      4.3.2.6 Nutrient N:P ratios at 80, 110 and 140 DAS ................................................................... 111
  4.4 Discussion ...................................................................................................................................... 112
    4.4.1 P uptake and response to P fertiliser ....................................................................................... 112
    4.4.2 Plant tissue P concentrations ................................................................................................... 116
    4.4.3 N uptake and response to P fertiliser ....................................................................................... 117
    4.4.4 Plant tissue N content ............................................................................................................. 119
    4.4.5 Nutrient N:P ratios .................................................................................................................. 120
    4.4.6 Internal P use efficiency ........................................................................................................... 120
      4.4.6.1 Effect of cultivars ................................................................................................................ 120
      4.4.6.2 Effect of experiment sites ................................................................................................... 122
  4.5 Conclusions ..................................................................................................................................... 124

CHAPTER 5
MAIZE AND SWEET CORN ROOT SYSTEMS IN THE HAWKE’S BAY AND MANAWATU FIELD EXPERIMENTS .................................................................................................................. 125
  5.1 Introduction .................................................................................................................................... 125
  5.2 Materials and Methods ................................................................................................................ 127
    5.2.1 Root sampling techniques and dates ....................................................................................... 127
    5.2.2 Profile wall technique .............................................................................................................. 129
      5.2.2.1 Digging the pits and preparation of profile wall ................................................................. 129
      5.2.2.2 Exposing and counting the roots ....................................................................................... 129
5.2.3 Soil coring technique .................................................. 131
  5.2.3.1 Application of Matthew’s developed root corer ........ 131
  5.2.3.2 Modification and development of root corer ............. 131
  5.2.3.3 Root washing and drying .................................... 134
  5.2.3.4 Root length and root dry weight ............................. 134
5.2.4 Soil penetration resistance measurement .......................... 137
5.2.5 Mycorrhiza infection analysis ..................................... 137
5.2.6 Statistical analyses .................................................. 138

5.3 Results ......................................................................... 139
  5.3.1 Hawke’s Bay field experiment season 2001-02 ................ 139
    5.3.1.1 Root count numbers (by profile wall technique) ......... 139
    5.3.1.2 Root dry weight (by soil coring technique) ............. 142
  5.3.2 Manawatu field experiment season 2002-03 ..................... 143
    5.3.2.1 Root dry weight at 50 DAS (by excavation technique) .. 143
    5.3.2.1 Root dry weights at 80, 110 and 140 DAS (by soil coring technique) ........................................ 143
    5.3.2.3 Root length density at 80, 110 and 140 DAS (by soil coring technique) ........................................ 144
    5.3.2.4 Maize and sweet corn maximum rooting depth ............ 145
    5.3.2.5 Soil penetration resistance .................................. 147
    5.3.2.6 Mycorrhiza infection ........................................... 148

5.4 Discussion .................................................................... 150
  5.4.1 Comparison of root measuring techniques ....................... 150
  5.4.2 Cultivar differences in root biomass and rooting depths .... 154
    5.4.2.1 Root biomass ...................................................... 154
    5.4.2.2 Rooting depth .................................................... 154
    5.4.2.3 Penetration resistance ......................................... 155
  5.4.3 Root system development ............................................. 155
  5.4.4 Root system response to P fertiliser .............................. 159
  5.4.5 Root system P uptake efficiency ................................... 163

5.5 Conclusions ................................................................. 164

CHAPTER 6 INTERACTIONS BETWEEN CROP WATER USE AND
NITROGEN AND PHOSPHORUS UPTAKE BY MAIZE
AND SWEET CORN .................................................................. 165

6.1 Introduction .................................................................... 165
6.2 The central equations ..................................................... 166
6.3 Evaluating the parameters in FAO 56 ................................. 167
  6.3.1 Reference crop evaporation ($E_o$) ................................. 167
  6.3.2 Crop coefficient ($K_c$) ................................................. 167
  6.3.3 Water stress coefficient ($K_s$) ....................................... 168
  6.3.4 Total and readily available water storage capacities ($W_T$ and
        $W_R$) ........................................................................ 168
  6.3.5 Topsoil water balance .................................................. 171
  6.3.6 Model implementation ............................................... 172
6.4 Results and discussion .......................................................... 173
  6.4.1 Predicted and measured plant available water during the growing season ......................................................... 173
  6.4.2 Root zone available water (simulated vs observed) .......... 173
  6.4.3 Topsoil available water (simulated vs observed) .......... 175
  6.4.4 Trend in crop water use and depth of water extraction .... 175
  6.4.5 Trend in plant and root growth ........................................ 176
  6.4.6 Trend in nutrient N and P uptake during growing season .... 177
  6.5 Conclusions ............................................................................ 185

CHAPTER 7 SUMMARY AND SUGGESTIONS FOR FUTURE
ACTIVITY ....................................................................................... 186
  7.1 Summary ................................................................................. 186
  7.2 Suggestions for future activity ................................................ 189
REFERENCES ................................................................................. 191
APPENDICES .................................................................................. 210
LIST OF TABLES

Table 2.1 Approximate amounts of P removed from soil per season by specific crops ................................................................. 9
Table 2.2 MAF soil P test nutrient ranges in New Zealand .................. 10
Table 2.3 Mineral nutrient concentration ranges in healthy plants expressed as percentage or concentration of dry matter .................. 11
Table 2.4 Nutrient concentration (dry matter basis) below which plants are deficient (Ferry’s growth stage, youngest fully expanded leaf). 11
Table 2.5 Maize crop vegetative and reproductive stages .................. 12
Table 2.6 Annual P dressings applied in four treatments of a field experiment and Olsen P test values in the topsoil (0-30 cm) taken in January 1995 and 1997 prior to growing maize ........................................ 27
Table 2.7 Fertiliser P response field studies for sweet corn (overseas & New Zealand) ................................................................. 30
Table 2.8 Laboratory studies on the fertiliser P response of maize root growth ................................................................. 40
Table 2.9 Techniques used in field/laboratory experiments to estimate size of maize root system and reported results ........................... 42
Table 3.1 Soil chemical properties (0-150 mm soil depth) before planting in the Hawke’s Bay experiment (season 2001-02) ............. 48
Table 3.2 Soil chemical properties (0-150 mm soil depth) before planting in the Manawatu experiment (season 2002-03) ..................... 48
Table 3.3 Summary of monthly climatic data obtained from Whakatu station, Hastings ................................................................. 59
Table 3.4 Soil water content (θv) under maize and sweet corn at 67 and 102 DAS taken by TDR method in the Hawke’s Bay field experiment .... 61
Table 3.5 Soil P status under maize and sweet corn during crop growth period at 0-150 mm depth in the Hawke’s Bay field experiment ........ 63
Table 3.6 Soil P status under maize and sweet corn during crop growth period at 150-300 mm depth in the Hawke’s Bay field experiment .... 63
Table 3.7 Maize and sweet corn total plant dry matter yields at 33, 75 and 100 DAS in the Hawke’s Bay during season 2001-02 .................. 64
Table 3.8 Effect of P fertiliser on fresh cob and maize grain yields in the Hawke’s Bay field experiment (season 2001-02) .................. 67
Table 3.9 Climatic data (monthly averaged) for crop growth period for 2002-03 season recorded at AgriResearch Palmerston North at 9.00 AM daily ................. 69
Table 3.10  Soil water content at different depths under maize and sweet corn in the Manawatu field experiment during the 2002-03 season................. 71
Table 3.11  Soil P status under maize and sweet corn during crop growth stages at 0-150, 150-300 and 300-400 cm depth in the Manawatu experiment.......................................................... 73
Table 3.12  Soil nitrate-N contents under maize and sweet corn during crop growth stages at 0-150, 150-300 and 300-400 mm depth in the Manawatu experiment.......................................................... 75
Table 3.13  Maize and sweet corn plant and root characteristics at 50 DAS in the Manawatu experiment.......................................................... 76
Table 3.14  Maize and sweet corn total plant dry matter yields at 80, 110 and 140 DAS during 2002-03 season in the Manawatu experiment......................... 77
Table 3.15  Effect of P fertiliser on sweet corn fresh cob and maize grain yields in the Manawatu experiment (season 2002-03)................................. 81
Table 3.16  Effect of P fertiliser on plant height at different crop growth stages in the Manawatu experiment (season 2002-03)................................. 81
Table 3.17  Maize and sweet corn crop parameters comparison between regions........................................................................................................................ 91
Table 4.1  Total P uptake by maize and sweet corn at 33, 75 and 100 DAS in the Hawke’s Bay field experiment during 2001-02 season.............................. 100
Table 4.2  Maize and sweet corn plant P concentration in the Hawke’s Bay experiment............................................................................................................. 102
Table 4.3  Maize and sweet corn internal P use efficiency (E_{PI}) at 33, 75 and 100 DAS during 2001-02 season in the Hawke’s Bay experiment.................. 103
Table 4.4  Total P uptake by maize and sweet corn at 80, 110 and 140 DAS in the Manawatu experiment during the season 2002-03.......................... 104
Table 4.5  Maize and sweet corn plant P concentration during growth in the Manawatu experiment in the season 2002-03........................................... 106
Table 4.6  Maize and sweet corn internal P use efficiency (E_{PI}) at 80, 110 and 140 DAS during the 2002-03 season in the Manawatu experiment............. 107
Table 4.7  Total N uptake by maize and sweet corn at 80, 110 and 140 DAS during the 2002-03 season in the Manawatu experiment............................ 108
Table 4.8  Maize and sweet corn plant N concentration during growth in the Manawatu field experiment (season 2002-03)........................................ 110
Table 4.9  Summary of nutrient ratio (N:P) calculated from maize and sweet corn crop grown in the Manawatu experiment (season 2002-03)................. 111
Table 4.10 The percentage of total P taken up (%) by maize and sweet corn at different growth intervals in the Hawke’s Bay and Manawatu experiments................................................................. 114

Table 4.11 The amount and percentage total N uptake (%) by maize and sweet corn at different growth intervals in the Manawatu experiment............. 119

Table 5.1 Summary of total root count numbers under maize and sweet corn at various crop growth stages during 2001-02 in the Hawke’s Bay........ 139

Table 5.2 Estimated root dry weight for maize and sweet corn in the Hawke’s Bay field experiment at 100 DAS (0-400 mm depth) (2001-02)........ 142

Table 5.3 Maize and sweet corn root dry weight (kg/ha) at 80, 110 and 140 DAS in the Manawatu experiment (season 2002-03).............................. 143

Table 5.4 Maize and sweet corn root length density (cm/cm³) at 80, 110 and 140 DAS in the Manawatu experiment (season 2002-03).................. 144

Table 5.5 Soil penetration resistance (MPa) under maize and sweet corn (control plots) in the Manawatu experiment site (season 2002-03)....... 147

Table 5.6 Laboratory determined soil volumetric water content (m³/m³) at different pressure potentials for soil samples from Manawatu fine sandy loam soil................................................................. 170

Table 6.2 Field measured soil volumetric water content (m³/m³) for dry and wet soil conditions at experimental site (Manawatu fine sandy loam soil)........................................................................ 170

Table 6.3 Plant and root dry matter yield (kg/ha) at 80 and 110 days after sowing in the maize control treatment (Manawatu)............................... 176

Table 6.4 Plant and root dry matter yield (kg/ha) at 80 and 110 days after sowing in the sweet corn control treatment (Manawatu)....................... 177

Table 6.5 Effect of soil water content on effective diffusion coefficient ($D_e$) influencing the rate of P uptake by maize and sweet corn roots........ 185
LIST OF FIGURES

Figure 2.1 Process that govern the availability of soil and fertiliser P to plants .......................................................... 7

Figure 2.2 Possible mechanisms by which mycorrhizal fungi increase the P uptake by plants from soil (Redrawn from Trolove et al., 2003) ......................................................... 36

Figure 3.1 Distribution of growing degree days for maize (hybrid 34E79) and sweet corn (hybrid Challenger) in the Hawke’s Bay experiment during the season 2001-02 ................................................. 58

Figure 3.2 Soil water content distribution in the Hawke’s Bay experiment at 14 DAS ............................................................... 60

Figure 3.3 Olsen P depth distribution in the Hawke’s experiment site (maize and sweet corn control treatments) at 14 DAS ........................................................................................................ 62

Figure 3.4 Maize (hybrid 34E79) plant partitioning dry matter yield (t/ha) at 33, 75 and 100 DAS in the Hawke’s Bay (2001-02 season). Results are presented as means of the 3 P treatments ........................................ 65

Figure 3.5 Sweet corn (hybrid Challenger) plant partitioning dry matter yield (t/ha) at 33, 75 and 100 DAS in the Hawke’s Bay (season 2001-02). Results are presented as means of the 3 P treatments. 65

Figure 3.6 Predicted and measured dry matter yields of maize at 33, 75, 100 and 182 DAS in the Hawke’s Bay experiment (2001-02) ................................................................. 67

Figure 3.7 Distribution of growing degree days for maize (hybrid 36H36) and sweet corn (hybrid Challenger) in the Manawatu experiment during the season 2002-03 ............................................ 69

Figure 3.8 Olsen P depth distribution in the Manawatu experiment (maize and sweet corn control treatments) at 175 DAS ............................................................ 72

Figure 3.9 Soil nitrate-N depth distribution in the Manawatu experiment (maize and sweet corn control treatments) at 140 DAS .............................................................. 75

Figure 3.10 Maize (hybrid 36H36) plant partitioning dry matter yield (t/ha) at 80, 110 and 140 DAS in the Manawatu experiment. Results are presented as means of the 3 P treatments ........................................................................ 78

Figure 3.11 Sweet corn (hybrid Challenger) plant partitioning dry matter yield (t/ha) at 80, 110 and 140 DAS in the Manawatu experiment. Results are presented as means of the 3 P treatments ........................................................................ 78

Figure 3.12 Effect of P fertiliser rate on maize (hybrid 36H36) plant dry matter yield (t/ha) at 80, 110 and 140 DAS during 2002-03 season in the Manawatu experiment ....................................................... 79
Figure 3.13  Effect of P fertiliser rate on sweet corn (hybrid Challenger) plant dry matter yield (t/ha) at 80, 110 and 140 DAS during 2002-03 season in the Manawatu experiment.......................... 79

Figure 3.14  Predicted and measured dry matter yields of maize at 50, 80, 110, 140 and 200 DAS in the Manawatu experiment during 2002-03 season.......................................................... 82

Figure 3.15  Regression analysis for GDD (8°C) and total dry matter yield (mean P treatments) for sweet corn in the Hawke’s Bay and Manawatu. .................................................. 91

Figure 4.1  Maize P uptake and partitioning (kgP/ha) at 33, 75 & 100 DAS during 2001-02 season in the Hawke’s Bay experiment. Results are the mean of 3 P treatments. Detailed data with statistical analyses are in Appendix 4.1a,b,c........................................... 101

Figure 4.2  Sweet corn P uptake and partitioning (kgP/ha) at 33, 75 &100 DAS during 2001-02 season in the Hawke’s Bay experiment. Results are presented as the mean of 3 P treatments. Detailed data with statistical analyses are in Appendix 4.1a,b,c................. 101

Figure 4.3  Maize P uptake and partitioning (kgP/ha) at 80, 110 & 140 DAS during 2002-03 season in the Manawatu experiment. Results are presented as the mean of 3 P treatments (Detailed data with statistical analyses are in Appendix 4.2a,b,c).......................... 105

Figure 4.4  Sweet corn P uptake and partitioning (kgP/ha) at 80, 110 & 140 DAS during 2002-03 season in the Manawatu experiment. Results are presented as the mean of 3 P treatments (Detailed data with statistical analyses are in Appendix 4.2a,b,c).......................... 105

Figure 4.5  Maize N uptake and partitioning (kgN/ha) at 80, 110 and 140 DAS during 2002-03 season in the Manawatu experiment. Results are presented as the mean of 3 P treatments. Detailed data with statistical analyses are in Appendix 4.3a,b,c .................................................. 109

Figure 4.6  Sweet corn N uptake and partitioning (kgN/ha) at 80, 110 and 140 DAS during 2002-03 season in the Manawatu experiment. Results are presented as the mean of 3 P treatments. Detailed data with statistical analyses are in Appendix 4.3a,b,c .................................................. 109

Figure 4.7  The relationship between total plant P uptake (mean P 3 treatments) and accumulated thermal time for both cultivars in the Hawke’s Bay and Manawatu experiments; Sigmoid curve fits for sweet corn P uptake. Hawke’s Bay  Y=35 (1+1861e ^0.0111t ) & Manawatu Y=20 (1+138e ^0.0077t ). ................................. 115

Figure 4.8  The relationship between E_P values (mean 3 P treatments) and accumulated thermal time for maize and sweet corn in the Hawke’s Bay and Manawatu experiments; power fits.......................................................... 121
Figure 4.9 The relationship between total dry matter yield (mean P 3 treatments) and accumulated thermal time for both cultivars in the Hawke’s Bay and Manawatu experiments; Sigmoid curve fits for sweet corn growth. Hawke’s Bay Y=16 (1+6849e 0.01277t) & Manawatu Y=12 (1+416e 0.00949t)

Figure 5.1 The 12 root sampling positions (s) in 3 soil cores (L0, L1, L2) below plants and adjacent to maize and sweet corn plants

Figure 5.2 Root distribution for maize (control treatment) at 37, 67 and 100 DAS during the 2001-02 season at Hawke’s Bay (by profile wall technique)

Figure 5.3 Root distribution for sweet corn (control treatment) at 37, 67 and 100 DAS during the 2001-02 season at Hawke’s Bay (by profile wall technique)

Figure 5.4 Hand drawn maize and sweet corn mature root system under Manawatu fine sandy loam soil at 150 DAS

Figure 5.5 Soil profile showing range of soil strength with root numbers under maize in the Manawatu experiment. Circles represent relative root count numbers measured around single plant

Figure 5.6 Maize and sweet corn total root count numbers at 0-500 mm depth at 37, 67 and 100 DAS in the Hawke’s Bay experiment. Results are presented as mean of the 3 P treatments

Figure 5.7 Relationship between shoot and root biomass at 37, 67 and 100 DAS in the Hawke’s Bay experiment. Results are presented as mean of 3 P treatments

Figure 5.8 Maize and sweet corn total root dry weight (kg/ha) at 80, 110 and 140 DAS (0-400 mm depths) in the Manawatu experiment. Results are presented as mean of the 3 P treatments

Figure 5.9 Root: shoot ratios at 80, 110 and 140 days in the Manawatu experiment. Results are presented as mean of the 3 P treatments

Figure 5.10 Conceptual diagram showing P deficiency effects on the maize plant and subsequent effects on root growth

Figure 5.11 Root system P uptake efficiency ratios during crop growth in Manawatu. Results are presented the means of 3 P treatments

Figure 6.1 FAO-56 soil water balance predicted and measured available water at 0-150 and 0-1200 mm soil depths under maize during season 2002-03

Figure 6.2 FAO-56 soil water balance predicted and measured available water at 0-150 and 0-1000 mm soil depths under sweet corn during season 2002-03
Figure 6.3  Amount of KCL-extractable soil nitrate-N in 0-150, 150-300 and 300-400 mm soil depths at 80 and 140 DAS under maize during 2002-03 season .................................................. 178

Figure 6.4  Amount of KCL-extractable soil nitrate-N in 0-150, 150-300 and 300-400 mm soil depths at 80 and 140 DAS under sweet corn during 2002-03 season .................................................. 179

Figure 6.5  Amount of NaHCO₃ extractable phosphate in 0-150, 150-300 and 300-400 mm soil depths at 80 and 140 DAS under maize during 2002-03 season .................................................. 179

Figure 6.6  Amount of NaHCO₃ extractable phosphate in 0-150, 150-300 and 300-400 mm soil depths at 80 and 140 DAS under sweet corn during 2002-03 season .................................................. 180

Figure 6.7  The changes in extractable soil nitrate-N (0-400 mm) and N uptake by maize and sweet corn between 80 and 140 DAS during 2002-03 season .................................................. 180

Figure 6.8  Contribution of soil depths (0-150, 150-300 and 300-400 mm) to total soil nitrate-N depletion by maize and sweet corn between 80 and 140 DAS during 2002-03 season in the Manawatu .................................................. 181

Figure 6.9  Contribution of soil depths (0-150, 150-300 and 300-400 mm) to total Olsen P depletion by maize and sweet corn between 80 and 140 DAS during 2002-03 season in the Manawatu .................................................. 181
LIST OF PLATES

Plate 2.1  Sweet corn emergence to vegetative stages in the Manawatu experiment during 2002-03. The crop was planted on 22 October, 2002. VE stage at 25 DAS (a) V1-V5 stage at 40 DAS (b) and V6-V9 stage at 74 DAS (c) ....................................................... 13

Plate 2.2  Sweet corn reproductive stages in the Manawatu experiment during 2002-03. R1/R2 stage at 100 DAS (a) and R6 stage at 140 DAS (b) .................................................................................... 14

Plate 2.3  Maize and sweet corn root system in the Manawatu experiment at 50 DAS during season 2002-03 in New Zealand (by excavation technique) .......................................................... 37

Plate 3.1  A profile of Manawatu fine sandy loam soil ............................................... 49

Plate 3.2  P fertiliser broadcasting and band placement in field .................................. 52

Plate 5.1  Soil sample locations for roots under maize plant at 80 DAS in Manawatu .......................................................... 128

Plate 5.2  Cores pushed onto the flat tray to divide into 4 soil depths in Hawke’s Bay .......................................................... 128

Plate 5.3  Maize roots exposed in 70 x 50 cm pit in field at 37 DAS in Hawke’s Bay ......................... 130

Plate 5.4  Root counting by profile wall technique in field at 37 DAS in Hawke’s Bay ......................... 130

Plate 5.5  Matthew’s root corer driven by driving hammer in Hawke’s Bay field ............................. 132

Plate 5.6  Soil root corers developed at Massey (Aslam’s root corers) and used for root sampling in Manawatu; a) for dry soil condition & b) for soft soil condition ............................................. 133

Plate 5.7  Roots washing by hydro-pneumatic elutriation system at Massey University .... 135

Plate 5.8  Root washing by filling a sink tank water at PTC Massey University .......... 135

Plate 5.9  Digital cone penetrometer measuring soil strength at 200 DAS (Manawatu) 137

Plate 5.10  Maize root infected by VAM, containing mycorrhizal vesicles. Mag.350x 149

Plate 5.11  Sweet corn root infected by VAM, containing mycorrhizal vesicles. Mag.350x 149

Plate 5.12  Maize and sweet corn root systems at V6-V7 stage showing lack of response to fertiliser P in the Manawatu experiment during season 2002-03 ....................................................... 160
### APPENDICES

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Soil texture classifications of Hawke’s Bay experiment site at 14 DAS.</td>
<td>210</td>
</tr>
<tr>
<td>3.2a</td>
<td>Soil bulk density and porosity in the Hawke’s Bay experiment site at 37 DAS.</td>
<td>210</td>
</tr>
<tr>
<td>3.2b</td>
<td>Soil bulk density and porosity in the Manawatu experiment site at 45 DAS.</td>
<td>210</td>
</tr>
<tr>
<td>3.3a</td>
<td>Maize (hybrid 34E79) and sweet corn (hybrid Challenger) partitioning of dry matter yield (t/ha) at 75 DAS (28.1.2002) in the Hawke’s Bay experiment (2001-02).</td>
<td>211</td>
</tr>
<tr>
<td>3.3b</td>
<td>Maize (hybrid 34E79) and sweet corn (hybrid Challenger) partitioning of dry matter yield (t/ha) at 100 DAS (25.2.2002) in the Hawke’s Bay experiment (2001-02).</td>
<td>211</td>
</tr>
<tr>
<td>3.3c</td>
<td>Maize (hybrid 34H36) and sweet corn (hybrid Challenger) partitioning of dry matter yield (t/ha) at 80 DAS (10.1.2003) in the Manawatu experiment (2002-03).</td>
<td>212</td>
</tr>
<tr>
<td>3.4a</td>
<td>Maize (hybrid 34H36) and sweet corn (hybrid Challenger) partitioning of dry matter yield (t/ha) at 110 DAS (10.2.2003) in the Manawatu experiment (2002-03).</td>
<td>213</td>
</tr>
<tr>
<td>3.4b</td>
<td>Maize (hybrid 34H36) and sweet corn (hybrid Challenger) partitioning of dry matter yield (t/ha) at 140 DAS (12.3.2003) in the Manawatu experiment (2002-03).</td>
<td>213</td>
</tr>
<tr>
<td>3.5a</td>
<td>Raw data for Harvest Index (grain yield/total dry matter) for the Hawke’s Bay experiment.</td>
<td>214</td>
</tr>
<tr>
<td>3.5b</td>
<td>Raw data for Harvest Index (grain yield/total dry matter) for the Manawatu experiment.</td>
<td>214</td>
</tr>
<tr>
<td>4.1a</td>
<td>Maize (hybrid 34E79) and sweet corn (hybrid Challenger) P uptake (kg P/ha) at 33 DAS (17.12.2001) in the Hawke’s Bay experiment (2001-02).</td>
<td>215</td>
</tr>
<tr>
<td>4.1b</td>
<td>Maize (hybrid 34E79) and sweet corn (hybrid Challenger) P uptake (kg P/ha) at 75 DAS (28.1.2002) in the Hawke’s Bay experiment (2001-02).</td>
<td>216</td>
</tr>
<tr>
<td>4.1c</td>
<td>Maize (hybrid 34E79) and sweet corn (hybrid Challenger) P uptake (kg P/ha) at 102 DAS (25.2.2002) in the Hawke’s Bay experiment (2001-02).</td>
<td>216</td>
</tr>
</tbody>
</table>
Appendix 4.2a Maize (hybrid 36H36) and sweet corn (hybrid Challenger) P uptake (kg P/ha) at 80 DAS (12.1.2003) in the Manawatu experiment (2002-03)........................................ 217

Appendix 4.2b Maize (hybrid 36H36) and sweet corn (hybrid Challenger) P uptake (kg P/ha) at 110 DAS (12.2.2003) in the Manawatu experiment (2002-03). ........................................ 218

Appendix 4.2c Maize (hybrid 36H36) and sweet corn (hybrid Challenger) P uptake (kg P/ha) at 140 DAS (12.3.2003) in the Manawatu experiment (2002-03). ........................................ 218

Appendix 4.3a Maize (hybrid 36H36) and sweet corn (hybrid Challenger) N uptake (kg N/ha) at 80 DAS (12.1.2003) in the Manawatu experiment (2002-03). ........................................ 219

Appendix 4.3b Maize (hybrid 36H36) and sweet corn (hybrid Challenger) N uptake (kg N/ha) at 110 DAS (12.2.2003) in the Manawatu experiment (2002-03). ........................................ 220

Appendix 4.3c Maize (hybrid 36H36) and sweet corn (hybrid Challenger) N uptake (kg N/ha) at 140 DAS (12.3.2003) in the Manawatu experiment (2002-03). ........................................ 220

Appendix 4.4a Raw data for P and N uptake by maize grain for Hawke’s Bay experiment (182 DAS)........................................ 221

Appendix 4.4b Raw data for P and N concentration (%) uptake by maize grain for the Hawke’s Bay experiment (182 DAS)........... 221

Appendix 4.4c Raw data for P and N uptake by maize grain for the Manawatu experiment (200 DAS). ........................................ 221

Appendix 4.4d Raw data for P and N concentration (%) uptake by maize grain for the Manawatu experiment (200 DAS). ........................................ 221

Appendix 6.1 Application of FAO-56 soil water balance model in the Manawatu experiment........................................ 222