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THE EFFECTS OF DRILL COULTER DESIGNS  
ON SOIL PHYSICAL PROPERTIES AND PLANT  
RESPONSES IN UNTILLED SEEDBEDS.

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by

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TO *my parents*  
in Vietnam

## TABLE OF CONTENTS

### ABSTRACT

<u>CHAPTER</u>		<u>PAGE</u>
1.	GENERAL INTRODUCTION	1
2.	THE INTERACTION OF SOIL AND DRILL COULTER PASSAGE	
2.1	Introduction and review of literature	3
2.1.1	Soil water and compaction	4
2.1.2	Soil air and compaction	6
2.1.3	Soil temperature and compaction	7
2.1.4	Soil bulk density, compaction and pore system	9
2.1.5	Soil strength and compaction	10
2.1.6	Soil stress and compaction	12
2.1.7	Draft	14
2.1.8	Visual assessments of macrostructural changes in soils	16
2.1.8.1	Thin sections	16
2.1.8.2	Scanning electron microscope techniques (S.E.M.)	18
2.1.9	Functional requirements of drill coulters	18
2.2	Experimental methods	23
2.2.1	Soil bin experiments	23
2.2.1.1	Site and soil type selection	23
	1. Field capacity and soil dry bulk density	24
	2. Permanent wilting point	24
	3. Available water capacity	25
	4. Soil porosity	25
2.2.1.2	Soil bin collection procedures - post collection preparation of turf blocks	29
2.2.1.3	Experimental designs	30

2.2.2	Drilling of turf blocks	35
2.2.2.1	Pre drilling	35
2.2.2.2.	Drilling operations	35
2.2.3	Field experiments	36
2.3	Measurements	39
2.3.1	Measurement of soil compaction by soil bulk density	39
2.3.1.1	Core sampling method	39
2.3.1.2	Small core sampler	40
2.3.1.3	Procedures	40
2.3.2.	Mechanical resistance of soil	41
2.3.2.1	Description of the measuring equipment	41
2.3.2.2.	Procedures	45
2.3.3	The instantaneous zone of influence (soil pressures)	48
2.3.3.1	Description of the measuring equipment	48
2.3.3.2.	Procedures	49
2.3.4	The assessment of macrostructural changes by visual methods	53
2.3.4.1	Materials and methods	53
	a. Thin sectioning - impregnating	53
	b. Electron microscopy	57
2.3.5	Draft Measurements	59
2.3.5.1	Description of the measuring apparatus	59
2.3 5.2	Procedures	62
2.3.6	Assessment of the zone of disturbance on the soil surface	62
3.	THE RESPONSE OF PLANTS AND ROOTS TO CHANGES IN SOIL PHYSICAL CONDITIONS WITHIN A SEED BED	66
3.1	Introduction and review	66
3.1.1	The effects of soil bulk density on root growth	69
3.1.2	The effect of mechanical soil strength on root growth	71

3.1.3	The effect of interactions amongst soil moisture, soil compaction, soil strength on root growth	76
3.1.4	The effect of direct drilling on crop yields	77
3.2	Experimental methods used in root studies	78
3.2.1	Laboratory tillage bin experiments	78
3.2.2	Box experiments	81
3.2.3	Field experiments	81
3.3	Seedling emergence	81a
4.	THE INFLUENCE OF SOIL FAUNA IN DIRECT DRILLED SOIL	82
4.1	Review	82
5.	OBJECTIVES AND RESULTS OF INDIVIDUAL EXPERIMENTS	83
5.1	General objectives	83
	a. Laboratory experiments	83
	b. Field experiments	83
5.2	Experiment 1.	85
5.2.1	Objectives	85
5.2.2	Results and discussion	
	a. Bulk density (permanent deformation)	86
	Results	
	Discussion	
	b. Soil strength (permanent deformation)	88
	Results	
	Discussion	
	c. Soil pressure (instantaneous deformation)	94
	Results	
	Discussion	
	d. Draft force	101
	Results	
	Discussion	
	e. Root studies	103
	Results	
	Discussion	
5.2.3	Brief summary of Experiment 1.	107
5.3	Experiment 2.	108
5.3.1	Objectives	108
5.3.2	Results and discussion	108
5.3.4	Macrostructural changes of soil under compression	117
5.3.4.1	Results and discussions	117

a.	Thin sectioning	117
b.	Electron microscopic technique	123
5.3.5	Root responses	130
	Results	
	Discussion	
5.4	Experiment 3.	135
5.4.1	Objectives	135
5.4.2	Results and discussions	136
a.	Bulk density and soil strength	136
	Results	
	Discussion	
b.	Soil surface disturbance	139
	Results	
	Discussion	
c.	Root responses	143
	Results	
	Discussion	
5.4.3	Brief summary	152
5.5	Experiment 4.	154
5.5.1	Objectives	154
	Results	
	Discussion	
5.5.2	Brief summary	162
5.6	Experiment 5. (field experiment)	163
5.6.1	Objectives	163
	Results	
	Discussion	
5.7	Experiment 6. (field experiment)	169
5.7.1	Objectives	169

5.7.1 (continued)	
Results	
Discussion	
a. Root and herbage dry weights	184
b. Seedling emergence	184
c. Earthworms	185
d. Yields	186
6. SUMMARY AND DISCUSSION	187
A. Equipment and measuring technique	187
B. Soil physical changes and plant and root response	192
a. Permanent deformation data	192
Bulk density	
Soil strength	
b. Coulter operational forces	195
c. Instantaneous dissipation of soil stress	197
d. Interactions	200
e. The effects of coulter shapes on root growth	200
7. CONCLUSIONS	206
8. REFERENCES	209

ACKNOWLEDGEMENTS

APPENDICES

## LIST OF FIGURES

		PAGE
1.	Soil moisture content and suction curve of Tokomaru silt loam	28
1a.	The positioning of treatment bins on the testing rig	30e
1b.	The experiment layout	30f
1c.	The randomised block design	30g
2.	Turf block extraction procedure - Part 1.	31
3.	Turf block extraction procedure - Part 2.	32
4.	Turf block extraction procedure - Part 3.	33
5.	The experimental design of 12 bins	34
6.	The chisel coulter assembly	38
7.	The triple disc coulter assembly	38
8.	The multipoint penetrometer	44
9.	The measuring positions of the penetrometer	45
10.	The multipoint penetrometer at work	46
11.	Typical soil strength curves obtained with the multipoint penetrometer apparatus	47
12.	Holding magnets with adjustable clamp	50
13.	The soil pressure sensing tube assembly	50
14.	The positioning of the pressure tube in the turf block	52
15a, b & c.	Equipment used in thin sectioning	54
16.	The side view of draft measuring apparatus	61
17.	Rear view of moving gantry and tool testing apparatus	61
18.	Penetration of coulter assemblies by dead weights	64
19.	The instrumentation for monitoring the zone of influences around coulters	65
20.	The interrelationships of soil physical parameters and root growth under compaction	68
21.	Extraction of samples for root studies with perplex pin boards	79
22.	Soil resistance at eight side of the triple disc and	91

	disc coulter grooves	
23.	Variation of soil resistance at either side of the triple disc and chisel coulters	92
24.	Sidewall pressure detected at 30mm away from the groove	97
25.	Pressures detected at 50mm away from the base of the groove	98
26.	The effects of direct drilling coulter designs on lupin and dry weight (Expt 1.)	104
27.	The effects of direct drilling coulter designs on lupin root length (Expt 1.)	105
28.	The effects of direct drilling coulter designs on wheat root dry weight (Expt 1.)	106
29.	Soil resistance at either side of the triple disc and chisel coulters	112
30.	Variation of soil resistance at either side of the triple disc and chisel coulter	113
31.	Thin section sampling sites	118
32.	Sections of soil in their original condition	118
33.	Soil sections taken at 10mm from the soil/triple disc coulter interface	119
34.	Soil sections taken at 10mm from the soil/chisel coulter interface	119
35.	Soil sections taken at 20mm from the soil/triple disc coulter interface	120
36.	Soil sections taken at 20mm from the soil/chisel coulter interface	120
37.	Soil sections taken at 30mm from the soil/triple disc coulter interface	121
38.	Soil sections taken at 30mm from the soil/chisel coulter interface	121
39.	Subsampling positions for electron microscopic studies	125
40.	Micrograph (x170) of soil in "undisturbed" condition	125

41.	Micrograph of soil/triple disc coulter interface	126
42.	Micrograph of soil/chisel coulter interface	126
43.	Micrograph taken at 10-20mm away from the soil/ triple disc coulter interface	127
44.	Micrograph taken at 10-20mm away from the soil/ chisel coulter interface	127
45.	Micrograph taken at 20-30mm away from the soil/ triple disc coulter interface	128
46.	Micrograph taken at 20-30mm away from the soil/ chisel coulter interface	128
47.	Micrograph taken at the base of the triple disc coulter	129
48.	Micrograph taken at the base of the chisel coulter created groove	129
49.	The effects of direct drilling coulter designs on lupin root dry weight (Expt 2.)	132
50.	The effects of direct drilling coulter designs on lupin root length (Expt 2.)	133
51.	The effects of direct drilling coulter designs on wheat root dry weight	134
52.	The effects of direct drilling coulter designs on soil surface disturbance	140
53.	The triple disc coulter has a greated longitudinal soil/coulter contact	142
54.	The chisel coulter shatters soil abruptly on both sides of the coulter	142
55.	Distorted root growth of a lupin seedling in the triple disc groove	148
56.	A lupin root which has been deflected at the base of a triple disc groove	149
57.	Lupin root cross-section grown in uncompacted soil	150

58.	Cortex portion of lupin root cross-section flattened because of hard soil	151
59.	Poor seedling establishment in the triple disc coultter treatment	153
60.	Better seedling establishment in the chisel coultter treatment	153
61.	The characteristic shaped groove of the triple disc coultter	156
62.	The characteristic subsurface shattering of the chisel coultter	156
63.	Close-up seedling emergence with the smeared V-shaped groove	159
64.	Effects of smearing on seedling performance from various shapes of grooves	159
65.	The interrelationship between soil moisture content, soil bulk density and counter type in direct drilled silt loam	201

## LIST OF TABLES

		PAGE
1.	The mechanical properties of soil	26
2.	Values of probe pressure at which root elongation ceased	75
3.	The sequence of root related measurements	80
4.	The effects of drill coulter designs on soil bulk density at groove base	86
5.	The effects of coulter designs on soil strength around the groove	88
6.	The effects of coulter designs on soil strength on either side of the groove	90
7.	The effects of coulter designs in maximum soil pressure at the base of the drilled groove	94
8.	The effects of coulter designs on maximum soil pressure at the sidewall of the drilled groove	95
9.	Draft forces required by two drill coulter designs in a silt loam at 23% w/w moisture content	101
10.	The effects of drill coulter designs on soil density around the groove (Expt 2.)	109
11.	The effects of drill coulter designs on soil strength	110
12.	The effects of drill coulter designs on soil strength on either side of the groove	111
13.	The effects of drill coulter designs on maximum soil pressure at the base of the drilled groove (Expt 2.)	114
14.	The effects of drill coulter designs on maximum soil pressure at the sidewalls of the groove	114
15.	The effects of drill coulter designs on draft force	116

16.	The effects on soil compaction of multiple runs with vibration rollers	135
17.	The effects of drill coulter designs on bulk density	137
18.	The effects of drill coulter designs on soil strength	138
19.	The effects of drill coulter designs on root properties of lupin seedlings sown in wet and dry soil	146
20.	The effects of drill coulter designs on wheat seedlings at day 4 in wet soil	147
21.	The effects of direct drilling groove formation techniques on seedling emergence	160
22.	The effects of shape, smear, compaction and cover of direct drilled grooves on wheat and lupin plants	161
23.	The effects of soil and drill coulter designs on lupin and wheat root dry weights in field conditions	167
24.	The interaction of soil and coulter on lupin and wheat root dry weight in field conditions	168
25.	The effects of drill coulter designs and soil on root and shoot growth of wheat and lupin crops at 3 weeks (main treatment effects)	171
26.	The interaction of direct drilling coulter designs and soil compaction on root and shoot growth of wheat and lupin crop at 3 weeks (interactions)	172
27.	The effects of drill coulter designs and compaction on root and shoot growth of wheat and lupin crops at 5 weeks (main treatment effects)	173
28.	The effects of direct drilling coulter designs and soil compaction on root and shoot growth of wheat and lupin crops at 5 weeks (interactions)	174
29.	The effects of drill coulter designs and soil compaction on	

	root and shoot growth of wheat and lupin crops at 7 weeks (main treatment effects)	175
30.	The effects of drill coulter designs and soil compaction on root and shoot growth of wheat and lupin crops at 7 weeks (interactions)	176
31.	The effects of drill coulter designs and soil compaction on seedling emergence of wheat and lupin (main treatment effects)	177
32.	The effects of drill coulter designs and soil compaction of wheat and lupin (interactions)	178
33.	The effects of drilling coulter designs and soil compaction on Earthworm population (main treatment effects)	179
34.	The effects of drill coulter designs and soil compaction on Earthworm population (interaction effects)	180
35.	The effects of drill coulter designs and soil compaction on Wheat yield	181
36.	The effects of drill coulter designs and soil compaction on lupin yield (main treatment effects)	182
37.	The effects of drill coulter designs and soil compaction on lupin yield (interactions)	183
38.	Summary of the effects of drill coulter designs on bulk density, porosity and soil strength	19
39.	Summary of forces required for coulter penetration of two direct drilling coulters	19
40.	Summarized effects of direct drilling coulter designs on soil pressure	19

## LIST OF APPENDICES

1.       a.     Results of soil bulk density measurement Expt.1.
- b.     Results of soil bulk density measurement Expt.2.
- c.     Results of soil bulk density measurement Expt.3.
  
2.       Soil strength data.
  
3.       Draft force data.
  
4.       Root dry weight per plant basis.
  
5.       Estimation of evaporation from turf blocks under rain canopies.
  
6.       Calibrations.
  
7.       Determination of root percentage in soil cores.
  
8.       Meteorological data.
  
9.       Brief descriptions of soil bins, testing apparatus and coulter  
          designs.
  
10.      Equipment.
  
11.      Computer listings.

## ABSTRACT

During the process of direct drilling different shaped drill coulters have been observed to create different micro-environments at the seed zone. This study has been to examine possible changes in soil structure and the state of soil compaction around the groove, which in turn might affect root penetration.

Several methods and pieces of equipment were developed to investigate the influence on the soil of two contrasting coulters shapes. These were the commercially-available triple disc coulters and an experimental chisel coulters. To measure soil bulk density in the drilled groove zone, a small core sampler was designed and tested. Soil strength was assessed using a modified multi-point penetrometer which could be inserted vertically into the soil or normal to the groove walls.

The instantaneous and permanent soil pressure zone of influence around the groove, which was created by the passing of the coulters, was monitored using a liquid-filled tube with a terminal diaphragm and a minipressure transducer.

Macroscopic visual assessment of the compaction of soil at the seed level was undertaken using a freezing sampling technique which facilitated thin section subsamples to be studied by photographic techniques. In addition, 3 mm<sup>3</sup> subsamples were taken directly from the grooves for electron microscopy study.

Supplementary measurements included draft force and the coulters-passage-disturbance-zone at the soil surface using a load cell and a displacement transducer respectively.

Wheat and lupin seeds were sown to study the effects of soil changes on root growth of a fibrous and tap root system.

The data suggested that the triple disc coulter tended to compact well-defined zones around the groove while the chisel coulter produced no apparent compaction.

Such soil compaction in a moist silt loam of initial bulk density less than 1.1g/cc did not result in any apparent differences in plant root responses between the two coulter types. In a drier, harder soil however (greater than 1.32g/cc) there appeared to be a clear disadvantage from use of the triple disc coulter in this respect. With lupin, root growth was restricted and deformed from use of the latter coulter, while in the case of wheat, seedling emergence was restricted in comparison with the chisel coulter.

Smearing was found on the groove wall in moist soil with the triple disc coulter but the experiments were not able to show any mechanical restriction to root and plant development arising from the smear.

In the field conditions, in contrast to the laboratory conditions (where seedling performance and root growth were better with the chisel coulter in almost all of the tested conditions except with moist and loose soil where it was equivalent to the triple disc) any localised compaction of soil by the triple disc coulter (particularly at and near the base of the groove) appeared to be compensated by other factors (weather, earthworms etc.) during the plant's full growth cycle.

Compaction and mechanical impedance in isolation did not appear to be solely responsible for the root and plant growth responses.

A physiological study of soil moisture transport process and soil water vapour availability in the seed zone should therefore be the subject of further studies.