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

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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 coulter shapes. These were the commercially-available triple disc coulter and an experimental chisel coulter. 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^3 subsamples were taken directly from the grooves for electron microscopy study.

Supplementary measurements included draft force and the coulter-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.