THE REQUIREMENTS OF DRY FERTILIZER PLACEMENT IN DIRECT DRILLED CROPS BY IMPROVED CHISEL COULTER

A THESIS PRESENTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE
OF

MASTER OF PHILOSOPHY IN
AGRICULTURAL MECHANISATION AT
MASSEY UNIVERSITY, PALMERSTON NORTH

BY

CHOUDRY MUHAMMAD AFZAL
1981

CHAPTER OF CONTENTS

LIST OF TABLES

PAGE

LIST OF FIGURES

ABSTRACT

This study was conducted to evaluate the effects of dry fertiliser placement as a function of design criteria for direct drills.

The study was conducted in three parts.

1. Rectangular turf blocks (140 x 140 x 200 mm) of undisturbed soil were taken from a Tokomaru concretionery silt loam soil, site of permanent pasture. Seed and fertiliser placement was achieved by removing 2.5 mm diameter soil cores at 20% (d.b.) soil moisture content. Ammonium sulphate (21-0-0) was applied at the rate of 60 kg N ha^{-1}. It was either mixed with rape seed (*Brassica napus* L. c. Tower) or separated from the seed by 10 or 20 mm of soil, horizontally or vertically. A control treatment had no fertiliser. Where seed and fertiliser were mixed or separated vertically by a 10 mm soil core, seedling emergence was reduced significantly ($P < 0.01$) compared to control. Where separated horizontally by either 10 or 20 mm of soil, or vertically by 20 mm of soil, emergence counts were similar to no fertiliser placement. Initiation of emergence was significantly ($P < 0.05$) more rapid with 20 mm separation than with only 10 mm or no separation (mixed) of seed and fertiliser. Maximum seedling emergence counts were significantly ($P < 0.05$) delayed when seed and fertiliser were either mixed or horizontally separated by 10 mm or vertically separated by 10 or 20 mm. Horizontal separation of fertilizer by 20 mm from seed produced significantly more height, weight and total yield than the mixed or 10 mm placements, harvested 5 weeks after sowing ($P < 0.05$).

2. An improved chisel coulter was used for drilling rape seed with simultaneous fertiliser placement in cultivated and uncultivated Tokomaru silt loam soil under field conditions. Ammonium sulphate (75kg-N ha^{-1}) was placed along with the seed, horizontally separated by 20mm of soil. Significantly greater plant populations ($P < 0.01$) were obtained with direct drilled plots compared to plots cultivated a week before drilling. This trend was more pronounced at lower soil moistures (19-20% db) at the time of drilling than higher ones (23-37%).

3. Direct drilling of large turf blocks (1.8 m x 660 mm x 200 mm) was carried out in the laboratory using both the improved chisel coulter and the modified version. The blocks were extracted from the same pasture as in 1 above. Horizontal and vertical placements of ammonium sulphate and mono-ammonium phosphate fertilisers at 20mm from the rape seed and at rates of either 30 or 60 kg-N ha^{-1} largely resulted in higher germination and fewer dead seeds compared to mixed seed and fertiliser placements. Placements of fertiliser in wet soil and horizontal placements in dry soil tended to produce higher germination percentages and fewer viable seeds. The interaction of fertiliser x placement indicated that mono-ammonium phosphate (16-9-0) mixed with rape seed was likely to cause more dead seeds than at 20mm placement.

It appears from the results of these 3 experiments that the horizontal separation of fertiliser by 20mm from rape seed was desirable from the point of view of germination, seedling emergence, initiation of emergence, delay in maximum seedling emergence and yield characteristics of plants. With this fertiliser placement arrangement plant populations in uncultivated soil were greater (up to 30%) than in cultivated soil. The improved direct drilling chisel coulter was capable of achieving this fertiliser placement objective without modification.

1 INTRODUCTION

Interest in direct drilling in many parts of the world is growing as farmers and researchers experiment with this newly discovered, but anciently principled concept. The technique offers a number of advantages over conventional tillage practices, especially in the areas of conservation of energy, time, water and soil (Phillips *et al* 1980).

Inorganic fertilisers are an essential input in modern agriculture. In conventional cultivation techniques, the fertilisers can be applied through various implements and at different times of seedbed preparation, sowing or crop establishment. The easily manipulated soil after tillage offers easy machinery penetration and thereby increases flexibility of fertiliser placement. In direct drilling fertiliser application at present is limited to surface broadcasting or mixing of fertiliser with the seed in the soil (if not in the seed hopper) during sowing.

Some surface applied fertilisers are at risk from volatilization or fixation losses and often depend on rain or irrigation water for their downward movement. There may also be preferential movement of water soluble nutrients down cracks and worm channels, thus distributing the nutrients unevenly (Scotter 1978; Kanchanasut *et al* 1978). Mixed fertiliser and seed may risk adverse effects on germination and seedling emergence (Carter 1969; Baker 1979; Olson and Dreier 1956; and Cooke 1960).

Direct drilling, on the other hand, has often resulted in accumulation of nutrients near the soil surface (Triplett and Van Doren 1969; Drew and Saker 1975; and Ketcheson 1980). The technique has given either poorer (Ketcheson 1980; Riley *et al* 1975), similar (Baeumer 1970) or increased (Triplett and Van Doren *loc cit*) yields compared to conventionally cultivated crops in response to applied fertilisers. Uncultivated soils have also been reported to be more resistant to structural damage (Hughes and Baker 1977), and have resulted in increased soil moisture, earthworm population and improved soil temperature regimes (Triplett and Van Doren 1969; Soane *et al* 1974)

Despite evidence of the positive effects of direct drilling on soil physical properties, which might or might not indirectly affect soil fertility, there have been few reported experiments to examine the relationships between different methods of applying fertiliser and seed, and plant responses in direct drilling.

At the same time the recent development of a chisel coulter with the claimed capability of placing seed and fertiliser simultaneously, (but separated by 20mm) in the soil, offered promise of greater flexibility in fertiliser application during direct drilling (Baker *et al* 1979). It was by no means clear though whether or not horizontal placement of seed and fertiliser was superior to vertical placement by the same distance, or indeed mixing of the two together. The experiments reported here were therefore conducted to explore some basic aspects of dry fertiliser placement, mainly in uncultivated soil, under semi-controlled and field conditions. The primary objective of the study was to ascertain the design criteria for simultaneous seed and fertiliser placement equipment in the direct drilling of cereals and brassicas.