THE INFLUENCE OF DIFFERENT CULTIVATION TECHNIQUES ON CHANGES IN SOIL PROPERTIES AND SOIL MESOFAUNA

BY

David K. Malinda B.Agr.Eng. (U.S.S.R)
Grad. Diploma Dry Land Farming International
(Roseworthy - Australia)

Thesis submitted in total fulfilment
of the requirement for the degree of
Master of Agricultural Science

Department of Soil Science
Waite Agricultural Research Institute
The University of Adelaide

September 1982

C O N T E N T S

Page No.

Page No.

Page No.

CHAPTER 4

CHAPTER 5

Page No.

CHAPTER 6

Page No.

CHAPTER 7

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES

S U M M A R Y

A review of the effect of different seedbed preparation techniques on soil physical properties and soil fauna is presented. Field work on the subject was carried out at 3 sites in South Australia; Avon, Tarlee and the Waite Institute.

At Avon, the effect of direct drilling and conventional cultivation on the distribution of soil pores >40 µm was considered to be an appropriate study. Pores >40 µm are considered to drain the soil of excessive water, and the larger pores serve as a habitat for the mesofauna which are 200-600 µm in diameter or about the same diameter as roots of cereal plants. Measurement of pore size distribution was made using an image analysis computer directly on thin sections. Total porosity was calculated from the bulk density of the soil.

The results indicate that conventional cultivation produced more pores in the 0-4 cm soil layer compared with direct drilling, but the pores were unstable. Also, conventional cultivation caused a compacted layer to develop in the 4-8 cm layer (and deeper) with about 50% of the pores >40 µm in diameter. Results from direct drilling, however, indicate a stable continuous porosity throughout the 0-8 cm layer.

Macro-organic matter was extracted from soil by a flotation method using $ZnBr_2$. The results indicate that much of the leaf material remained on the soil surface after direct drilling but not after conventional cultivation. However, the total macro-organic matter content to a depth of 8 cm did not differ between the two treatments.

The effects of different implements were compared at the Waite Institute. As expected the Mouldboard plough buried plant residues whilst other treatments distributed them in and over the soil surface.

Soil which was direct drilled had a higher water content than conventional cultivated soils, especially during drier periods. This may have been influenced by the differences in porosity and distribution of organic matter in the two soils. Determination of the effects of 4 treatments on both water content and soil temperature were made at the Waite Institute. Soils which were disc ploughed and soils treated with herbicide had lower water contents and temperatures than soils tilled with tined implements and a Mouldboard plough.

The effect of direct drilling, conventional cultivation and single runs with different implements on soil structure and macro-organic matter was related to the populations and distribution of soil animals. The deleterious effect of conventional cultivation on soil fauna was probably a result of changed soil structure and macro-organic matter (quality and distribution). The effect was greater than that of direct drilling which included the toxicity of the herbicides used.

Crop rotation may or may not be suitable for the restoration of large populations of soil animals. Permanent and annual pastures were found to favour soil animals, probably due to the availability of plant litter and a favourable micro-environment. A rotation including a fallow period showed the most deleterious effect on both soil animals and macro-organic matter.

The disposal of trash by different methods after harvesting a crop, i.e. rotary hoe (incorporation), burning or retention on the soil surface, was investigated at Tarlee. The results indicate that trash retention favoured soil animals since significantly more animals were found after trash retention than other treatments.

The movement of soil animals in beds of soil aggregates and the ability of mites and Collembola to degrade leaves was also examined. Poduridae (Collembola) were used to investigate movements of animals in aggregates because they move faster than mites. The results indicate that fewer animals found their way through beds of smaller aggregates. Increasing temperatures and the drying of soil aggregates from top to bottom, and the resultant low humidity created in the aggregates, also affected the animal movements.

To test the effect of the soil mesofauna on the degradation of plant materials, leaves from common Lantana were observed in culture tubes, together with selected animals. The leaf area consumed in unit time by Astigmata (mites) and Poduridae (Collembola) was measured: Astigmata were found to consume more than Poduridae.

It is concluded that in the South Australian environment mites and Collembola may be as beneficial to agricultural soils as earthworms and termites.

S T A T E M E N T

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University or College, and this thesis contains no material published previously or written by any other person, except where due reference is made in the text of the thesis.

Any assistance received in preparing this thesis, and all sources used, have been acknowledged.

SEPTEMBER, 1982 DAVID K. MALINDA

ACKNOWLEDGEMENTS

I wish to thank my supervisors Professor J.M. Oades and Dr. B.R. Hutson for their interest, invaluable discussions and guidance throughout this project. Grateful acknowledgement is made to C.S.I.R.O. in particular Dr. A.D. Rovira and his staff for allowing me to carry out my experiments at their research site at Avon. Also, for the same reason, grateful acknowledgement is due to the South Australian Department of Agriculture, in particular Mr. J. Schultz (Tarlee).

I thank Dr. Jarvis of Flinders University, Medical School, for showing me how to operate the Quantimet and allowing me to use other facilities. Also, grateful acknowledgement is due to Mrs. Greenslade and David Lee of the South Australian Museum for their help in identifying some of the species of Collembola and Mites; Dr. J.S. Hewitt for helping me with the mathematical model described in Chapter 6.

I am highly indebted to the F.A.O. for funding my study and stay in Australia and my Government, in particular the Ministry of Agriculture for allowing this study and securing my job.

I would like to acknowledge the following people: Mrs. Brock for time devoted to typing this project; Mr.B.A.Palk for initial preparation of some of the photographs; staff of the Biometry Section, in particular Mr. T. Hancock and Miss P. Phillips for their time spent with me analysing the data; my colleagues for helpful discussions on the project matter.

The patience of my Mother shall never be forgotten for the time she has not seen me.