THE POTENTIAL OF CEREAL-LEGUME MIXTURES AS FORAGE CROPS

by

Sartaj Khan, M.Sc. Hons. (Peshawar, Pakistan)

A thesis submitted to the University of Adelaide
in fulfilment of the requirements for the degree
of Master of Agricultural Science

Department of Plant Science

Waite Agricultural Research Institute

The University of Adelaide

April, 1991

TABLE OF CONTENTS

ABSTRACT

The quantitative and qualitative relationships of cereal and legume species grown as pure and mixed stands were studied in a series of field experiments (Experiments 1, 2, 3, 4 and 5) at the Waite Agricultural Research Institute. The effect of sowing rates, sowing ratios and nitrogen fertilizer, on the plant establishment, dry matter accumulation, herbage crude protein contents at various stages of growth, number of tillers/m^2 of oats, plant height, soil water status, grain yield, grain crude protein contents and the effect of pure cereal and legume or cereal/legume mixed stands on the residual soil mineral nitrogen were assessed.

As the sowing rate of oats, medic and vetch increased the early winter forage production of these species increased during the 1988 growing season. There was however no significant difference in the dry matter yield between high and medium sowing rates towards the end of the season. A similar response in winter forage production of oats plus vetch sown as pure and mixed stands was recorded in 1989.

The total dry matter yield of oats plus vetch sown at various sowing ratios increased as vetch seed in the sowing mixture increased from 25 to 75 percent during the 1988. In contrast the total dry matter yield of oats plus vetch grown as mixed crop increased as the oat content of the sowing mixture increased from 25 to 100 percent in the sowing mixture during the 1989 growing season. The dry matter yield of medic declined 118 days after sowing. The dry matter yield of the mixed oats plus medic stands was greater than the pure stands of oats or medic 118 days after sowing. The total dry matter yield obtained from oats plus vetch or oats plus medic was higher from oats plus vetch mixed stands in the later part of the season compared to that of oats plus medic mixed stands.

The oat cultivar Dolphin produced significantly higher dry matter yield than Coolabah oats. Similarly Namoi vetch produced significantly higher dry matter yield than Popany vetch in the early part of the season. But there was no significant difference

in the dry matter yield within oat cultivars or within vetch species in the later part of the season. Also there was no significant difference in the grain yield of oat cultivars. On the other hand Popany vetch produced significantly higher grain yield than Namoi vetch.

There was no effect of nitrogen fertilizer on the plant establishment when applied at the time of sowing. The use of nitrogen fertilizer increased the mean herbage dry matter yield of oats but it depressed vetch dry matter yield. Also nitrogen fertilizer increased the dry matter yield of weeds in the early part of the season, however as maturity approached there was no significant effect of nitrogen on dry matter yield of weeds. The application of nitrogen fertilizer increased the number of tillers/m^2 of oats, plant height of oats and vetch, also grain yield of oats but it depressed the mean grain yield of vetch. The effect of nitrogen fertilizer on the mean crude protein percentage was significant 48 days after sowing but not at other stages of growth. Application of nitrogen fertilizer resulted in an increase in the mean grain protein of oats and vetch in pure stands. However there was no significant effect of nitrogen fertilizer on the grain crude protein percentage of oats plus vetch in the mixed stands.

The forage protein percentage of vetch was higher than medic which in turn was higher than the cereals (barley, oats and triticale). The protein percentage of oats and vetch decreased with the progressive stages of maturity. The protein percentage of vetch was significantly higher than oats throughout the growing season with one exception that 48 days after sowing the protein percentage of oats was significantly higher than vetch. In the later part of the season the herbage crude protein percentage of oats significantly increased in the mixed stand of oats plus vetch compared to the pure stands of oats. On the other hand the herbage crude protein percentage of vetch decreased in the mixed stands of oats plus vetch compared to the pure stands of vetch. Similarly, the grain crude protein percentage of oats was significantly higher in the mixed stands of oats plus vetch than the pure stands of oats while there was no significant difference in the grain crude protein percentage of vetch between vetch plots sown as pure stands or mixed with oats.

The soil mineral nitrogen concentration was higher on 128 and 197 days after sowing under pure stands of vetch than the pure stands of oats or oats plus vetch mixed stands. Presumably this was a result of the nitrogen fixing capacity of the vetch, whereas the oats in the pure stands and in mixtures would deplete soil nitrogen resources.

STATEMENT

This thesis contains no material which has been submitted previously in full or part to any other University for any degree or diploma and to the best of my knowledge and belief, it contains no material previously published or written by any other person except when due reference is made in the text. I consent to the thesis being made available for photocopying and loan if accepted for the award of the degree.

Sartaj Khan

ACKNOWLEDGEMENTS

The research for this thesis was planned and carried out under the supervision of Mr E.D. Carter, Senior Lecturer in the Department of Plant Science, Waite Agricultural Research Institute, The University of Adelaide. I am deeply grateful to him for his patience, guidance, support and criticisms during the planning of experimental work and the preparation and checking of this thesis.

Special thanks are due to Professor D.R. Marshall and Dr G.K. McDonald for reviewing drafts of parts of this thesis. I gratefully acknowledge the excellent assistance of Lynne Giles with statistical analysis and Mr Berry Felberg for all his help with acquisition of equipment and chemicals. The guidance of Dr F.L Stoddard with methods of nitrogen analysis and computer assistance is acknowledged with thanks.

I would like to thank Steve Challis and Diona Mobsby for their help with field work. Also thanks to Dr. Arun Aryan who kindly provided me with a photograph (Plate 2.1).

Dr G. McDonald, T. Klein and P. Thongbai rendered invaluable assistance in the final preparation of the thesis for printing.

I am most grateful for the surgery and medical treatment I received during hospitalisation in Adelaide during January, 1990.

Finally, I acknowledge the support of the Australian International Development Assistance Bureau which provided me with a scholarship for this work.

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF APPENDICES