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A STUDY OF NITROGEN FIXATION, NITROGEN DISTRIBUTION AND SEED
YIELD OF SELECTED LEGUMES WITH TWO DIFFERENT GROWTH TYPES.

A thesis

Presented in partial fulfilment of the requirements

for the degree of

Doctor of Philosophy

at

Massey University

Palmerston North

New Zealand.

SUWIT LAOHASIRIWONG

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ACKNOWLEDGEMENTS

I am most grateful to Dr A.C.P. Chu my chief supervisor for his sincere and invaluable guidance throughout this study. I would also like to thank my co-supervisors Dr N.J. Withers of the Agronomy Department, Massey University and Mr I.J. Warrington of the Plant Physiology Division (PPD), Department of Scientific and Industrial Research (DSIR) for their helpful advice, discussion and comments.

I sincerely acknowledge the helpful support from Professor B.R. Watkin (former Head, Agronomy Department, Massey University), Dr Terd Charoenwatana and Dr Kavi Chutikul (Khon Kaen University, Thailand).

I would also like to acknowledge the assistance given to me by the following:

- Khon Kaen University, Thailand for giving me this study leave.

- Plant Physiology Division, DSIR, Palmerston North for permission to use the glasshouse and controlled environment rooms and other facilities.

- Mr J.A.D. Anderson of the Crop Research Division, DSIR, Pukekohe for supplying seeds.

- Dr I.L. Gordon of the Agronomy Department, Massey University for his advise in statistical analysis and permission to use some of his excellent computer programmes.

- Dr J. Crush of the Grasslands Division, DSIR, Palmerston North for permission to use gas chromatography and some assistance provided.

- Mr R. Tillman of the Soil Science Department, Massey University for his advice in Kjeldahl nitrogen content determination.

-Mr A.G. Robertson of the Agronomy Department, Massey University for providing *Rhizobium* cultures.

-Dr W.A. Laing of the Plant physiology Division, DSIR, Palmerston North for his advice in ^{14}C analysis.

-Mrs. C. Hedley for her illustrations.

-Mrs. M. Hunt for typing this thesis.

I would also like to thank the following groups of people for their prompt and efficient service.

-The secretaries and the technicians of the Agronomy Department, Massey University.

-The staff of the Massey University Computer Centre.

-The staff of the Massey University library and DSIR library.

-The staff of the Plant Physiology Division, DSIR Climate Laboratory.

Financial assistance from the following are gratefully acknowledged.

-New Zealand Government ODA Scholarship.

-MacMillan Brown Agricultural Research Scholarship.

-John Alexander Hurley Scholarship.

-Farmer Union Scholarship.

Finally, a big thank you to my two great women Suwanna and Supawan for their encouragement and support throughout this study.

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ABSTRACT

Plant growth types of the determinate and indeterminate growth forms are commonly distinguished in many legume species. However, there do not appear to be many studies where direct comparisons have been made of the two growth types in relation to nitrogen fixation and nitrogen distribution. Furthermore, there are disagreements in the literature about the yield advantage of these two growth types.

This study was initiated to identify the influence of different growth types of selected grain legumes on seed yield, nitrogen fixation, and nitrogen distribution. In addition, the emphasis was also put on finding amongst the measured parameters, one that had the greatest influence on the differences observed.

Initially determinate and indeterminate growth types of bean (Phaseolus vulgaris) and soybean (Glycine max), were studied in glasshouse conditions. The indeterminate cultivar of both species had higher leaf area and nodule dry weight, more root growth, accumulated more total dry weight and had higher yield than that of the determinate cultivar. In both species, the indeterminate cultivar accumulated more total plant nitrogen than the determinate cultivar. However, only the indeterminate soybean cultivar showed significantly more nitrogen fixation (Acetylene reduction) than that of the determinate cultivar.

Subsequently the same soybean cultivars ('Matara' =determinate and 'Amsoy' =indeterminate) were studied in controlled

environment conditions. The indeterminate cultivar produced higher vegetative dry-matter and seed yield than that of the determinate cultivar. The higher acetylene reduction activity of the indeterminate cultivar came primarily from a greater nodule mass. About 30-40% of seed nitrogen of both cultivar came from re-distribution from vegetative parts, but the stem of the indeterminate cultivar re-distributed a higher proportion of nitrogen to the seed than that of the determinate cultivar. Among several plant characters measured (viz. the dry-weights of the roots, nodules, stems, leaves, and pods, the leaf area, acetylene reduction activity and the total plant nitrogen) leaf area was identified as the key factor in determining the difference between the two growth types.

In order to determine the relative importance of leaf area as a factor influencing seed yield, nitrogen fixation and nitrogen distribution the leaf area of the indeterminate cultivar 'Amsoy' was manipulated by imposing different levels of partial leaf removal starting at the flowering stage. For one treatment, partial pod removal was also applied to induce a reduced demand of assimilate. Partial defoliation of the indeterminate cultivar reduced markedly the root growth and the number of branches, but nodule growth, acetylene reduction activity and nitrogen distribution was reduced to a lesser extent. Partial pod removal did not change the overall pattern of response. When about 60% of the leaves of the indeterminate cultivar were removed, seed yield was reduced by about 17% and it was still significantly higher than the undefoliated determinate cultivar. There was no significant difference between the rates of nitrogen accumulation in the pods under each treatment. The final seed

nitrogen concentration was not affected by defoliation treatments nor was the partitioning of nitrogen to seed.

It was concluded that there were differences between the two growth types of soybean for seed yield, nitrogen fixation, and nitrogen distribution. Leaf area was the most important parameter in determining these difference. The greater overlapping of vegetative and reproductive growth in the indeterminate cultivar seemed to be advantageous rather than disadvantageous. This longer period of vegetative growth enabled the indeterminate cultivar to produce a bigger source capacity which consequently supported more nitrogen fixation activity and produced higher seed yield.

The possible implications to tropical agriculture were discussed and some future research topics were also suggested.