A STUDY OF PRODUCTION FACTORS AFFECTING SEED VIGOUR IN GARDEN PEAS (*Pisum sativum* L.) AND THE RELATIONSHIPS BETWEEN VIGOUR TESTS AND SEED LOT FIELD AND STORAGE PERFORMANCE

A thesis presented in partial
fulfilment of the requirements for the degree of
DOCTOR OF PHILOSOPHY IN SEED TECHNOLOGY
at Massey University, Palmerston North,
New Zealand

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1992

ABSTRACT

Results of studies on seed vigour of 206 seed lots from six cultivars of garden peas (*Pisum sativum* L.), conducted at Massey University, Palmerston North, New Zealand are reported in this thesis. The relationship between vigour tests and field emergence of garden pea seed lots with varying seed quality characters was evaluated in 1988 for 82 seed lots from six cultivars under unirrigated conditions and under both irrigated and unirrigated conditions in 1989 for 23 seed lots from three cultivars (Section One). Vigour of seeds produced from various plant populations, row spacings, sowing times, methods of harvest and pod positions from field experiments in the 1988-1989 and 1989-1990 cropping seasons was recorded from 96 seed lots for two cultivars (Section Two). The performance of five seed lots of varying seed quality characters stored under eight different conditions formed the basis for a discussion of potential storage, relative storability and prediction of storage life in garden peas (Section Three).

Stressful conditions, i.e. extremely dry or very wet conditions, can limit germination and field emergence in garden peas. The 1988 environment (favourable rainfall and temperature) allowed good field emergence. However, low rainfall in November 1989 (unirrigated sowings) and excessive water following rain at the 30 October and 20 December 1989 (irrigated) sowings, caused reductions in field emergence. The germination test was strongly correlated with field emergence when conditions for sowing were favourable and when low germinating seed lots were included in the analysis. However, when low germinating seed lots (less than 85%) were excluded, the relationship between germination and field emergence was low and unreliable. Differences in field emergence between seed lots were a reflection of differences in vigour which were detected by the conductivity test. The conductivity test was strongly correlated with field emergence of garden pea seed lots under all sowing conditions.

Expected field emergence (EFE) did not differ from the conductivity test for cv. Small Sieve Freezer under stress conditions, but it did not predict field emergence under all sowing conditions and for all cultivars. Multiple linear regression equations derived from the results differed among cultivars and for various sowing conditions, but none resembled the EFE equation currently used commercially. Removing the hollow heart effect from the EFE increased the relationship between EFE and field emergence under

favourable conditions but reduced the relationship under stress conditions. Hollow heart is therefore an important component of seed lot performance under stress sowing conditions. In order to include the effect of hollow heart in the prediction of field emergence, EFE should be used. Further, use of EFE allows the determination of the quantity of seed needed for sowing to achieve a specific population, which the conductivity test result alone cannot provide. The EFE approach should be further evaluated.

Conductivity and controlled deterioration test results illustrated seed vigour differences resulting from various production practices i.e.:

- seeds from a population of 200 plants m^{-2} and a 10 cm row width harvested at 15% seed moisture content (SMC) had lower vigour than less dense plantings. Furthermore, there was a high hollow heart incidence, especially in bottom pod seeds. At lower population densities (50 and 100 plants m^{-2}), the top pod seeds harvested at 15% SMC had higher leachate conductivity than the bottom pod seeds. These effects on seed quality were attributed to high temperature and RH within the crop canopy. The temperature within the crop canopy was 2°C - 5°C higher than the air temperature, especially at the 200 plants m^{-2} population density. The relative humidity within the canopy at the 200 plants m^{-2} population density was 5% - 10% higher than within the canopy at the 50 and 100 plants m^{-2} population densities.
- seeds harvested at 40% SMC were of low vigour when machinery was used in harvesting. Although the seeds had attained physiological maturity, they were prone to damage when harvested at this seed moisture content. Higher vigour seeds were produced when harvesting was done at 25% SMC than at 15% SMC, even when machinery was used.
- seeds from a December sowing were higher in vigour than seeds from a November sowing, which was attributed to a more favourable environment during seed development and maturity. For the later sowing, seeds developed and matured during February / March when the temperature (2°C - 5°C lower than January) and RH (5% - 10% lower than January) were more suitable for seed development.
- seed deterioration in the field was increased by windrowing because during the time seeds were in the swath prior to harvest, they were exposed to high temperature and relative humidity.

Decline in germination and field emergence was faster in low vigour seed lots than high vigour seed lot in all storage conditions. Results from the conductivity and controlled deterioration tests (vigour tests) provided better data for determining potential storability in garden peas than the germination test. The conductivity and 6 day CD tests had the best relationships in most of the controlled storage conditions and were good predictors of germination and field emergence after storage. However, better prediction of storage life was obtained under controlled storage conditions than under ambient storage conditions, probably because of greater uniformity in the germination decline. Further work is required to develop a test for predicting storage life in ambient conditions.

Probit analysis of the decline in germination under the eight different storage conditions produced variable results. Under controlled storage (e.g. 25°C / constant 13% SMC) which produced a high decline in germination, the germination data when transformed into probits followed a curve, rather than the expected straight probit line for all seed lots. This may be attributed to the indeterminate character of peas which causes variable seed quality parameters at harvest, and therefore the production of heterogeneous seed lots. The data suggest that the probit model is not entirely appropriate for the prediction of storage life in garden peas, and more work is required to determine the effect of heterogeneity on storage performance.

ACKNOWLEDGEMENTS

A thesis produced from enormous research identifies a person, but can only be completed through the efforts of many helping hands. My sincerest thanks and gratitude to my chief supervisor, Dr. John G. Hampton of the Seed Technology Centre, Massey University, for his patience and wise supervision throughout the conduct of the experiments and the writing of the manuscript.

Appreciation and thanks are extended to Dr. Peter Coolbear and Dr. Hugo Varela-Alvarez, my co-supervisors. The encouragement and guidance during the conduct of the experiments and patience shown in the improvement of the manuscript by Dr. Peter Coolbear was extremely valuable. The guidance of Dr. Hugo Varela-Alvarez in the analysis of data was vital in the completion of the manuscript.

My sincere thanks are also extended to:
Professor Murray J. Hill, Director of the Seed Technology Centre, Massey University, for his guidance and parental care, especially for my family while we were in New Zealand.

All the staff of the Seed Technology Centre, Massey University, for their valuable help in so many ways which allowed the successful completion of this study.

The students of the Seed Technology Centre for their friendship and help in very many ways, especially Roger, Songvut, Luck, Joe and Nit.

The New Zealand Government, particularly the Ministry of External Relations and Trade in giving financial assistance for me and my family while we enjoyed the beautiful atmosphere of New Zealand.

I also extend my great appreciation to the Philippine Government, specifically the University of Southern Mindanao, for allowing me to study in New Zealand.

Lastly, I thank all my relatives, particularly my wife and children for their great support and sacrifice during the conduct of the experiments and writing of the manuscript. This work is dedicated to them, especially to my late mother.

Finally, I thank the LORD for all HIS blessings during our wonderful stay in this scenic AOTEAROA, NEW ZEALAND.

PREFACE

This thesis is composed of studies concerned with seed vigour in garden peas (*Pisum sativum* L.) an l is presented in three sections. Each section is presented as a complete piece of work, containing an introduction, review of literature, materials and methods, results and discussion.

Section One (Relationships between seed quality and field emergence in garden peas (*Pisum sativum* L.)) presents the vigour problems associated with field emergence. The vigour test methods used in the prediction of field emergence under various sowing environments are discussed.

Factors affecting seed vigour during seed development and maturation are discussed in Section Two (Seed vigour associated with mother plant environment and method of harvest in garden peas (*Pisum sativum* L.)). Particular attention is paid to the environmental factors associated with the mother plant and how they affect vigour of the seeds produced.

Section Three (Laboratory methods for the prediction of storage life in garden peas (*Pisum sativum* L.)) discusses the problems of storage in garden peas, factors affecting seed storage life and the prediction of seed storage life. Results from 24 months storage of garden peas under various storage conditions are presented and discussed.

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