EFFECTS OF SEED VIGOUR ON SEED PRODUCTION AND QUALITY IN ZEA MAYS L. CV. ILLINI GOLD

BY

ISAKA M. MASHAURI

SEED TECHNOLOGY CENTRE
MASSEY UNIVERSITY
NEW ZEALAND

1993

EFFECTS OF SEED VIGOUR ON SEED PRODUCTION AND QUALITY IN ZEA MAYS L. CV. ILLINI GOLD

A thesis presented in partial fulfilment
of the requirements for the

Degree of Master of Agricultural Science

in Seed Technology, at Massey University
Palmerston North
New Zealand

ISAKA M. MASHAURI

1993

ABSTRACT

MASHAURI, I.M (1993). EFFECTS OF SEED VIGOUR ON SEED PRODUCTION AND QUALITY IN *ZEA MAYS* L. CV. ILLINI GOLD

SUPERVISORS: Professor John G. Hampton, Mrs Karen Hill and Mr Allan K. Hardacre

Some of the consequences of seed deterioration can be a reduction in field emergence and stand establishment, retarded plant growth and reduced seed yield. From the available literature it is not clear whether the reported lower seed yields are solely a consequence of lower population density resulting from low vigour seed and hence poor emergence, or are a result of poor individual performance of plants grown from low vigour seed.

Two high vigour seed lots of shrunken-2 super sweet corn (*Zea mays* L.) cv. Illini Gold were artificially aged to obtain differential vigour levels (high and low vigour seed lots). These seed lots were then used to study the effects of seed vigour on field emergence and emergence rate, vegetative and reproductive growth and development, and seed yield and quality. The quality of unaged and aged seed lots was judged by the use of standard germination, health and vigour tests. This last category included seedling growth and evaluation tests, eg seedling growth test; stress tests, eg cold germination, soil cold test, complex stress vigour test (CSVT) and soak germination test; and biochemical tests, eg electroconductivity, respiration and tetrazolium tests.

The two high vigour seed lots differed significantly ($P < 0.05$) in thousand seed weight and mechanical damage levels, but not in their germination and vigour performance. However, both these seed lots were heavily infected by *Fusarium subglutinans*. The internally-borne *Fusarium subglutinans* survived the high temperature employed during the artificial ageing treatment, and was able to cause severe damage in the deteriorated seed lots. Aged seed lots demonstrated a decrease in germination and vigour as illustrated by a slower rate of seedling growth and accumulation of dry weight, an increase in electroconductivity leakage, a decrease in respiratory oxygen uptake and an increase in respiratory quotients. Interestingly, however, the performance of these seed lots in the soil cold test, cold germination test, and low temperature respiration test, did not differ significantly from that of the unaged seed lots, presumably because the activity of the seed-borne *Fusarium subglutinans* was reduced by low temperature (10°C or less). This cultivar

has some cold tolerance and exposing seed lots to low temperature did not cause the extent of physiological disorder expected, possibly because of adaptive protection mechanisms that allowed the seeds to undertake some cellular repair.

Field emergence and emergence rates were poor but did not differ significantly between high and low vigour seed lots over three spring sowings at the same site, probably because the environment exerted little stress, but more probably because the effects of both seed-borne and soil-borne *Fusarium* spp on chemically untreated seeds masked any other seed quality differences. As a consequence, no seed quality test was significantly related to field emergence, with the exception of the CSVT which was significantly ($P < 0.05$) correlated with field emergence for the November sowing. A greater ($P < 0.05$) loss of plants from low vigour seed lots due to post emergence damping-off and seedling blight caused by seed-borne and soil-borne pathogens was recorded in the October and December sowings, with the result that plant population was significantly reduced when compared to that of high vigour lots. While the reason for this increased loss was not explained conclusively, it is possible that seedlings produced from low vigour seeds were less able to withstand the fungal attack. However, in plants which survived there were no differences in heterotrophic plant growth as demonstrated by similarities in leaf, stem and plant dry weight at the 3rd leaf stage for all seed lots within any one sowing date. Significant sowing date effects were recorded, however, during autotrophic growth (5th leaf stage), the performance of high vigour seed lots (measured as leaf, stem and plant dry weight) was significantly ($P < 0.05$) superior to that of low vigour seed lots. However, these differences decreased as the plants grew and were no longer present at the 7th leaf stage, because plants from low vigour seed lots had produced thicker tillers.

From silking on, no significant differences among populations were recorded as grain filling rate and days to maximum grain dry weight did not differ. However, for the two sowings (October and December) when plant population differed significantly, plants grown from the low vigour seed lots significantly ($P < 0.05$) outyielded those grown from high vigour seed lots because the former compensated for lost plants by producing more tillers and hence reproductive parts.

The seed vigour status of the parent did not affect the seed vigour of the progeny as demonstrated by similarities in seed quality, vigour and field performance among seed lots of freshly harvested seeds. However, seed quality differed with sowing date, with seed harvested from the November and December sowings having a significantly ($P < 0.05$) lower quality than that from the October sowing. These results should be treated with caution,

because seed quality from all harvests was poor, due to heavy infection of seeds by *Fusarium* species and also damage incurred during drying. The performance of the original seed lots after storage for 14 months showed that the high vigour seed lots had a significantly ($P < 0.05$) higher germinability, vigour and field performance in comparison with their pre-storage performance because the occurrence and activity of *Fusarium subglutinans* which was rampant in unstored seed lots, decrease considerably following storage. Although seed-borne pathogens also decreased in low vigour seed lots after storage, the deterioration originally induced by the accelerated ageing had increased. For stored seed lots, a significant relationship existed between field emergence and both the standard germination and cold germination tests.

The results from both the laboratory tests and field trials were confounded by *Fusarium subglutinans* and other fungi. This work should be repeated in the absence of particularly seed-borne pathogens before any definite conclusions can be drawn.

ACKNOWLEDGMENTS

My studies and the preparation of this thesis depended on the support of many individuals and organisations. I gratefully thank my Chief Supervisor, Professor John G. Hampton of the Seed Technology Centre, Massey University, for his excellent supervision, understanding, and warm encouragement throughout my study, especially for his enthusiastic help, constructive criticism, endless patience and his concern for my personal welfare throughout. Without him, this work would not have been possible. I owe a great debt to him.

I also wish to express my sincere thanks to Mrs Karen A. Hill and Mr Allan K. Hardacre, my Co-supervisors, for their friendship, help and valuable suggestions.

Appreciation and thanks are also extended to:

Professor Murray J. Hill, Director of the Seed Technology Centre, Massey University, for his guidance, support, parental care, his efforts to obtain scholarship funding and concern for my personal welfare, without all of which this work would have not been possible. I can't thank him enough.

Flavia Kabeere, PhD student, Seed Technology Centre, for her expert help in the seed health testing which played a vital role in completion of this thesis.

Dr Peter Coolbear, Seed Technology Centre, Massey University, for his support, persistent efforts to obtain scholarship funding, discussion on the physiological topics and his searching questions which stimulated my lateral thinking.

All the staff of the Seed Technology Centre, Massey University, for their valuable help in so many ways, particularly Mr Craig McGill and Mr Robert Southward for their excellent technical help.

Drs S. Ganeshanandam and Charles R.O. Lawoko, Statistics Department, Massey University, for many helpful suggestions regarding statistical analysis and computing. Mrs Kathryn Hamilton for her humour and skillful typing of this manuscript, and Mr Graeme Donaldson for his help in the graphics.

Financial support for this research programme was received from the New Zealand Ministry of Foreign Affairs and Trade and the Helen E. Akers Scholarship. Professors Murray J. Hill

and John G. Hampton strongly supported my efforts to obtain extra funding, without which my family's welfare would have been jeopardised. My employer, the General Manager, Tanzania Seed Company Limited (TZ) for granting me leave of absence for the duration of study. Mrs Halima I. Kamote for her encouragement and constant support and care in very many ways.

The students of the Seed Technology Centre, Massey University, for their valuable help, especially Cunibert Mtolera, Bambang Budhianto and Daniel Hampton.

Lastly, a huge vote of thanks is due to my family for support, resilience, sacrifice and understanding.

Finally, I thank the LORD for showering me HIS graces of good health, luck and good predisposition.

Isaka M. Mashauri

TABLE OF CONTENTS

Page

Page

Page

Page

Page

LIST OF TABLES

Page

Page

LIST OF FIGURES

Page

Page

LIST OF PLATES

LIST OF APPENDICES

Page