Storage Root Production in Sweetpotato

(*Ipomoea batatas* (L.) Lam.)

Stephen L. Lewthwaite

2004

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This is to certify that the research carried out in the Doctoral thesis entitled "Storage root production in sweetpotato (*Ipomoea batatas* (L.) Lam.)" in the Institute of Natural Resources at Massey University, New Zealand:

(a) is the original work of the candidate, except as indicated by appropriate attribution in the text and/or in acknowledgements;

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CANDIDATE'S DECLARATION

This is to certify that the research carried out for my Doctoral thesis entitled "Storage root production in sweetpotato (*Ipomoea batatas* (L.) Lam.)" is my own work and that the thesis material has not been used in part or in whole for any other qualifications.

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Storage root production in sweetpotato (*Ipomoea batatas* (L.) Lam.)

A thesis presented in partial fulfilment of the requirements for

the degree of

Doctor of Philosophy in Plant Science

at

Massey University
New Zealand

Stephen L. Lewthwaite

2004

To my wife

Michelle

1966 – 1993

&

our daughter

Holly

Abstract

Sweetpotato (*Ipomoea batatas* (L.) Lam.) is a root crop well established throughout the world's tropical and sub-tropical regions. Despite sweepotato's importance, it has been under-researched relative to many other major crops. The main objective of this thesis is to contribute to a fuller understanding of the genetic and physiological factors underlying the production of sweetpotato storage roots for human consumption.

The sweetpotato genome is diverse and subject to high levels of natural somatic mutation. Applying the AFLP (amplified fragment length polymorphism) technique allowed a direct comparison of inter and intra-cultivar DNA (deoxyribonucleic acid) base sequence variation. Analysis of the variation indicated that although sweetpotatoes are clonally propagated, clones show a lack of genetic fidelity to their source. Further, the level of genetic variation within the cultivar 'Owairaka Red' indicated the continuing emergence of distinct new strains.

Plant field establishment represents the interaction of both propagation and growth phases of storage root production. A range of establishment techniques were investigated in a field trial under commercial conditions. Sprouts cut from seed roots and held for six days rather than immediate planting improved establishment as measured by growth, at little expense. Plug raised plants also improved establishment, while potentially reducing the degree of intra-cultivar genetic variation.

Plant carbohydrate partitioning in three cultivars, 'Beauregard', 'Beniazuma' and 'Owairaka Red' was examined by field trial over the period of storage root growth. While cultivars differed in the proportions of dry matter partitioned to leaf, stem and root organs, the cultivar specific ratios of leaf to stem dry weight were relatively stable over time. Total storage root dry weight increased with time for all cultivars, but the distribution of storage root grades by size was cultivar specific. Within the storage roots % dry weight increased over time in all cultivars, but total sugar concentration only increased for 'Beauregard' and 'Beniazuma'.

Finally, a storage root disorder called 'brown centre' curtails the temperate growing season so was investigated using low temperature storage and a field trial with various nutrition regimes. The disorder was found to be associated with susceptible germplasm, high soil nitrogen and harvest time.

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The view at the end of this project certainly differs from that at the start, so with appreciation based on this experience I would like to thank Dr. David Woolley and Dr. Keith Fisher of the Institute of Natural Resources, Massey University, for willingly taking the part of head supervisor for various stages of the journey. My sincere thanks to them and my co-supervisors Dr. Mike Nichols of the Institute of Natural Resources, Massey University, Professor Chris Triggs, Department of Statistics, University of Auckland and John Anderson, Crop Improvement Team, New Zealand Institute for Crop & Food Research Ltd., for freely sharing their knowledge and displaying patience throughout the course of this project.

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List of Abbreviations

a.i.	active ingredient
AFLP	amplified fragment length polymorphism
ANOVA	analysis of variance
AVRDC	Asian Vegetable Research and Development Centre
B	boron
B.C.	Before Christ
BC	brown centre
bp	base pair
BT	brown tissue
C	cavity
c.	*circa* or approximately
^{o}C	degrees Centigrade
C&FR	New Zealand Institute for Crop & Food Research Ltd.
CIP	International Potato Centre
cm	centimetre
CTAB	hexadecyltrimethylammonium bromide
cv.	cultivar
^{11}C	Carbon isotope 11
^{14}C	Carbon isotope 14
DAT	days after transplanting
DNA	deoxyribonucleic acid
dNTP	deoxynucleoside 5'-triphosphate
%DW	percent dry weight
EDTA	ethylenediaminetetra-acetic acid disodium salt
FAA	formol-acetic-alcohol
g.	g-force
g	gram
ha	hectare
HC	Hardcore
HI	harvest index

HPLC	high performance liquid chromatography
K	Potassium
Kb	kilobase
kg	kilogram
KLC	potassium chloride
L.	Linnaeus
LA	Individual leaf area
LAD	Leaf area duration
LAI	leaf area index
Lam.	Lamarck
LAR	leaf area ratio
Lat.	Latitude
LDM	leaf dry matter
LDW	Individual leaf dry weight
Log_e	natural logarithm
LSD	least significant difference
LSU	Louisiana State University
m	metre
μg	microgram
μL	microlitre
μM	micromole
me	milliequivalent
mL	millilitre
mm	millimetre
mM	micromole
N	Nitrogen
NAR	net assimilation rate
NASA	National Aeronautics and Space Administration
ng	nanograms
NIWA	National Institute of Water and Atmospheric Research Ltd.
P	Phosphorous
P	probability
PAUP	phylogenetic analysis using parsimony
PCR	polymerase chain reaction

pH	potential of hydrogen or acidity/alkalinity
pmol	picomole
R^2	coefficient of determination
RDM	root dry matter
REML	Residual maximum likelihood
RGR	relative growth rate
rpm	revolutions per minute
s	second
s.e.	standard error of the mean
SDM	stem dry matter
SLA	specific leaf area
t	metric ton
TAE	Tris acetate EDTA
TDM	total plant dry matter
TS	total sugar
UPGMA	unweighted pair group method with arithmetic averaging
USA	United States of America
v/v	volume per volume
VAM	Vesicular-Arbuscular Mycorrhizae
w/v	weight per volume