

**STRATEGIES TO IMPROVE YIELD AND QUALITY OF SWEET SORGHUM AS A
CASH CROP FOR SMALL SCALE FARMERS IN BOTSWANA**

by

Thabsile Virginia Balole

**Submitted in partial fulfilment of the requirements for the degree of
Doctor of Philosophy**

**Department of Plant Production and Soil Science
in the Faculty of Biological and Agricultural Sciences**

University of Pretoria

Pretoria

August 2001

Supervisor: Prof. P.S. Hammes

Co-supervisor: Prof. H.A. van de Venter

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	i
ABSTRACT.....	ii
CHAPTER 1	
GENERAL INTRODUCTION.....	1
CHAPTER 2	
LITERATURE REVIEW.....	4
2.1 Crop uses.....	4
2.2 Crop Description.....	5
2.3 Cultivars.....	9
2.4 Lodging	11
2.5 Environmental effects	12
2.6 Production aspects	14
2.7 Future prospects of the crop in Botswana.....	19
CHAPTER 3	
QUALITY OF SWEET SORGHUM SEEDLOTS OF BOTSWANA LANDRACES	22
3.1 Abstract	22
3.2 Introduction	23
3.3 Materials and methods	26
3.4 Results and discussion	29

CHAPTER 4

SEED DEVELOPMENT AND MATURATION IN SWEET SORGHUM.....	35
4.1 Abstract	35
4.2 Introduction	36
4.3 Materials and methods	37
4.4 Results and discussion	38

CHAPTER 5

CHARACTERISATION AND EVALUATION OF TEN SWEET SORGHUM

LANDRACES	49
5.1 Abstract	49
5.2 Introduction	50
5.3 Materials and methods	51
5.4 Results and discussion	54

CHAPTER 6

MANIPULATION OF TILLERS AND INFLORESCENCES TO INCREASE SUCROSE

CONCENTRATION IN SWEET SORGHUM STEMS	69
6.1 Abstract	70
6.2 Introduction	70
6.3 Materials and methods	72
6.4 Results and discussion	74

CHAPTER 7

EFFECT OF PLANTING DATE AND SPACING ON THE STALK YIELD AND SUCROSE

CONCENTRATION OF SWEET SORGHUM	80
7.1 Abstract	80
7.2 Introduction	81
7.3 Materials and methods	83
7.4 Results and discussion	85

CHAPTER 8

EFFECT OF NITROGEN AND SPACING ON STALK YIELD AND JUICE QUALITY OF SWEET SORGHUM

.....	92
8.1 Abstract	92
8.2 Introduction	93
8.3 Materials and methods	94
8.4 Results and Discussion	96

CHAPTER 9

GENERAL DISCUSSION	103
SUMMARY	109
LITERATURE CITED	112
APPENDIX	131

ACKNOWLEDGEMENT

I would like to express my sincere appreciation to the following individuals and organisations for their help and encouragement during the period of this study:

- * Botswana College of Agriculture for releasing me from duties to pursue my studies and their financial assistance.
- * Prof. P.S. Hammes and Prof. H.A. van de Venter, for their guidance, advices and encouragement during the period of this study.
- * All staff members in the departments of Plant Production and Soil Science and Plant botany in the University of Pretoria for their professional advices and encouragement during the course of the study.
- * Mrs Joey Herman for her willingness to help me with word processing, printing and her continuous encouragement during my happiest and saddest times of my stay in Pretoria.
- * Mr. Gene Beyers and Johan de Beer (Late), for their encouragement and enthusiastic assistance with field experiments, laboratory work and organisation of data.
- * The staff at the Experimental farm of the University of Pretoria for their continuous support with field and laboratory manual work.
- * The South African Sugar Association (SASA) for their technical advices and their valuable help in the analyses of my sweet sorghum samples.
- * My family, colleagues and friends for their encouragement and support from the beginning till the end of my study.
- * My loving husband for his encouragement, support and taking care of the children when I was away.
- * My children, Thuso (Late), Neo, Phindile, Pako and Phumla for their support and understanding in times when I should have been there for them but I was not.
- * Finally my Creator, who led me through rough and difficult times, and gave me strength and encouragement to complete this study.

**STRATEGIES TO IMPROVE YIELD AND QUALITY OF SWEET
SORGHUM AS A CASH CROP FOR SMALL SCALE FARMERS IN BOTSWANA**

BY

THABSILE VIRGINIA BALOLE

SUPERVISOR: PROF P S HAMMES

Department of Plant Production and Soil Science

CO -SUPERVISOR: PROF H A van de VENTER

Department of Botany

ABSTRACT

Strategies to improve stem yield and juice quality in sweet sorghum were investigated in this study. Seed quality of sixty five accessions (landraces) from Botswana was investigated. Standard germination tests revealed that only 66% of the accessions had germination percentages in excess of 85%. The Accelerated Ageing test showed that only 50% of the 26 accessions had germination percentages above 80%. The results indicated that Botswana sweet sorghum seed quality is generally poor. Seed development and maturity observations demonstrated that maximum seed quality occurred 14 to 17 days after mass maturity (physiological maturity) and this coincided with maximum seed germination. These results suggest that harvesting sweet sorghum seed prior to mass maturity can lower seed quality. Farmers should, therefore be advised to select plants intended for seed harvesting and allow them to mature properly before the seeds are harvested.

Differences in seed colour, shape and compactness of the inflorescences were observed amongst the 65 landraces collected from farmers in Botswana. Ten landraces were characterised and from the results it was evident that there was a range of genetic diversity which can be utilized in the improvement of the crop. Large panicles were characteristic of most sweet sorghum landraces, the effect of tiller, panicle and floret removal on juice quality

was consequently studied. Removal of panicles and florets significantly improved juice quality whilst removal of tillers did not. Selection and breeding of genotypes with small panicles and male sterile varieties may improve juice quality and should be investigated.

Effect of planting date, spacing and nitrogen were investigated. Early planting (October) resulted in increased stem yields but reduced juice quality. A 30 cm intra-row spacing resulted in high stem yields per plant and good juice quality. Nitrogen fertilisation increased stem yield and improved juice quality. On the bases of the results obtained from this study, early planting (October), application of 60 kg N ha⁻¹, and 30 cm intra-row spacing could be recommended for sweet sorghum production in pure stands.

In pure stands yields of more than 37 000 stems (per hectare) of good quality can be attained. These could be sold at an estimated price of P2.00 (R2.25) per stem indicating the potential of sweet sorghum as a cash crop. However, its economic viability depends on the price elasticity in the supply - demand function.

Keywords: Sweet sorghum, small -scale farmers, stem yield, juice quality, seed quality, standard germination test, Accelerated Ageing test, seed development and maturation, mass maturity, landraces, characterisation, panicle removal, floret removal, tiller removal, planting date, spacing, nitrogen.