GENETIC IMPROVEMENT OF SWEETPOTATO FOR β-CAROTENE AND YIELD IN BURKINA FASO -

Koussao SOME, PhD

Supervisors: Asante I.K., Gracen V., Danquah E.Y. and Ouédraogo J.T.

WEST AFRICA CENTRE FOR CROP IMPROVEMENT
SCHOOL OF AGRICULTURE
COLLEGE OF AGRICULTURE AND CONSUMER SCIENCES
UNIVERSITY OF GHANA
LEGON

INTRODUCTION

- Sweetpotato (*Ipomoea batatas* [L.] Lam) is an herbaceous Dicotyledonous plant, member of Convolvulaceae, series *batatas*

- It is an hexaploid cross-fertilizing crop with 2n=6x=90

- Important crop: Economically, nutritionally, ecologically, resilient crop.

In Burkina Faso

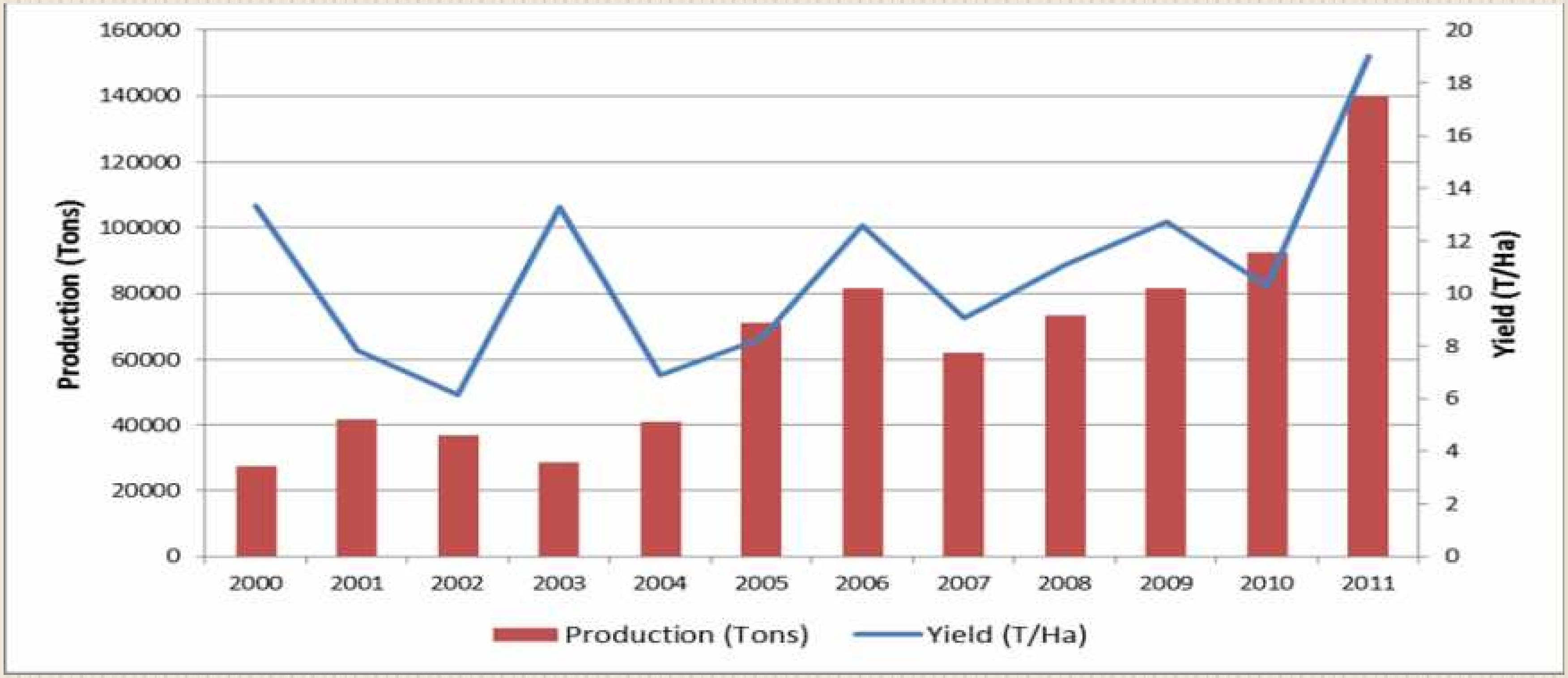


Fig1. Evolution of sweetpotato production and yield from 2000 to 2011. (DGSPA, 2012)

- The production increased from 27366 t in 2000 to 140,061t in 2011, and **377,728t in 2014** : **rapid increase mainly due to increase of production area**
- However, yield over time has been unstable.

OBJECTIVES

- Identify the main production constraints and understand farmer's and consumer's preferences.

- Assess the diversity of sweetpotato germplasm in Burkina Faso prior to selection of superior parents to be used in a basic breeding program.

- Estimate the heritability of economically important traits as a guide to parental selection necessary for a significant breeding progress.

- Identify high yielding and beta-carotene rich clones specific to wide adaption to the local environments.

II. DIVERSITY ANALYSIS OF SWEETPOTATO (Ipomoea batatas [L.] Lam) GERMPLASM FROM BURKINA FASO USING MORPHOLOGICAL AND SSR MARKERS

The objectives were to:

(1) estimate diversity among sweetpotato germplasm from Burkina Faso;

(2) develop a core collection for conservation and use in breeding program.

MATERIAL AND METHODS

Plant materials

- 112 were used for this study
- Morphological characterization using 30 descriptors
- Molecular characterization using 30 SSR markers

PRODUCTION CONSTRAINTS

- Major constraints have been identified for the Sub-Saharan Africa on small farms scale (ASHS, 2007; Fuglie, 2007)

- These include:
  - ☹ viral diseases,
  - ☹ lack of processing technology,
  - ☹ poor availability of quality planting materials
  - ☹ Lack of improved control of weevil
  - ☹ short storage ability duration
  - ☹ lack of improved cultivars with high and stable yield.
  - ☹ unavailability of cultivars with high beta-carotene content which could help to address VAD.

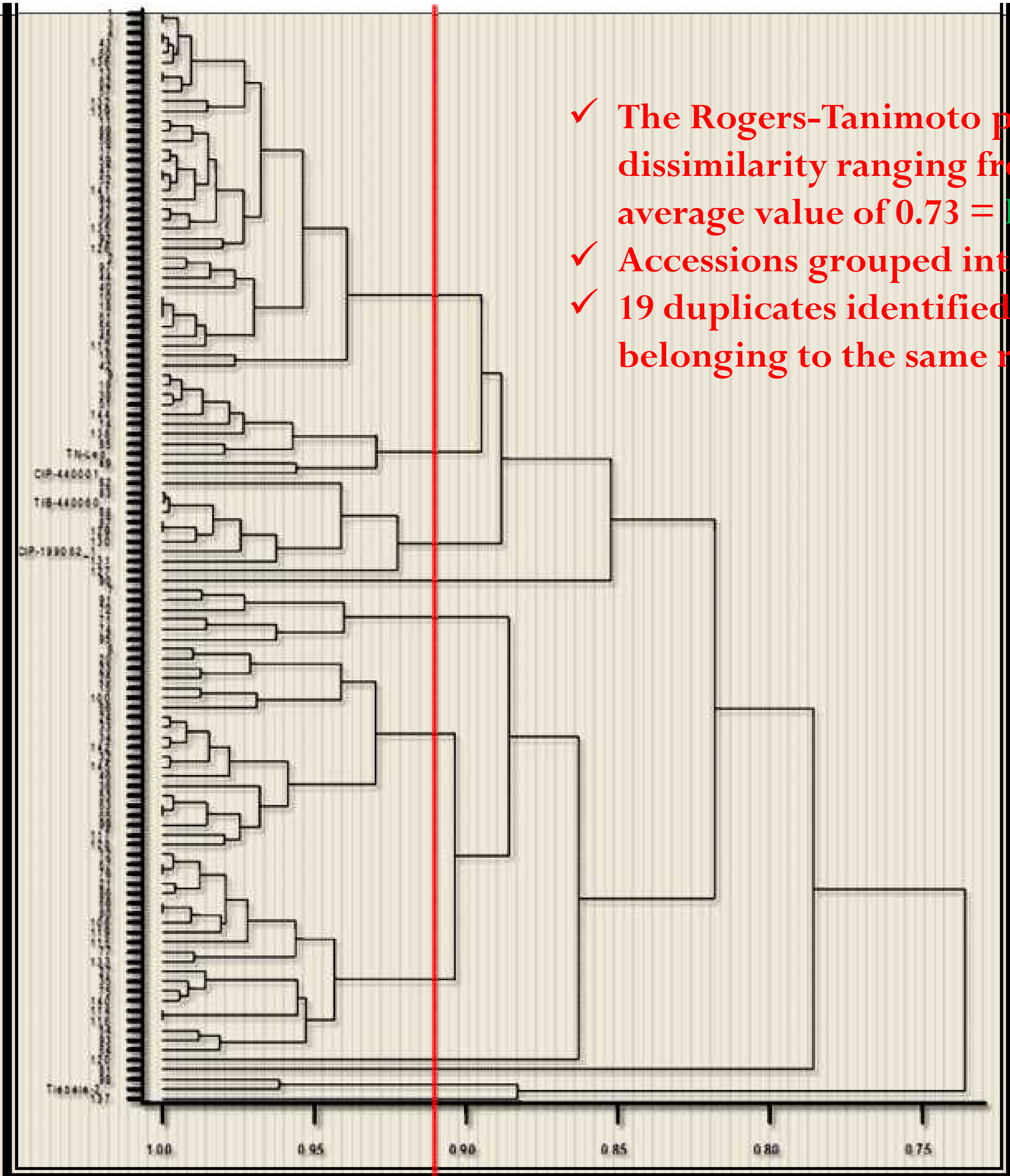
RESULTS and DISCUSSION

Table 5 .Eight morphological characters selected by the STEPDISC procedure of Genstat, 14th Ed

Step	Entered	Partial R-Square	F Value	Pr > F	Wilks' Lambda	Pr < Lambda	Average Squared Canonical Correlation	Pr > ASCC
1	Predominant Flesh Color (PFC)	0.8498	299.81	<.0001	0.15022095	<.0001	0.42488952	<.0001
2	Leaf Lobe Number (LLN)	0.4128	36.90	<.0001	0.08821579	<.0001	0.62429365	<.0001
3	Leaf Lobe Type (LLT)	0.1204	7.12	0.0013	0.07759628	<.0001	0.65429960	<.0001
4	Mature Leaf Size (MLS)	0.1035	5.94	0.0036	0.06956707	<.0001	0.66236509	<.0001
5	Vine Tip Pubescence (VTP)	0.0711	3.91	0.0232	0.06461809	<.0001	0.67647456	<.0001
6	Storage Root Surface Defects (SRSD)	0.0525	2.80	0.0655	0.06122257	<.0001	0.68154041	<.0001
7	Petiole Pigmentation (PP)	0.0514	2.71	0.0716	0.05807721	<.0001	0.69485966	<.0001
8	Storage Root Formation (SRF)	0.0508	2.65	0.0759	0.05512967	<.0001	0.69785323	<.0001

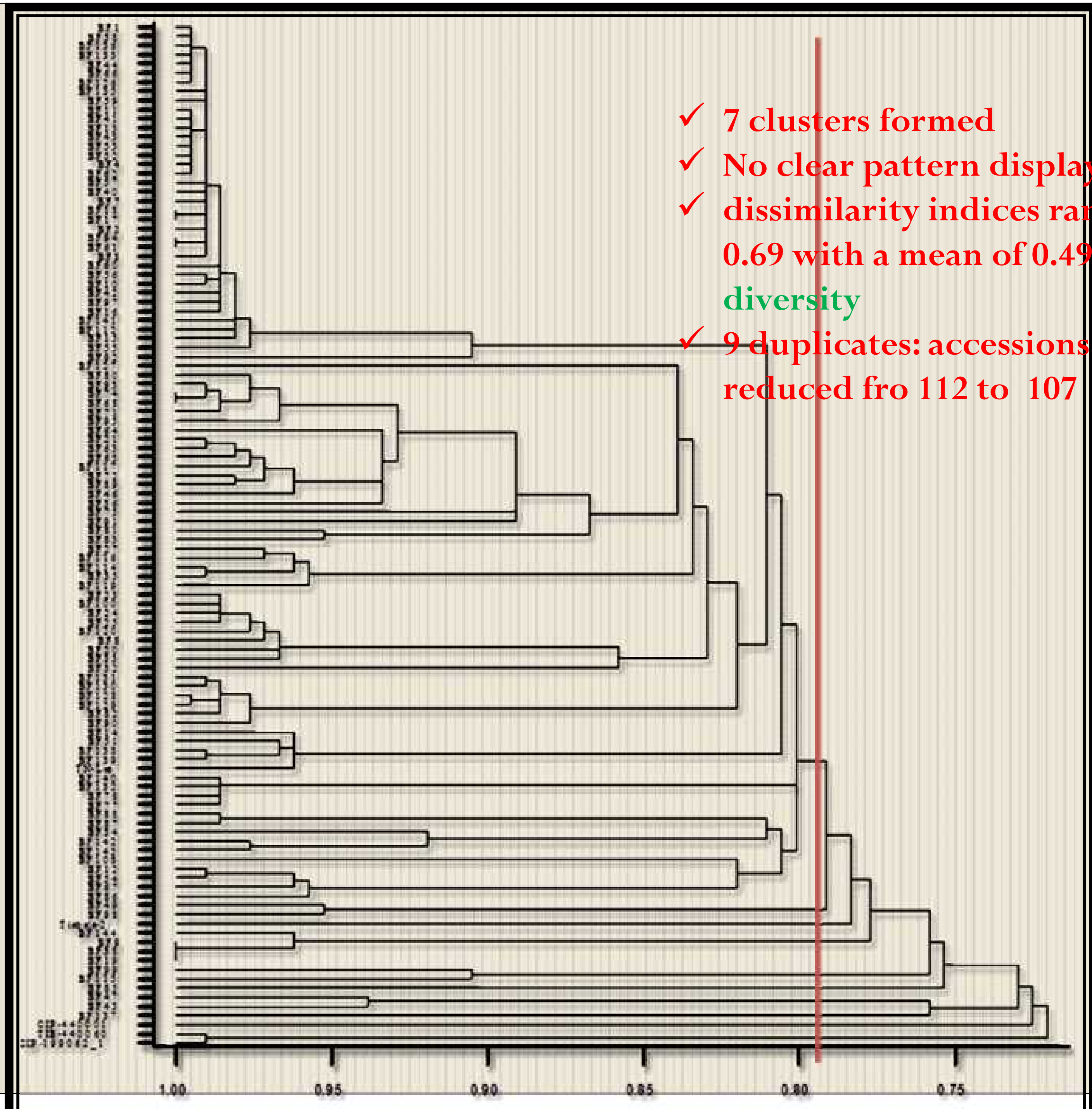
The F values revealed that PFC and LLN respectively with 299.81 and 36.90 had the greatest discriminating power associated with highly significant F values.

Fig 7. Morphological based Dendrogram of the 112 sweetpotato accessions using the 8 discriminant phenotypic characters



- ✓ The Rogers-Tanimoto pairwise dissimilarity ranging from 0 to 1 with an average value of 0.73 = high diversity
- ✓ Accessions grouped into 11 clusters
- ✓ 19 duplicates identified, mostly belonging to the same regions

Figure 8. SSR based Dendrogram of the 112 sweetpotato accessions



- ✓ 7 clusters formed
- ✓ No clear pattern displayed
- ✓ dissimilarity indices ranged from 0 to 0.69 with a mean of 0.49 = moderate diversity
- ✓ 9 duplicates: accessions number reduced fro 112 to 107

Comparison between morphological and SSR data

- **4.7% agreement was detected between the morphological and molecular data:** no correlation between the two set of data.

- The Quartet tree distance estimate as a measure of dissimilarity between the two trees was **0.95** : confirmed the absence of correlation between the two approaches.

- Furthermore, the duplicates identified using the morphological data were different to those identified using the SSR-based data.

- Despite the poor correlation between morphological and molecular markers, both techniques were useful in characterizing this sweetpotato germplasm.

- SSR based data will be used for core collections constitution, while the eight phenotypic characters will be useful to describe the cultivars in the field.

Somé K., Gracen V., Asante I.K., Danquah E.Y., Ouedraogo J.T., Tignegre J. B., Belem J. and Tarpaga M.V., 2014. Diversity analysis of sweet potato (*Ipomoea batatas* [L.] Lam) germplasm from Burkina Faso using morphological and simple sequence repeats markers. *Afr. J. Biotechnol*., 13(6):729-742.

III. GENETIC ANALYSIS OF INHERITANCE OF YIELD COMPONENTS AND BETA-CAROTENE IN SWEETPOTATO USING PARENT-OFFSPRING REGRESSION

- The objectives of this study were:

1) to estimate narrow sense heritability for economically and nutritionally important traits

2) to estimate the genetic gain from selection of the breeding product

MATERIALS AND METHODS

Parental choice

- based on flowering ability, the origin and flesh color

- 2 sets:
  - ✓ **Local accessions** of white to yellow flesh: considered as female parents
  - ✓ Introduced **OFSP** (beta-carotene source) considered as male

- **15 F_1 families were generated**

Table 10'. F1 family average performance for storage root yield, DM and β-carotene

Family	RtYield	DM	BetaCar
BF24xCIP	10.65±8.27	33.16±11.68	0.048±0.043
BF24xResisto	11.38±7.76	27.90±6.51	0.024±0.029
BF24xTainung	10.73±6.68	28.25±7.25	0.036±0.136
BF59xCIP	13.19±6.79	27.59±9.22	4.625±4.125
BF59xResisto	14.71±9.35	25.68±5.02	0.042±0.054
BF59xTainung	12.36±8.68	25.21±5.26	0.067±0.060
BF77xCIP	17.08±11.18	21.62±3.22	0.082±0.057
BF77xResisto	13.28±8.58	27.48±5.91	0.018±0.024
BF77xTainung	17.14±7.75	26.29±6.42	0.028±0.039
BF82xCIP	12.29±8.70	26.06±6.61	3.156±3.730
BF82xResisto	6.97±6.76	27.30±6.88	0.082±0.250
BF82xTainung	13.79±9.35	23.31±6.60	0.717±1.978
BF92xCIP	14.53±13.41	26.84±5.96	2.273±3.440
BF92xResisto	12.70±8.29	24.73±6.21	0.945±2.849
BF92xTainung	11.06±6.91	28.20±3.57	0.0467.060

CIP = CIP199062.1

Table 10. Comparison of parents and offspring mean performance and their significance

Generation	Rtyield (T/ha)	BetaCar (mg/100g of fresh root)	DM (%)	Biomass (kg/per plot)	Rootnum (Number /plant)	IRtwgt (g/plant)	VL (m)
Offspring	12.83	0.89	26.22	15.05	2.96	134.23	1.70
P_{female}	8.26	0.28	29.61	7.15	2.58	97.15	1.43
F_{male}	11.45	3.27	27.93	7.47	2.95	130.62	1.01
Mid-Parent	9.86	1.77	28.77	7.31	2.77	113.87	1.22
% increase/MP	30.12	-49.72	-8.86	105.88	6.86	17.88	39.34
%increase/P_f	55.33	216.73	-11.45	110.49	14.73	38.17	18.88
All entries	***	ns	***	***	***	*	***
Offspring	***	***	***	***	***	***	***
Offsp.vs(Pf+Pm)	**	ns	***	***	ns	ns	***

Table 11. Narrow sense heritability (h^2) estimate per location and genetic advance from improvement

	Heritability estimate				
	Farakoba	Kouare	Loumbila	**Combined**	**Genetic advance (%)**
Storage root yield	0.20±0.25	0.58±0.25	0.58±0.32	**0.21±0.16**	**5.85**
Dry Matter	0.75±0.06	0.93±0.03	0.75±0.14	**0.76±0.003**	**22.60**
Beta-Carotene	0.43±0.63	0.49±0.44	0.97±0.02	**0.90±0.039**	**3.37**
Biomass yield	0.58±0.18	0	0.05±0.42	**0.04±0.07**	**7.81**
Root number per plot	0.62±0.44	0.52±0.38	0.57±0.27	**0.41±0.21**	**8.03**
Individual Root weight	0.69±0.14	0	0.55±0.34	**0.27±0.12**	**6.35**
Vine Length	0.33±0.42	0.57±0.28	0.16±0.07	**0.48±0.28**	**0.26**

- The male parent CIP-199062-1 appears as an important parent of breeding for yield, DM and β-carotene
- Good local parents identified were:
  - BF77 for yield
  - BF59, BF82 and BF92 for β-carotene
  - BF24 for DM
- Regarding the low heritability for yield and yield related traits (Rootnum and Irwgt), a divergent source of parents is still needed for a significant improvement.

Somé K., Asante I.K., Belem J., Danquah Y.E., Ouedraogo J.T. and Vernon G., 2014. Breeding for high beta-carotene, dry matter content and yield in sweetpotato in Burkina Faso. CABI

IV. GENOTYPE BY ENVIRONMENT INTERACTION ANALYSIS OF F_1 ORANGE FLESHED SWEETPOTATOES DEVELOPED IN BURKINA FASO

Objectives were to

1. assess whether the 33 F_1 orange fleshed sweetpotato hybrids and their orange fleshed parental varieties response differently to environmental changes

2. identify varieties with stable performance or specific environment adaptation to be recommended to farmers.

- Best yielding Genotypes for:
  - **KOUARE**: BF82xTainung-8, BF24xTIB-3, BF82xTainung-20 and BF92xCIP-6;
  - **FARAKOBA**: BF82xTainung-8, BF80xTainung-2, BF82xCIP-17 and BF59xCIP-4
  - **LOUMBILA**: BF59xTIB-6, BF82xTainung-20, BF80xTainung-2 and BF82xTIB-9

Table 14. The Best twelve F_1 OFSP genotypes that had significantly higher yield than the best check (TIB-440060 with 11.11 t/ha)

Genotypes	Root yield (t/ha)	Upgr BiomYield (t/ha)	β-carotene (mg/100g of fresh weight)	Virus2 (1 to 9 scale)	DM (%)	Irwgt (g)
BF82xTainung-8	20.33	16.33	0.48	2.33	23.2	179.15
BF82xTainung-20	19.67	17.23	0.78	3.33	21.82	242.68
BF82xCIP-17	18.56	14.78	3.92	1.17	28.45	118.18
BF80xTainung-2	18.11	11.89	2	2.33	19.27	203.89
BF82xTainung-24	17.83	25.89	8.29	1	21.79	136.43
BF92xCIP-6	17.11	17.83	6.44	1.83	26.61	175.9
BF59xCIP-4	16.78	21.56	8.32	1.83	24.81	116.15
BF24xTIB-3	16.17	17.28	7.66	2.67	27.33	116.72
BF59xTIB-6	15.22	11.39	4.36	2.33	21.48	275.94
BF82xCIP-18	15.22	30.11	2.32	1.5	22.81	186.07
BF59xCIP-1	13.56	18.33	8.32	1.17	27.09	110.82
BF82xTIB-4	13.5	10.33	1.03	2.17	30.06	145.36

Table 15. The two F_1 genotypes that had higher yield than the best yielding check, good beta-carotene content and DM content over 28%

Genotypes	Root yield (t/ha)	BiomYield (t/ha)	β-carotene (mg/100g of fresh weight)	Virus2 (1 to 9 scale)	DM (%)	Irwgt (g)
BF82xCIP-11	**11.94**	11.67	**4.13**	1.83	**28.89**	104.26
BF82xCIP-17	**18.56**	14.78	**3.92**	1.17	**28.45**	118.18

CONCLUSION

- Pest, diseases and variety decline constituted the major sweetpotato production constraints in Burkina Faso
- Poor cooking and eating quality can lead to variety rejection
- Promising OFSP varieties must combine hierarchically: high and stable yield, high DM content, good storage ability, early maturing and good shape
- Sweetpotato germplasm in Burkina Faso has moderate (0.49) to high (0.73) diversity and can be used in a successful breeding program

- Eight (8) morphological characters were identified and can be used to describe sweetpotato germplasm in Burkina

- The parental genotypes CIP-199062-1 identified as important in developing high yielding, high β-carotene and DM content varieties

- Compared to the local parent mean, the storage yield and beta-carotene content were respectively increased by 55.33%, 216.73, while the dry matter content (-11.54%) need to be improved

- The best OFSP F_1 genotypes for yield (BF82xTainung-8) showed 82.99% increase over the best checks

- The F_1 OFSP BF82xCIP-11 and BF82xCIP-17 combined higher yield, higher beta-carotene content and with DM content over 28%

ACKNOWLEDGEMENTS

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