Introduction of high yielding and resource use efficient cowpea varieties in South Africa

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INTRODUCTION

As global population increases and climate becomes more unpredictable, the need for sustainable intensification of food production becomes more evident. Food security is key to ensuring peace and progress of society as a whole. Intensification means the production of more food on less land and in order for this to be sustained into the future, resource inputs must be minimized. Legumes are a natural answer to the intensification challenge because they have a relationship with soil microbes which allows for nitrogen fixation and nitrogen is the most costly fertilizer input in cereal crops. Nitrogen fixation limits or eliminates the need for additional nitrogen application and enhances the soil nutrient status for subsequent crops. Cowpea is a rapidly maturing, drought and heat tolerant legume; therefore, breeding efforts focused on shortening its maturity, enhancing drought and heat tolerance, resistance to biotic stress, and tolerance of low-phosphorous soil is pertinent. Cowpea [*Vigna unguiculata* (L) Walp] is an important grain legume in many tropical and subtropical countries where it is used as a source of high protein food and animal fodder, as well as a biological nitrogen fixer in the soil. Cowpea is water and nutrient efficient and earlier maturing lines are more efficient than traditional cultivars. In South Africa, cowpea production is limited due to the unavailability of improved varieties. Incorporation of improved cowpea varieties into resource efficient cropping systems is key to increasing yield while reducing resource input and biotic stresses associated with crop production.

Objective

Evaluate selected cowpea varieties with drought- and low-phosphorus tolerance to identify lines which have potential for use in low-input systems in Sub-Saharan Africa.

METHODS

- Ukulima Farm in Alma, Modimolle, Limpopo Province, South Africa
- Sandy, loam soil type
  - pH 5.5
  - Bray 33 mg kg^{-1} P; 51 mg kg^{-1} K
- Completely randomized block design
- Plot size was four rows (75 cm row spacing) by 5 m in triplicate
- **2012-13**
  - 97 improved varieties
    - 37 Early maturity (60 d) from the USA
    - 20 Early maturity from South Africa
    - 20 Medium maturity (75-85 d) from the USA
    - 20 Medium maturity from South Africa
  - Varieties from International Institute of Tropical Agriculture (IITA), Nigeria, TAMU breeding lines, cultivars released in USA and South Africa
  - 'Glenda' local cultivar served as control
  - Basagran used for weed control and Karate for insect control
- **2013-14**
  - 40 improved lines – greatest yielding pulse and fodder from the previous year

Data Collection & Analyses

- Number of days to maturity
- Pulse & fodder
  - Yield
  - Crude protein (%) concentration
- Data analyzed with Statistix 10.0

RESULTS

Fig. 1. Days to 90% pod maturity frequency distribution of 97 cowpea varieties grown in South Africa in 2012-13

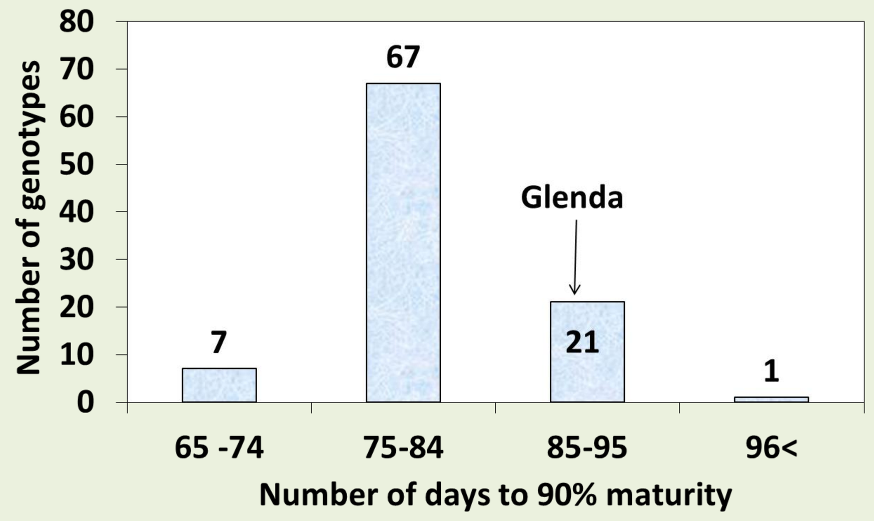

Fig. 2. Grain yield (kg ha^{-1}) frequency distribution of 97 cowpea varieties grown in South Africa in 2012-13

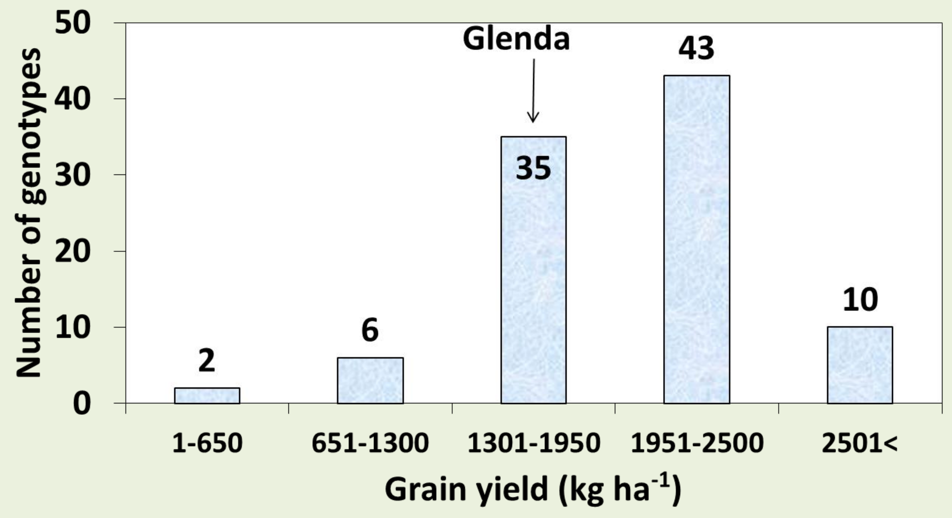

Fig. 3. Fodder yield (kg ha^{-1}) frequency distribution of 97 cowpea varieties grown in South Africa in 2012-13

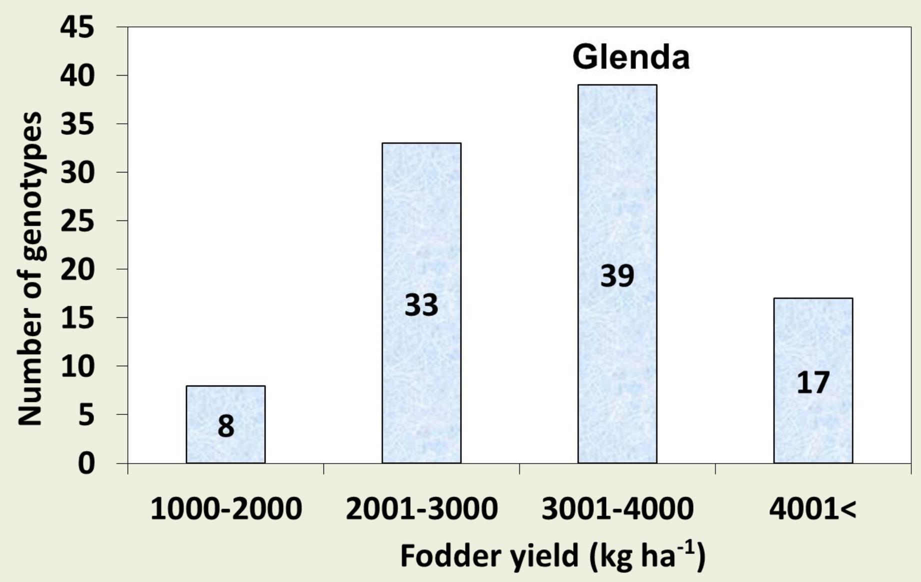

Fig. 4. Crude protein concentration (%) frequency distribution of 97 cowpea varieties grown in South Africa in 2012-13

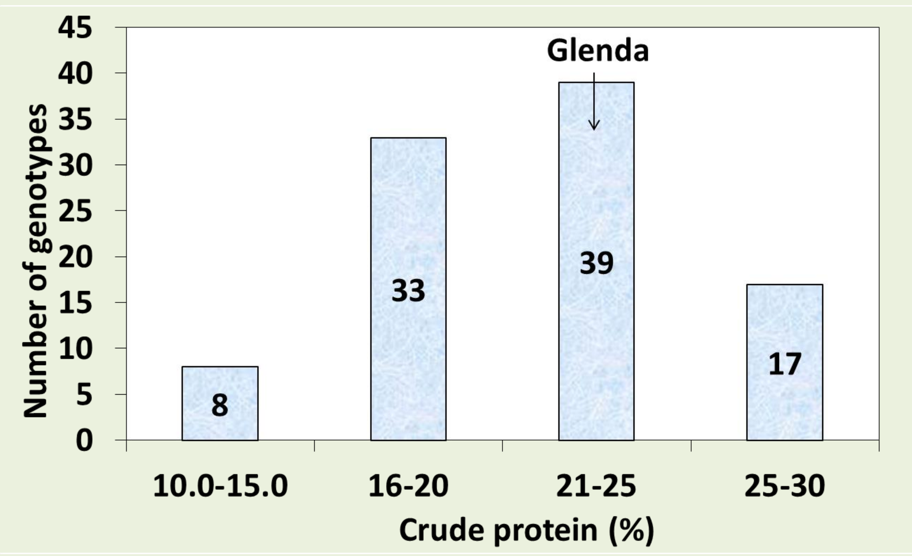

Table 1. Days to 90% pod maturity and grain and fodder yields (kg ha-1) of top 15 of 20 early maturity cowpea varieties grown in South Africa in 2013-14

Variety	Days to 90% pod maturity	Grain yield (kg ha^{-1})	Fodder yield (kg ha^{-1})
Glenda (control)	98	1087	4125
TX12-613	70a	1688b	2792b
CB-27	77a	.	.
Pan 311	78a	1660b	4417a
IT82D-889-1	80a	1485c	.
Tvu 13464	81a	1757b	2625b
CB-46	83b	1410.8c	.
CB-50	84b	.	2250c
IT98K-589-2	86b	2305a	5292a
IT86D-1010	88b	2183a	4667a
TX123	88b	.	2458c
IT95K-627-34	89c	1968b	2375c
IT98K-1111	91c	1528c	2792b
TX08-30-9	91c	1395c	
TX08-30-5	91c	2003a	2542b
TX08-30-1	91c	2049a	
TX08-4-1	.	.	2083c
GEC	.	1481c	4833a
TX08-49-1	.	2274a	4250a
TX08-494	.	1765b	2208c
SEM*	2	214	538
CV(%)**	4.5	26.4	38.0

a, earliest maturity or greatest yielding for each column
b, middle maturity or yielding for each column
C, latest maturity or greatest yielding for each column
., not reported

Table 2. Days to 90% pod maturity and grain and fodder yields (kg ha-1) of top 15 of 20 medium maturity cowpea varieties grown in South Africa in 2013-14

Variety	Days to 90% pod maturity	Grain yield (kg ha^{-1})	Fodder yield (kg ha^{-1})
Glenda (cntrol)	105	1438	3780
IT98K-690	91a	.	.
ARC-GCI-CP76	99a	.	.
TX12-541	100a	1570c	.
IT98K-205-8	102a	2266a	2798b
Big John	102a	1661c	2768b
IT98K-491-4	102a	1776b	2441c
UCR-288	103b	1819b	5566a
Bechuana white	104b	1733c	4196a
IT86D-1010	104b	.	.
IT99K-316-2	104b	1688c	2560b
IAR-48	104b	1799b	.
IT98K-391-2	105c	.	5982a
IT97K-499-35	105c	1891a	2202c
Ife Brown	105c	.	.
GEC	.	1594c	2798b
IT00K-1217	.	2364a	3095a
IT86D-1010	.	1859b	2768b
IT97K-499-39	.	1844b	2560b
IT97K-568-18	.	2394a	2381c
IT98K-962	.	2013a	1845c
SEM*	2.24	171.15	318.71
CV(%)**	4.34	19.64	23.86

*SEM, standard error of mean
**CV (%), percent coefficient of variation

DISCUSSION

Figs. 1-4

- Of 97 initial varieties, the majority were earlier maturity than Glenda (Fig. 1)
- Approximately half had greater or similar grain yields to Glenda (Fig. 2)
- 80 had greater or similar fodder yields to Glenda (Fig. 3)
- The CP (%) frequency was similar to that of fodder yield (Fig. 4)
- 20 early and 20 medium maturity varieties which had the combination of greater grain and fodder yield were selected for experimentation in Year 2

Table 1. 2013-14 Early Maturity Varieties

- 19 of 20 varieties matured earlier than Glenda
- 16 of 20 varieties had greater grain yield than Glenda
- 5 of 20 varieties had greater fodder yield than Glenda
- IT98K-589-2 (IITA), IT86D-1010 (IITA), and TX08-49-1 (TAMU) had greater grain and fodder yield, but of these three only the IT98K-589-2 and IT86D-1010 had moderate-early maturity
- TX08-30-5 (TAMU) had greater grain yield, but moderate fodder yield, and later maturity of the early maturity types
- Generally, the earliest maturity types had moderate or lesser grain and fodder yields, but grain yields were still greater than that of Glenda
  - TX12-613 (TAMU)
  - Pan 311 (local type)

Table 2. 2013-14 Medium Maturity Varieties

- 11 of 20 varieties matured earlier than Glenda
- 16 of 20 varieties had greater grain yield than Glenda
- 3 of 20 varieties had greater fodder yield than Glenda
- IT98K-205-8 (IITA) had earlier maturity and had greater grain and fodder yield
- UCR-288 had moderate maturity and grain yield, but greater fodder yield

CONCLUSIONS

- Many varieties show resistance to bacterial blight and aphid
- The best improved varieties yielded over 2500 kg ha^{-1} grain compared to 1500 kg ha^{-1} grain yield of Glenda
- The best improved varieties yielded over 4000 kg ha^{-1} fodder compared to about 3500 kg ha^{-1} fodder
- The crude protein of the best varieties ranged from 25 to 30% compared to 21% of Glenda
- The 10 best varieties have been selected for large scale on-farm and multi-location trials for 2014-15
- These 10 varieties will be used to meet the immediate needs of farmers for their production purposes and will also serve as breeding stock for the development of new well adapted high yielding varieties for South Africa.

ACKNOWLEDGEMENTS

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