BAMBARA GROUNDNUT IMPROVEMENT PROGRAM

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ABSTRACT

The Bambara groundnut (*Vigna subterranea* (L.) Verdc.) is a leguminous crop grown by communal farmers in the northern areas of Namibia. Its seeds are highly appreciated by the local people, eaten cooked in fresh or dried condition. However, until now it has not received the attention of agronomists and breeders in Namibia. In two trials, planted at Mahanene Research Station, different Bambara groundnut material has been evaluated in the 1995/6 season. In a comparison trial it was found, that seed from local markets and a variety from Botswana which was distributed by Extension Services had significant lower yields than germplasm and local farmer's seed. The yields of up to 850kg/ha which were achieved in a below average rainy season, indicate a good potential as food crop. Yield seemed to increase with earlier flowering and a good physiological appearance during the growing period.

INTRODUCTION

Interest was raised on several occasions during 1995 by farmers, NGO's, researchers and extensionists for the improvement of the Bambara groundnut. Up to now not much attention has been given to the crop although it is well known and widely grown in northern Namibia. Due to unstable yields, low uniformity and difficulties in obtaining seed, the cultivation of Bambara groundnut is restricted in most cases to horticultural dimensions. However, its tolerance to drought and poor soils, its benefits as a legume in a grain-dominated farming system and its market potential justify efforts for the improvement of the cultivation of Bambara groundnut concerning seed as well as agronomic aspects.

The first step of the program is to evaluate existing germplasm material, which has been collected by ICRISAT-scientists and local staff during early 1991, for its potential for improvement towards more uniformity, higher and stable yields and to meet with the requirements of the market concerning taste and seed size. The second step is a selection of plants for further testing which already meet with some of these requirements.

METHOD

In the 1995/96 season only two trials have been planted at Mahanene Research Station, Omusati Region in Namibia. This was due to the few seeds available.

The Bambara Groundnut Landraces Comparison Trial (BNLCT) aimed at a comparison between material from the Namibian germplasm collection, seed bought from local markets and seed obtained from farmers according to the area in the following characteristics: yield, pod size (- mass), pods per plant, yield per plant, agronomic appearance and flowering. One improved variety from Botswana, which was purchased in large scale from the Extension Services and sold to communal farmers in the 1995/96 season, was also included. Altogether the trial consisted of 12 entries, which were planted in Complete Randomized Block Design with three replications.

The Bambara Groundnut Observation Nursery (BNON) aimed at a description of characteristics of entries, as they were recorded in the BNLCT plus additional information about maturity, uniformity, leaf disease, plant height and leaf size. The nursery consisted of 60 erntries. Among the entries fourteen came from the Namibian germplasm collection, four from local markets and three from local farmers. Thirty-nine entries were seed samples received from Dr. C.J. Swanevelder from the Oil and Protein Seed Centre of the Grain Crops Institute, Potchefstroom, South Africa. The nursery was planted in three blocks without replication.

The statistical methods used were:

Bambara Groundnut Comparison Trial (BNLCT):
Single-Factor-Analysis of Variance done with calculator Casio fx-82 LB Fraction,
Stepwise Regression done with STATGRAPHICS.

Bambara Groundnut Observation Nursery (BNON):
No statistical analysis has been executed, only a collection of descriptive data.

For the BNLCT the plot size was 6m^2 (2 rows @ 0.75 x 4 m) and the net plot was also 6m^2. For the BNON the plot size and the net plot were 3m^2 (1row @ 0.75 x 4m). Planting date was 10 January 1996 and harvesting date varied between 16 April and 11 July 1996 due to variation in physiological maturity for both trials.

For a single plant evaluation of identified superior plants, which was planned for the 1996/97 season, the harvest and yield data collection has been done separately for all 1561 plants harvested from both trials. Thus the data presented in this paper are summarized from individual results.

RESULTS AND DISCUSSION

After planting, a rainfall of 250 mm was received (150 mm in first ten days after planting; total for 1995/96 353.6mm). The following abbreviations have been used for data descriptions and in the tables:

Yield: seeds shelled and air-dried, calculated from g/plot to kg/ha
%M: yield of entry as percentage of overall trial mean

CV:	coefficient of variation for entry
AS:	average agronomic score for entry from 3 scorings on 14/2/96, 27/2/96 and 5/3/96: 1 = excellent, 5 = poor
%F:	average percentage of plants flowering on 25/3/1996
Y/Pl:	average yield calculated per plant harvested
S/P:	average seed mass per pod in grams
M:	overall trial mean
HP:	harvested plants per plot LSD 5%: least significant difference (probability error < 5%)
LSD1%:	least significant difference (probability error < 1%)
SED:	Standard error of the differences

The entries on rank 3, 9 and 12 indicate a high variation in their yields (CV > 40%) and conclusions concerning their performance might not be reliable. However, they were also included in the Analysis of Variance. The results clearly indicate a statistically proven yield advantage of the group from rank 1 to 7 above the group from rank 9 to 12. Within the top group, only rank 7 shows a significant lower yield than the two top yielding entries. Rank 8 lies between the two groups and shows significantly lower yield than rank 1 to 4, but significantly higher yield than rank 12. This distinctly shows that entries from the germplasm collection (which have been collected from farmers) and two entries from farmer's seed have yielded significant better than entries from markets and the Botswana-type.

Looking at the agronomic scoring (which considers the physiological appearance and health of the plants) the tendency seems to be that higher yields are related to better scorings. It also seems that decreasing yield is correlated to later flowering. An exception from this tendency is the entry on rank 4.

A stepwise regression for yield with the variables plants/plot (plcount), yield/plant (yplant), pods/plant (podplant) and seed mass/pod (seedpod) brought the result that 95% of the yield differences between plots can be explained by the yield per plant and the number of harvested plants per plot (Table 2).

Looking towards another improvement parameter, seed size or g seed per pod, it appears like high yields are linked to small seeds. KFBN 9501 is the only entry from the top yielding group, which combines an above average yield with an above average seed size.

The summary of data from the BNON is presented in Table 3. Due to the volume of data, only the entries above or equal to the overall mean of 378.4 kg/ha and the six worst yielding entries have been summarized in Table 3. As there were no replications a statistical analysis can not be made with the available software.

TABLE 1: SUMMARY OF DATA RECEIVED FROM THE BNLCT.

Entry	Rank	Yield	%M	CV	AS	%F	Y/PI	S/P	Origin
AHM 787	1	562.5	167	21.3	1.3	52	10.6	0.34	Germplasm
KFBN 9501	2	553.7	164	19.4	1.7	33	10.9	0.44	Farmer
AHM 780	3	518.7	154	45.0	1.5	37	11.3	0.39	Germplasm
AHM 760	4	515.7	153	29.2	2.9	15	10	0.39	Germplasm
Mahanene Local	5	420.9	125	37.7	1.7	32	11	0.41	Farmer
AHM 753	6	378.9	112	10.4	2.8	27	9.7	0.35	Germplasm
AHM 201 B	7	358.6	106	17.0	2.4	33	8.6	0.42	Germplasm
KFBN 9502	8	283.3	84	32.7	2.4	23	6.3	0.44	Farmer
KFBN 9505	9	178.1	53	55.3	2.6	18	6.4	0.48	Market
KFBN 9506	10	151.9	45	34.5	3.3	15	6.4	0.38	Market
KFBN 9503	11	107.6	32	13.3	4.1	17	7.4	0.46	Market
Botswana Type	12	24.2	7	42.2	3.8	10	3	0.51	Extension

YIELD MEAN	**337,4**
LSD5%	**176.8**
LSD1%	**239.4**
SED	**85.8**

TABLE 2: SUMMARY OF A STEPWISE REGRESSION FOR YIELD IN THE BNLCT.

Stepwise Selection for Yield

Selection : Forward		Maximum steps : 500		F-to-enter : 4.00	
Control : Manual		Step : 2		F-to-remove : 4.00	
R-squared : .95545	Adjusted : .95275		MSE : 711.692		d.f. : 33
Variables in Model	Coeff.	F-Remove	Variables Not in Model	P . Corr .	F-Enter
3. plcount	6.84796	128.1707	1. podplant	.0574	.1058
4. yplant	22.1140	158.5745	2. seedpod	.1399	.6385

TABLE 3: SUMMARY OF DATA COLLECTED FROM THE BNON.

Entry	Origin	Rank	Yield	%M	HP	AS	%F	Y/pl	S/P
SB2-1	SA	1	859	227	15	1.5	70	17	0.50
AHM 787	NAM	2	834	220	22	2	40	11	0.51
AHM 760	NAM	3	812	214	19	1.5	25	13	0.33
AHM 968	NAM	4	786	207	18	2	15	13	0.43
AHM 780	NAM	5	756	199	23	1	50	9.9	0.39
KFBN 9501	NAM	6	742	196	19	2.7	5	12	0.55
AHM 1125	NAM	7	715	189	12	2.3	40	18	0.63
SB 16-5A	SA	8	707	187	19	1.7	40	11	0.38
AHM 867	NAM	9	694	183	21	1.2	50	9.9	0.41
SB 19-3	SA	10	629	166	9	2.7	35	21	0.65
AS 17	SA	11	627	165	14	2	25	13	0.66
SB 10-2	SA	12	607	160	15	3.2	50	12	0.52
1-12 means						**2**	**37**	**14**	**0.50**
AHM512	NAM	13	605	160	14	1	40	8.6	0.42
AHM 1056	NAM	14	598	158	16	1	10	11	0.42
SB 4-4C	SA	15	555	146	14	1.8	30	12	0.44
Swazi-VSA	SA	16	526	139	10	2.2	0	16	0.55
S13	SA	17	521	137	10	2.7	25	16	0.62
SB 17-1	SA	18	472	125	18	2.7	20	7.9	0.80
SB 4-2	SA	19	450	119	15	3.5	35	9	0.45
SB 11-1	SA	20	446	118	12	3.3	10	11	0.66
KFBN 9505	NAM	21	440	116	16	1	25	8.3	0.44
SB 9-1	SA	22	439	116	14	3	30	9.4	0.64
AHM 1064	NAM	23	435	115	21	3.2	10	6.2	0.42
AHM 449	NAM	24	376	99	9	3.3	10	13	0.68
13-24 means						**2.4**	**20**	**11**	**0.55**
SB 4-4E	SA	55	109	29	10	2.5	30	3.3	0.42
AS 9	SA	56	100	26	10	3.3	0	3	0.31
AS 13	SA	57	76	20	6	4.2	10	3.8	0.52
Potgiet. 3	SA	58	76	20	4	2.8	15	5.7	0.34
AS 7	SA	59	68	18	6	3	5	3.4	0.47
S 4	SA	60	47	12	8	2.5	15	3.5	0.40
55-60 means						**3.1**	**13**	**3.8**	**0.41**

However, by dividing the 24 above average entries into two groups, the same tendencies as in the BNLCT arise: the top yielding group has a higher yield per plant, a better agronomic scoring and earlier flowering. Comparing these two groups with the group of the worst six entries, these assumptions seem to be confirmed. An interesting result is that the top four yielding entries from the BNLCT are again among the six best yielding entries in the BNON.

Tendencies concerning a connection between yield and seed size can not be found. The potential for selection towards a bigger seed size is higher here than in the BNLCT. Some entries of the South African material come close to a desired 0.8g seed/pod. This value comes from a sample of fresh bambara groundnuts offered for sale on the big traditional market in Oshakati (Oshana Region). The sample has been dried and the average seed mass per pod has been calculated. An outstanding example for the potential of the bambara groundnut is entry SB 19-3, which does not only achieve an average of 0.65g seed/pod for the plot, but with an average yield per plant of 21.0g shows also a potential of more than one ton per hectare yield at a plant population of 5 plants per m^2.

CONCLUSION

Looking at the BNLCT the message seems to be clear. Seed which is kept by farmers (including germplasm) is of higher quality (concerning yield) than seeds available on markets. This means that in times of seed shortages a purchase of market seeds for planting bears the risk of poor yields. The distribution of locally non-evaluated and un-tested seeds, like in the case of the Botswana type, also bears the risk of yield failure, which will not only frustrate farmers at the end of a season of hard work, but also will question the credibility of the institution which distributes them.

The BNON gives good indications of the potential of the bambara groundnut in a semi-arid environment. Entries yielding an average of more than 800kg/ha in a below average rainfall season, others yielding more than 15g seed per plant and some having an average of more than 0.6g seed per pod, give reason for hope that the improvement of the bambara groundnut is not an illusion, but may result in a crop which can compete with other staple crops like pearl millet, sorghum, cowpea, and groundnut, and contribute to an improved nutritional status for the rural population.

REFERENCES

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