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Short Communication

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Pod Yield Comparison of Pure-Line Peanut Selections Simultaneously Developed from Georgia and Zimbabwe Breeding Programs

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With 2 tables

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Abstract

Crosses were made between two widely grown U.S. peanut (*Arachis hypogaea* L.) cultivars, 'Florunner' and 'Florigiant', and two genotypes adapted to growing conditions on the plateau of tropical Africa, 'Makulu Red' and 486 GKP. F_2 seed populations were equally divided between Georgia and Zimbabwe. Subsequently, pedigree selection was practised simultaneously at both locations in the early segregating generations. The highest yielding pure-line selections were then interchanged, and combined yield evaluations were determined over three growing seasons at each location.

'Florunner', 'Florigiant', and the Georgia pure-line selections tested at the Georgia location had significantly higher pod yields than 'Makulu Red', 486 GKP, and the Zimbabwe selections. Conversely, the mean yield of the Zimbabwe selections tested in Zimbabwe was significantly higher than that of the Georgia selections. Thus, the breeding environment under which selection is conducted among cross populations strongly influences the yield adaptability of selected peanut genotypes.

Key words: *Arachis hypogaea* — adaptability — cross populations — pedigree selection.

Peanut (*Arachis hypogaea* L.) cultivars do not always perform consistently over locations and years as attested by significant genotype × environment interactions (Wynne and Coffelt 1982). For example, the 'Makulu Red' cultivar, which was developed in Zambia, has yielded > 9000 kg/ha during two consecutive seasons on a farmers field in Zimbabwe (Smartt 1978). However, when tested in Georgia, 'Makulu Red' has yielded less than the Florida developed cultivars, 'Florunner' and 'Florigiant' (Hammons and Branch 1981).

This lack of yield stability may be attributed to the environmental conditions imposed upon a genotype at a particular breeding location. Our objective was to study the effect of simultaneous selection under different environments on yield adaptability within the same peanut cross populations.

Crosses were made in the greenhouse between two leading U.S. cultivars, 'Florunner' and 'Florigiant' (Hammons and Branch 1981) and two genotypes adapted to Zimbabwe, 'Makulu Red' and 486 GKP (Hildebrand and Smartt 1980). In 1977, an extremely large F_1 increase provided sufficient F_2 seed to begin a concurrent pedigree selection program within Georgia and Zimbabwe.

One hundred individual plants per cross were selected in the F_2 and F_3 generation and reduced to 75 progeny rows for planting the following season, respectively. Selection was based primarily upon yield components during these early generations. In the F_4, 50 individual plant selections were made per

cross and further reduced for subsequent increase and testing in a preliminary yield trial at each location. Standard cultural practices were followed throughout these studies to allow for maximum genetic expression.

Based upon the results obtained from these initial preliminary yield trials, the eight highest yielding selections at each location were then exchanged for combined yield evaluations over three growing seasons in both countries. The Georgia location lost a year during the exchange because of peanut stripe virus quarantive restrictions in the U.S.

The 20 entries in these combined trials consisted of two pure-line selections per cross from each breeding program plus the four parents. Respectively, Georgia and Zimbabwe selections from each cross combinations were as follows: 'Florunner' × 'Makulu Red' = GA T-2454, GA T-2455, PI 468133, and PI 468135; 'Florunner' × 486 GKP = GA T-2450, GA T-2451, PI 468134, and PI 468136; 'Florigiant' × 'Makulu Red' = GA T-2452, GA T-2453, PI 468137, and PI 468138; and 'Florigiant' × 486 GKP = GA T-2448, GA T-2449, PI 468139, and PI 468140. A randomized complete block design with six replications was used at each location. The Georgia tests consisted of 2-row plots, 6.1 m long × 1.83 m wide, and the Zimbabwe plots were 3-rows, 3.3 m long × 1.80 m wide.

The Georgia soil type was a Tifton loamy sand at the Coastal Plain Experiment Station (latitude: 31° 26′ N, longitude: 83° 35′ W, and altitude: 101 m), whereas the Zimbabwe soil was a Harare deep clay at the Gwebi Variety Testing Center (latitude: 17° 41′ S, longitude: 30° 52′ E, and altitude: 1448 m). Recommended production practises were followed throughout each growing season at both locations, and individual entries were harvested according to visual maturity estimations.

Data from each year were analyzed by analysis of variance, and then combined across years. Waller-Duncan's multiple range test (k-ratio = 100) was used for mean separations, and least significant differences were used for parent and selection comparisons.

As expected, year, location, and genotpye main affects and first and second order interactions were all highly significant for pod yield in the combined analysis of variance (Table 1). The third year and final season of testing was significantly lower in overall yield than the first two, and the Zimbabwe location outyielded Georgia when averaged over all three seasons. The first and second growing seasons in Zimbabwe were considerably drier than the last, and pod yields were significantly lower during this last season because of the wetter and cloudy conditions.

Table 1. Combined ANOVA for peanut pod yield from 20 genotypes tested over three growing seasons at two locations, Georgia and Zimbabwe

Source	df	Mean square
Year (Y)	2	180124823**
Location (L)	1	45728560**
Y × L	2	98863193**
Residual (Rep/Y × L)	30	733173
Genotype (G)	19	7143757**
Y × G	38	2202397**
L × G	19	27329642**
Y × L × G	38	591539**
Error	570	232787

** Significant at the 0.01 probability level

The combined genotypic means over locations and years showed 'Florunner' and the Georgia selection, T-2454, to be significantly higher in yield than the other eighteen entries (Table 2). At the Georgia location, GA T-2454 had the highest pod yielding ability. This pure-line selection is from the 'Florunner' × 'Makulu Red' cross combination. At the Zimbabwe location, the Zimbabwe selection, PI 468135, had the best yield (Table 2). This pure-line selection is also from the 'Florunner' × 'Makulu Red' combination.

Georgia versus Zimbabwe parents and selections were next compared for each location and averaged over the three growing seasons (Table 2). In Georgia, 'Florunner', 'Florigiant', and the eight Georgia selections had significantly higher yields than 'Makulu Red', 486 GKP, and the Zimbabwe selections. Conversely, the mean pod yield of the Zimbabwe selections, when tested in Zimbabwe, was significantly higher than that of the Georgia selections, but no difference was found between the mean yield of the two U.S. and African parents.

This lack of significant differences between these two sets of parents was somewhat surprising at the Zimbabwe location. The two U.S. parental lines, 'Florunner' and 'Florigiant', performed better than the African parents during the first two dry seasons in Zimbabwe, however both Zimbabwe parents

had higher yields than the U.S. parents during the wettest and final season of testing in Zimbabwe.

In summary, these results suggest that the environment under which selection is practised within genetically diverse populations strongly influences the yield adaptability of selected peanut genotypes. Thus, pure-line selections developed in a breeding program at one location should not be expected to perform comparably in different environments.

Zusammenfassung

Vergleich der Hülsenerträge von selektierten reinen Linien der Erdnuß, die im Rahmen eines Züchtungsprogramms gleichzeitig in Georgia und Simbabwe entwickelt wurden

Die zwei in den U.S.A. weit verbreiteten Sorten der Erdnuß (*Arachis hypogaea* L.) 'Florunner' und 'Florigiant' wurden mit zwei an die Anbaubedingungen der Hochebene des tropischen Afrikas angepaßten Genotypen, 'Makulu Red' und 486 GKP, gekreuzt. Die F_2-Populationen wurden gleichmäßig zum Anbau auf Georgia und Simbabwe aufgeteilt. Gleichzeitig wurde an beiden Orten in der frühen spaltenden Generationen Nachkommenschaftsauslese betrieben. Die ertragreichsten reinen Linien wurden wechselseitig ausgetauscht und mit ihnen an jedem Ort über drei Vegetationsperioden Ertragsleistungsprüfungen durchgeführt. Die Sorten 'Florunner', 'Florigiant' und die in Georgia selektierten Linien, die in Georgia geprüft wurden, hatten einen signifikant höheren Hülsenertrag als 'Makulu Red', 486 GKP und die Simbabwe-Selektionen. Andererseits war der Durchschnittsertrag der Simbabwe-Selektionen, die in Simbabwe geprüft wurden, signifikant höher als der Ertrag der Georgia-

Table 2. Mean pod yield (kg/ha) of 20 peanut genotypes at two locations averaged over three growing seasons

Genotype	Location		Mean
	Georgia	Zimbabwe	
Florunner	5937 bc[1]	5709 c	5823 a
GA T-2454	6404 a	4961 fg	5682 a
GA T-2451	5592 de	5368 d	5480 b
GA T-2449	6020 b	4820 gh	5420 b
GA T-2452	5378 de	4981 efg	5188 c
GA T-2448	6012 b	4345 j	5179 c
Florigiant	5334 e	4802 gh	5068 cd
GA T-2455	5635 cde	4499 ij	5067 cd
PI 468135	3473 i	6575 a	5024 cde
PI 468140	4350 g	5666 c	5008 cde
PI 468136	4216 g	5724 c	4970 de
PI 468133	3347 i	6303 b	4825 ef
GA T-2453	5656 cd	3844 k	4750 fg
486 GKP	4705 f	4708 hi	4707 fg
GA T-2450	5354 de	4029 k	4692 fg
PI 468137	3237 i	6069 b	4653 fgh
PI 468139	3511 i	5716 c	4614 gh
PI 468134	3886 h	5081 ef	4484 hi
Makulu Red	3374 i	5210 de	4292 i
PI 468138	2513 j	5604 c	4059 j

	GA	ZE	GA	ZE
Parents	5636A	3863B	5255A	5076A
Selections	5932A	3567B	4489B	5842A

[1] Genotypic means within each column or parent and selection averages within the last row followed by the same letter do not differ significantly at the 0.05 probability level

Selektionen. Die Umweltbedingungen, unter denen die Auslesen aus den Kreuzungspopulationen vorgenommen werden, beeinflussen also die Anpassungsfähigkeit der selektierten Erdnuß-Genotypen hinsichtlich des Ertrags in sehr hohem Maße.

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