Stability Analysis for Yield and Yield Components of Selected Peanut Breeding Lines *(Arachis hypogaea* L.*)* in the North Province of Cameroon

T. Mekontchou[1*], M. Ngueguim[2] & M. Fobasso[3]

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Summary

Six advanced Cameroonian peanut breeding lines (Arachis hypogaea *L.), two introductions from Kano (Nigeria) and one traditionally cultivated variety (control) were grown at four locations during three seasons, giving a total of twelve locations x year combinations. The purpose was to evaluate yield stability and a number of yield components. Significant lines x environment interactions were detected for all traits. Results revealed that most Cameroonian breeding lines including 82Ds 479, 854, 1809 and 1632 had above-average results for pod and seed yields, good stability shown by their regression coefficients (b) close to unity and low non-significant deviations from regression. Lines 82D22P-466 and 82D14S-1809, with mean yields and yield components higher than average and b values lower or close to unity are expected to perform well for these traits in less favourable environments. The introduced line K2044-80 was stable for seed yield but had below average yields. Such a line can be utilized in a breeding programme for transferring stability characters into high yielding cultivars. Significant positive correlations between pod and seed yields vs. 100-seed weight for some lines contributed to their yield increase in poor environments.*

Résumé

Analyse de la stabilité du rendement et de ses composantes de certaines lignées d'arachide *(Arachis hypogaea* L.*)* dans la province du nord Cameroun

*Six lignées avancées d'arachide (*Arachis hypogaea *L.) du Cameroun, deux introductions de Kano (Nigeria) et un témoin local ont été cultivés pendant trois saisons dans quatre localités, constituant ainsi douze combinaisons localité x saison. L'objectif était d'évaluer la stabilité du rendement et de ses composantes. A travers ces différentes combinaisons, l'interaction lignée x environnement était significative pour toutes les variables étudiées. Les résultats de l'analyse de stabilité ont révélé que la plupart des lignées avancées dont 82Ds 479, 854, 1809 et 1632 ont eu des rendements en gousses et en grains supérieurs aux moyennes générales ainsi qu'une bonne stabilité, démontrée par les coefficients de régressions (b) proches de l'unité, ainsi que des déviations par rapport à la régression faibles et non significatives. Les lignées 82D22P-466 et 82D14S-1809 sont supposées produire plus dans les environnements moins favorables compte tenu de leur bon rendement et de leurs coefficients de régression faibles ou proches de l'unité. La variété introduite, K2044-80, était stable pour le rendement en grains quoique inférieure à la moyenne générale. Une telle variété peut être utilisée dans un programme de croisement afin de transférer ses gènes de stabilité dans les cultivars plus productifs. La corrélation positive entre les rendements en gousses et en grains par rapport au poids de 100 grains pour certaines lignées montre leur bonne performance dans les environnements peu favorables.*

Introduction

Peanut (*Arachis hypogaea* L.) means the same thing as groundnut, in north Cameroon is the most important cultivated grain legume crop and covers an estimated 120,000 hectares annually. A wide range of soils are encountered in this zone. Climatic conditions vary not only with location (s) in the same year or growing season (unexpected drier period), but also from year to year at the same location (Table 1). Peanut genotypes do not always respond similarly under these varying climatic conditions. The phenotype reflects non-genetic as well as genetic influence on plant's growth and development. Effects of genotype and environment are not independent (3).

[1*] Institute of Agricultural Research for Development (IRAD), P.O. Box 163, Foumbot, Cameroon. E-mail: mekontchou_thomas@yahoo.com

[2] IRAD, P.O.Box 33, Maroua, Cameroon.

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Table 1
Climatic data (annual rainfall in mm measured with a rain gauge) in the various experimental sites

Sites	Years		
	1992	1993	1994
Touboro	1434	1043	1050
Bere	953	726	771
Mayo Galke	1235	880	1312
Soucoudou	956.5	1334	994

Source: Meteorological Service, IRAD Maroua, Cameroon (1998).

Significant interactions (variety x location, variety x year and variety x location x year) in peanut for yield and yield components (100-seed weight, 20-pod size, shelling percentage and days from planting to maturity) have been reported by several workers (6, 8, 9, 11).

Based on a 2- year data, it has also been reported that interaction influences on seed size were highly significant (7). Peanut varieties that only show small or no genotype x environment interactions are desirable, because of their stable performance across a range of environments. That is why the occurrence of significant first and second order interactions leads to the stability analysis of genotypes across environments (6).

The objective of the present research was to evaluate yield stability and yield components across environments using newly developed North Cameroonian peanut lines. The end result would be to replace the old variety, 28-206, introduced in Cameroon in 1971 (1), which has become less productive and unstable, by one or several more productive and stable genotypes.

Material and methods

Six advanced Cameroonians breeding lines, two introductions from Kano (Nigeria) and one control were grown in 1992, 1993 and 1994 in four locations, i.e. Touboro, Mayo Galke, Soucoudou and Bere, giving a total of twelve combinations of locations and years. The four locations chosen represent the main peanut belt of the country. At Touboro and Mayo Galke, experiments were conducted on paleustalfs; the soils at Soucoudou and Bere were acrustox and durustalfs, respectively (according to US taxonomy).

The experimental design, a randomized complete block design (4), number of replications (four) and, set of varieties (nine) were similar in all locations. Experimental plots consisted of four 8 m long rows. Seeds were spaced 20 cm between plants and 50 cm between rows. Experiments were conducted in accordance with locally recommended cultural practices (by SODECOTON*): row planting on flat land, followed by molding (at flowering time) and manual weeding; peanut is grown in rotation with cotton or maize, and only benefits from a residual fertilizer effect from the previous crop. Data were collected on the two inner rows of each plot and included pod and seed dry weights (about 8% moisture) per plot (kg), 100-seed weight (g), 20 pod size (cm) and shelling percentage (%) calculated from pod and seed weights ((seed weight/pod weight)* 100). Pod and seed weights were obtained using a laboratory scale (Universal) with precision to 0.1 g, and converted onto t/ha. Twenty pods were sampled and measured using an appropriate ruler with precision to 0.1 cm. After shelling, 100 seeds were sampled and weighed using an electronic scale with precision to 0.1 g (Mettler PC 4400).

Analysis of variance by location was first performed using MSTATC software on all variables. Means separation was carried out following Least Significant Difference method (10). Pooled analysis of variance was then performed on significant variables having homogenous variances. For this purpose, Bartlett's procedure (2) was used.

Environments were assumed to be random effects (susceptible to be affected by climatic conditions), while genotypes were considered fixed effects as the objective of the trial was limited to the nine peanut lines tested (i.e the result of the experiment was not going to be generalized on other peanut lines).

Stability parameters [linear regression coefficient (b value), and deviation from regression (S_d^2) of genotype means over environment index] were computed as suggested by Eberthart and Russell (5).

Simple correlations between all variables were computed for each genotype, with the understanding that components were not independent of yield.

Results and discussion

Environmental mean pod yield ranged from 0.927 to 2.527 t/ha, mean seed yield from 0.566 to 1.608 t/ha, mean 100-seed weight from 35.2 to 41.3 g and mean 20-pod size from 52.6 to 54.4 cm. The highest yielding environments were Mayo Galke and Bere whereas the lowest yielding were Soucoudou and Touboro. Low yields encountered at Soucoudou were attributed in part to soil erosion following heavy rains during the 1993 cropping season (Table 1).

Analysis of variance across lines, locations and years indicates highly significant differences among genotypes for all traits with the exception of shelling

* Société de développement de coton

Table 2
Analysis of variance for Pod yield, Seed yield, 100-seed weight, 20-pod size and Shelling percentage of peanut genotypes combined over years and locations

Source of Variation	df	Means squares				
		Pod yield	Seed yield	100-seed weight	20-pod size	Shelling percentage
Years (yrs)		13.2 ns	4.79 ns	37.47 ns	23.8 ns	246.9 ns
Location (loc)	2	56.0 **	22.2 **	693.3 *	65.64 ns	245.4 ns
yr * loc	3	5.19 **	1.45 **	83.35 **	38.38 **	761.7 **
Rep (yr* loc)	6	0.192	0.101	10.626	3.223	61.76
Line (L)	36	2.52 **	1.248 **	430.9 **	449.7 **	86.7 ns
L * loc	8	0.26 *	0.097 ns	14.09 ns	18.22 **	35.02 ns
L * yr	16	0.21 ns	0.11 ns	12.88 ns	12.09 ns	35.9 ns
L * loc * yr	48	0.14 **	0.078 *	11.13 **	7.229 **	62.76 **
Pooled error	288	0.096	0.051	6.765	4.593	33.34
C.V (%)		17.1	19.9	6.85	4.02	9.28

*, **, ns: significant at 0.05 and 0.01 probability levels and non-significant, respectively.

percentage (Table 2). Year x location and genotype x location x year interactions were significant for all traits, which indicates that differences exist among genotypes in their response to changes in environment. Genotype x location interaction was significant for pod yield and 20-pod size. Genotypes 82D22P-466 and 82D12P-479 outyielded the check variety by 29.3% and 33.0% for pod and seed yields, respectively. The performance of the control variety was always lower than the general mean obtained for all varieties and for all traits.

Mean pod and seed yields, mean 100-seed weight and 20-pod size, regression coefficients (b) and deviations from regression (S_d^2) are shown in table 3.

Table 3
Means and estimates of stability parameters for Pod yield, Seed yield, 100-seed weight and, 20-pod size, for peanut genotypes evaluated across 12 environments

Genotypes	Pod yield			Seed yield		
	Mean (t/ha)	b	S_d^2	Mean (t/ha)	b	S_d^2
82D22P-466	2.005	0.87	0.3	1.303	0.99	0.26
82D12P-479	2.041	0.92	-2.37	1.305	0.94	-0.91
82D02B-854	1.885	0.95	0.1	1.174	0.89	-0.8
82D14S-1809	1.875	1.04	-0.9	1.139	1.02	-0.74
82D23B-773	1.935	0.94	2.50	1.214	0.97	-0.03
82D14S-1632	1.904	0.99	-0.55	1.186	1.02	-0.15
K720-78	1.728	1.11	-1.3	1.068	1.06	-0.97
K2044-80	1.444	1.07	11.3	0.879	0.91	1.57
28-206 (check)	1.418	1.10	-1.85	0.873	1.16	0.23
Overall mean	1.804			1.127		
Lsd (0.05)	0.155			0.114		

Genotypes	100-seed weight			20-pod size		
	Mean (g)	b	S_d^2	Mean (cm)	b	S_d^2
82D22P-466	41.9	0.99	-1.042	53.5	0.65	-0.31
82D12P-479	42.1	1.00	-1.202	53.9	0.33	-0.55
82D02B-854	35.6	0.74	-0.257	49.9	1.34	-0.77
82D14S-1809	38.1	0.85	-1.542	54.9	0.29	-0.69
82D23B-773	40.5	0.98	0.390	54.0	1.69	-0.81
82D14S-1632	35.3	0.52	0.846	52.3	1.17	9.21
K720-78	36.3	1.41	-0.349	51.9	1.40	-1.02
K2044-80	37.3	1.26	0.330	59.8	0.81	-0.46
28-206 (check)	33.9	1.21	-0.208	49.5	1.34	1.31
Overall mean	37.9			53.3		
Lsd (0.05)	1.37			1.1		

Table 4
Simple correlations (r values) between yield and yield components by peanut genotype across 12 environments

Genotypes	Pod yield vs 100-seed weight	Seed yield vs 100-seed weight	Pod yield vs 20-pod size	Seed yield vs 20-pod size
82D22P-466	0.77**	0.83**	0.59*	0.65*
82D12P-479	0.70**	0.74*	0.50	0.42
82D02B-854	0.56**	0.51*	0.14	0.30
82D14S-1809	0.45	0.53	0.24	0.12
82D23B-773	0.68*	0.68*	0.85**	0.86**
82D14S-1632	0.04	0.09	-0.50	-0.52
K720-78	0.58	0.66*	0.55	0.56*
K2044-80	0.53	0.58	0.68*	0.72
28-206	0.58	0.53	0.26	0.27

*, **: significant at the 0.05 and 0.01 probability levels, respectively.

On the basis of the three stability parameters (mean performance, linear regression and deviation from regression) genotypes 82D03B-854, 82D14S-1809 and 82D14S-1632 were stable with respect to pod yield (5). The latter two genotypes were also stable with respect to seed yield (5). Genotypes K720-78 and 28-206 (control) are sensitive to environmental changes and have below average stability for pod yield, seed yield, 100-seed weight and 20-pod size. Genotype 82D22P-466 is stable for seed yield and 100-seed weight, hence responds well to favorable environments; it also interacts well with poor environments with respect to 20-pod size.

Cameroonian lines 82Ds 479, 854 1809 and 1632 had above average mean for pod and seed yields, good yield stability, with b values close to unity and low non-significant negative deviations from regression. Lines 82D22P-466 and 82D14S-1809, because they had mean yields and yield components higher than average and b values lower or close to unity are expected to perform well for these traits in less favourable environments (5). K2044-80 was stable for seed yield but had below-average yields; such a variety can be utilized in a breeding programme for transferring stability genes into high yielding cultivars. Genotype 82D23B-773 with b value lower than one and large S_d^2 seems to be adapted to low yield environments with respect to pod yield (5). On the contrary, 82D12P-479, with b value equal to unity for 100-seed weight can be used with success in a wide range of environments since it shows high mean performance for that trait.

Pod yield was significantly correlated with 100-seed weight in four out of the nine genotypes (Table 4), while seed yield was positively correlated with 100-seed weight in five genotypes; this probably explains their yield increase in poor environments.

Seed yield had the greatest positive correlations with 100-seed weight in all genotypes but one (Table 4) indicating that yield increases with 100-seed weight for these lines (i.e. the higher the 100-seed weight, the higher seed yield will be).

Genotype 82D14S-1632 was the only local line to show low and non-significant correlations between pod/seed yields and 100-seed weight. This indicates that for this particular genotype, 100-seed weight is not an appropriate parameter to characterize pod and seed yields when stability analysis is concerned. Negative and non-significant correlations between pod/seed yields and 20-pod size for the same genotype indicate poor pod filling.

Conclusion

New varieties generally combine high yields with stability in seed size. As such, genotype 82D12P-479 is therefore likely to be a good replacement for 28-206 and can help improve peanut production in the north province of Cameroon. This variety will undergo on-farm testing which will be followed later on by seed multiplication for release.

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T. Mekontchou, Cameroonian, MSc in Plant Breeding, Latest address: Legume Crops Programme, IRAD Foumbot Station, Cameroon.
M. Ngueguim, Cameroonian, MSc from North Carolina State University (USA), Soil Science Department, Soil scientist, Reseracher, IRAD Foumbot Station, Cameroon.
M. Fobasso, Cameroonian, Msc. from University of Alabama (USA), Researcher, IRAD Maroua, Cameroon.

ERRATA

In the article entitled “The Effect of Three Dietary Crude Protein Levels one Digestibility and Tests Function in Male Pubertal Rabbits” of which the authors are A.O.Ladokun, G.N. Egbunike, D.O. Adejumo & O.A. Sokundi, Volume 24,1, pp. 3-6, an error occurred into the title, on several times in the main text and in the contents. Testis in english is spelled in the plural with an e (testes), and cannot be confused with test (tests) in plurial.
In the french title and summary “Testicules” have to be in place of “Tests”.
We apologize to the main-author and to our readers.

Dans l’article intitulé “The Effect of Three Dietary Crude Protein Levels on Digestibility and Tests Function in Male Pubertal Rabbits” dont les auteurs sont A.O. Ladokun, G.N. Egbunike, D.O. Adejumo & O.A. Sokundi, Vol 24,1, pp. 3-6, une erreur s’est glissée dans le titre, à plusieurs reprises dans le corps du texte ainsi que dans le sommaire. Testis en anglais (testicule) s’orthographie au pluriel avec un e (testes), et ne peut être confondu avec tests.
Il y a lieu également de remplacer “tests ” par “testicules” dans le titre du résumé en français.
Nous nous en excusons auprès de l’auteur principal ainsi qu’auprès de nos lecteurs.