An Appraisal of Line Performance in Upland Cotton (*Gossypium hirsutum* L.) Breeding Trials in Northern Nigeria Using the Performance Index Approach

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Summary

The importance of genotype x environment interactions reflects the necessity of evaluating genotypes in more than a single environment. The plant breeder selects superior genotypes for eventual release as commercial varieties based on a rating of these genotypes across varied environments for stability/adaptability. This paper describes the performance of ten advanced cotton lines in experiments replicated over two seasons and four locations in northern Nigeria. A rating of the ten lines across environments was also attempted using the performance index approach. The lines SAMCOT-10 and ACSA (79) 5B were the most outstanding in yield performance across years and locations while ASA (74) 80 and RASA (78) 11A were the lowest in performance. The use of the performance index approach in the rating of cultivars across varied environments is recommended because of ease of computation and interpretation when the number of entries and test environments are large

Résumé

Evaluation de la performance des lignées du cotonnier *(Gossypium hirsutum* L.) au moyen de l'indice des performances dans les régions du nord du Nigeria

L'importance des interactions génotype x environnement souligne la nécessité d'évaluer les génotypes dans plus d'un environnement. L'améliorateur des plantes cultivées sélectionne des génotypes aux caractéristiques supérieures pour une éventuelle diffusion en tant que variétés commerciales en fonction de la stabilité et de l'adaptabilité de leurs performances dans une large gamme de milieux. Cet article décrit les performances de 10 lignées élites de cotonniers dans des essais répétés au cours de deux saisons de culture et dans quatre sites du nord du Nigeria. Le classement de ces dix lignées a également été effectué au moyen de l'indice de performance. Les lignées SAMCOT-10 et ACSA (79) 5B ont été les meilleures pour l'ensemble des sites et les deux saisons de culture tandis que ASA (74) 80 et RASA (78) 11A étaient les lignées les moins compétitives. L'utilisation de l'indice de performance dans le classement des génotypes à travers différents environnements est recommandée à cause de la facilité de calcul et d'interprétation de ce paramètre quand le nombre d'entrées et le nombre de sites d'évaluation sont élevés.

Introduction

The ultimate aim of a crop improvement programme is the development of improved crop varieties and their release for production. Before lines are released as superior performing types, they are tested in multilocational and macroplot experiments for several years. Such zonal trials identify which line is best for what environment. The identification of superior lines is based on an assessment of differences among line means and their statistical significance. Whenever a significant test is used to discriminate between entries, the usual way of presenting data is to arrange the entry means in order of descending magnitude. Any two means not differing significantly are either underscored by the same line or signed by the same letter. Likewise any two means differing significantly are not underscored by the same line or are signed by different small letters. This presentation of data although universally established, lacks simplicity and as the number of entries increases, discrimination by the eye becomes problematic (6). This paper presents the use of an alternative approach, the performance index (6) to evaluate the performance of entries in upland cotton variety trials in northern Nigeria.

Material and methods

The materials used as entries were selections from advanced breeding lines from the germoplasm pool of the Institute for Agricultural Research, Ahmadu Bello University, Samaru (2, 3, 4). Ten of these lines were evaluated for two years, 1992 and 1993 at four locations, Samaru, Daudawa, Kadawa and Tumu, in northern Nigeria using the randomized complete block design with three replications. Plots consisted of two rows 10 m long, spaced 0.91 m apart. Four to six dressed seeds were planted per hole with 45 cm spacing between holes and the seedlings were thinned to two plants per hill at 3- 4 weeks after planting. Boronated single superphosphate (with 5% borax as source of boron) was applied to the experimental area at the rate of 125 kg per hectare during land preparation. Calcium

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ammonium nitrate (Nitrochalk) was applied at the rate of 125 kg per hectare after thinning. Weeding started early and was done regularly. Insect pests were controlled by three fortnightly sprays of Cymbush 10 EC at the rate of 2.5 liters per hectare starting at 9 weeks after planting. Data used for the analysis was taken from mean seed cotton yields per plot. An analysis of variance was done according to Steel and Torrie (10). For computation of the cultivar performance index, the mean values of seed cotton yield for the entries were arranged in descending order of magnitude per site and per year. Applying a one –tailed test, LSD obtained from the analysis of variance for each site and year was substracted from the first mean. The value obtained was compared to the entry means. The number of entry means smaller than this value depicts the number of entries that are significantly inferior, at the chosen level of significance, to the first entry mean. This number is noted "m". The process is repeated for the second and subsequent entries and a series of "m" values are obtained for each entry in each year and site. The cultivar performance index calculated as:

$$P = \frac{100\ m}{(n-1)} \qquad .....(6)$$

Where: m = number of significantly inferior lines
n = number of lines tested in the trial

Results and discussion

The performance of the ten advanced lines in two years and four locations are summarized in tables 1 and 2.

The lines, SAMCOT-10 and SAMCOT-8 with cultivar performance indices of 56 and 44 respectively were the most outstanding in yield performance in the 1992 trials at Samaru. Their performance indices denote that these lines outyielded significantly 56% (SAMCOT-10) and 44% (SAMCOT-8) of all the lines tested at Samaru. The lines SAMCOT-6, SAMCOT-9, ACSA (79) 8C and RASA (78) 11A have zero P, denoting that they failed to outyield significantly even a single line at this location. At Kawada, the lines SAMCOT-10, RSA (79) 4A, SAMCOT-6 and ACSA (79) 5B performed very well, outyielding significantly, 11% of all the other lines entered in the trial. There were however no significant differences between entries in the trial at Daudawa (P= 0). Although the entries RSA (79) 4A, ACSA (79) 5F, RASA (78) 11A and ACSA (79) 8C all had a performance index of 11 at Tumu, indicating that their yield performance were not significantly different from each other, each one of them was significantly higher yielding than 11% of all the other entries at this site. The trend in performance of the entries in the 1993 trials (Table 2) was apparently different from 1992 trials.

At Samaru, the lines SAMCOT-9, with a performance index of 56 was the most superior, outyielding, significantly, 56% of all the other entries. At Kadawa, ACSA (79) 8C outperformed 44% of all the lines tested. The two lines SAMCOT-10 and SAMCOT-6 were the highest yielding entries at Daudawa where they both significantly outyielded 33% of all the other entries. All the entries in the trial at Tumu in 1993 performed very well. One entry, ACSA (79) 5B, however stands out as superior, outyielding significantly 67% of all entries at the

Table 1
Performance of ten advanced cotton lines according to mean and performance index (P), 1992

Entry	Samaru			Kadawa			Daudawa			Tumu		
	Mean	m	p	Mean	m	p	Mean	m	p	Mean	m	p
SAMCOT- 10	1058	5	56	1355	1	11	452	0	0	1154	0	0
SAMCOT- 8	1002	4	44	1172	0	0	500	0	0	1044	0	0
RSA (79) 4 A	874	2	22	1338	1	11	302	0	0	1209	1	11
ACSA (79) 5B	874	2	22	1374	1	11	494	0	0	1154	0	0
ACSA (79) 5F	842	1	11	1282	0	0	420	0	0	1191	1	11
ASA (74) 80C	793	1	11	1209	0	0	540	0	0	915	0	0
RASA (78) 11 A	700	0	0	971	0	0	538	0	0	1172	1	11
1ACSA (79) 8C	693	0	0	1209	0	0	375	0	0	1227	1	11
SAMCOT- 9	608	0	0	1300	0	0	522	0	0	1136	0	0
SAMCOT- 6	484	0	0	1429	1	11	375	0	0	1117	0	0

Table 2
Performance of ten advanced cotton lines according to mean and performance index (P), 1993

Entry	Samaru			Kadawa			Daudawa			Tumu		
	Mean	m	p	Mean	m	p	Mean	m	p	Mean	m	p
SAMCOT- 10	613	0	0	567	0	0	760	3	33	1172	1	11
SAMCOT- 8	358	0	0	591	0	0	492	0	0	1282	1	11
RSA (79) 4A	568	0	0	696	0	11	570	0	0	1209	1	11
ACSA (79) 5B	468	0	0	751	0	11	503	0	0	1483	6	67
ACSA (79) 5F	559	0	0	623	0	0	557	0	0	1154	1	11
ASA (74) 80C	681	0	0	824	0	0	532	0	0	916	0	0
RASA (78) 11A	496	0	0	586	0	0	562	0	0	1264	1	11
1ACSA (79) 8C	757	0	0	916	4	44	750	2	22	1300	1	11
SAMCOT- 9	988	5	56	824	0	0	448	0	0	1319	1	11
SAMCOT- 6	613	0	0	696	0	11	782	3	33	1191	1	11

site. The differential performance of the ten genotypes in the two years and four locations used for these trials brings out very cleary the existence of genotype x environmental interactions. The existence of genotype x environmental makes the screening of genotypes for high stability/adaptation under varying environmental conditions an essential step in all any plant breeding programme. The rating of genotypes across environments for yield stability/adaptation has been done using several methods (1, 7, 8, 9, 11, 12). An alternative method is the cultivar performance index (P). A rating of the ten lines tested across years, locations and year x locations using this method is presented in table 3.

Across the two years, SAMCOT-10, SAMCOT-9 and SAMCOT-8 having the highest values of P were the most superior lines at Samaru. ACSA (78) 8C, RSA (79) 4A and SAMCOT-10 were the best in Kadawa, SAMCOT-10 and ACSA (79) 8C were the most outstanding at Daudawa and ACSA (79) 5B was the most outstanding at Tumu. When the performance index is taken across the four locations, the best entries in 1992 were SAMCOT-10, SAMCOT-8 and RSA (79) 4A and in 1993 were ACSA (79) 8C, SAMCOT-9, and ACSA (79) 5B. Across the two years and four locations the most outstanding lines were SAMCOT-10, ACSA (79) 5B and ACSA (79) 8C. It will be noted that apart from small shifts in position, the performance index brings out the two lines SAMCOT-10 and ACSA (79) 5B as the most outstanding in these trials. The lines SAMCOT-10 incidentally has been found to be a very stable cotton cultivar and was recently released for production as a new cotton variety (5) because of this attribute. The attraction of the performance index approach in the rating of cultivars across environments is in relation to its ease of computation and interpretation especially when the number of entries and test-environments are large, a situation which makes other conventional methods more cumbersome.

Table 3
Rating of ten advanced cotton lines using to performance index

Entry	Across two years Py				Across four locations Ps			Across 2 years = & four locations	
	Samaru	Kadawa	Daudawa	Tamu	Entry	1992	1993	Entry	Pys
SAMCOT- 10	28	6	17	6	SAMCOT-10	17	11	SAMCOT-10	15
SAMCOT- 9	28	0	0	6	ACSA(79)5B	8	17	ACSA (79)5B	13
SAMCOT- 8	22	0	0	6	SAMCOT- 8	11	3	ACSA (79)8C	11
RSA (79) 4A	11	6	0	11	RSA (79) 4A	11	3	SAMCOT- 9	9
ACSA (79)5B	11	6	0	34	SAMCOT- 6	3	11	SAMCOT- 8	7
ACSA (79)5F	6	0	0	11	ACSA (79)5F	6	3	SAMCOT- 6	4
ASA (74) 80C	6	0	0	0	ACSA(79)8C	3	19	RSA (79) 4A	7
ACSA (79)8C	0	22	11	11	RASA(78)11A	3	3	ACSA (79)5F	4
SAMCOT- 6	0	0	0	6	SAMCOT- 9	0	17	RASA(78)11A	3
RASA(78)11A	0	0	0	11	ASA (74) 80C	3	0	ASA (74) 80C	1

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