38 VERONA, C.A.; LOFFLER, C.M.; FERNANDEZ, O.N. 1980. Efecto de la densidad de plantas sobre el rendimiento y la distribución del nitrógeno en "T. durum" Desf. Revista de Inv. Agropecuarias (Arg.) 15(1):75-95

39 WARDLAW, I.F. 1970. The early stages of grain development in wheat response to light and temperature in a single variety. Australian Journal of Biology Science 23:765-774.

40 YOSHIDA, S. 1972. Physiological aspects of grain yield. Annual Review of Plant Physiology 23:437-464.

Evaluation of Soybean Lines for Drought Tolerance and the Influence of Water Availability on Cookability[1]

O.D. Mwandemele, A. Doto***

ABSTRACT

Thirty soybean germplasm lines were evaluated for drought tolerance and the influence of water availability on cookability was studied. Genetic variation among lines was observed for most characters studied. Water availability appeared to have affected the number of pods per plants, beans per pod, days to 95% maturity, bean yield and cookability. The importance of screening of existing germplasm lines and selection of suitable lines for use in drought-affected areas is discussed.

COMPENDIO

Se evaluaron treinta líneas de germoplasma de soya por tolerancia a la sequía; a la vez, se estudió la influencia de la disponibilidad de agua en la capacidad de cocción de esas líneas. Se registró la variación genética entre líneas para varias características estudiadas. Pareciera que la disponibilidad de agua afectó el número de vainas por planta, semillas por vaina, número de días a 95% de madurez, rendimiento de grano y capacidad de cocción. Se discute la importancia de seleccionar (por "tamizado") el germoplasma existente así como la determinación de cuáles líneas se deben utilizar como progenitoras, en programas de mejoramiento que se lleven a cabo en áreas afectadas por la sequía y en donde ésta sea un factor limitante de la producción.

INTRODUCTION

Drought is a major limiting factor on crop yields. Soybean experiments have shown that it is sensitive to water stress in the post-flowering rather than pre-flowering period (9). Varietal differences in susceptibility to water stress were reported by Mederski *et al.* (4), indicating the possibility of selecting drought-resistant lines for areas of limited water supply. For countries like Tanzania, which consists of different agroecological zones, with high frequencies of drought spells in some zones, breeding and selection of soybeans for the different zones becomes important. Because of limited resources, screening of germplasm lines for drought-tolerant lines takes priority over searching for resources to mount an intensive breeding programme, since it is a quicker way of providing the needed varieties to farmers.

Whereas the effect of water stress on such important traits as yield, protein and oil are fairly well studied (2, 5), there is no information available in the literature on the influence of drought on the cookability of soybeans. This study was undertaken in order to provide information on the influence of water availability during growth on the cooking quality of soybeans, in addition to providing information on the variability for drought tolerance among germplasm lines used in the soybean crop improvement programme.

MATERIALS AND METHODS

Evaluation of soybean lines for drought tolerance was achieved by growing the plants under simulated drought-stressed conditions in field experiments at Morogoro during the dry season. Three identical experiments were set up, each with two replications. In one experiment, the plants were irrigated once every five days, in the second every ten days, and in the third plants were irrigated every 14 days. Plant rows in each plot were 2.0 m long, and were 0.75 m

1 Received for publication 24 April 1987.

* Department of Botany, University of Dar es Salaam, P.O. Box 35060 Dar es Salaam – Tanzania

** Department of Crop Science, Sokoine University of Agriculture, P.O. Box 3005, Morogoro – Tanzania.

Table 1. Mean squares obtained from analysis of variance for each of the characters studied.

Source of variation	df	F^{50}	P^{95}	Height	Pods/Plant	Seed/Pod	Seed Yield	Cookability
Replications	1	9 34NS	0 55 NS	296.96NS	0 09NS	0 04NS	65 073.89*	75 102.34**
Soybean lines (A)	29	107 86**	381 64**	194.91**	41 69NS	0 152NS	16 543 35**	6 539.87**
Error (a)	29	4 48	12.78	71 59	34.49	0 10	6 285.95	1 102.89
Water Treatments (B)	2	12 54NS	180.00**	388 48NS	966.01**	0 53**	115 322.95**	118 242.19**
Interaction AxB	58	15 79**	16 16NS	27 79NS	44.21NS	0 15NS	6 573 02NS	2 385.60**
Error (b)	60	6.35	13 37	129.76	34 51	0 10	7 519.35	1 421.76

NS Indicates not significant

* and** indicate significant values at 0 05% and 0 01% level of probability, respectively

apart. Between replications, spacing was 2.0 m. The experiments were 3.0 m apart. Sowing rate was 30 seeds/m. Single super phosphate plus Mo super was used to fertilize the soil at the rate of 224 kg/ha

Data collected during the experimentation included days taken for 50% of plants in a row to flower (F^{50}), time taken to reach 95% maturity (P^{95}), plant height at maturity, pods per plant, number of beans per pod, bean yield and hardness after cooking the beans for half an hour (cookability). Cookability was tested using the method of Makkar *et al* (3), with a slight modification (8).

RESULTS

Genotype variation was observed for plant height, days taken to reach F^{50}, days taken to reach P^{95}, and bean yield (Table 1). Water availability was found to have profound effects on pods per plant, number of beans per pod, time taken to reach maturity, and bean yield Characters such as plant height and flowering time appeared not to be influenced by water availability in this study, suggesting that these two traits may not be good indicators of water stress effects in some soybean populations

Table 1 gives also the mean square values derived from the analysis of variance for cookability Differences in cookability were observed among lines indicating the possibility of selecting rapid-cooking lines among the germplasm material. The significant mean square value for water treatments indicates that water availability during growth affected the cookability of beans even though the significant interaction term suggests that the influence of water availbility on cookability was not the same for all genotypes. This observation is further supported by the mean values for cookability presented in Table 2.

DISCUSSION

The influence of water availability on bean yield and yield component has been well demonstrated in this study. Line differences among the germplasm material were observed and the genotype TGX536-02D, C14, TGX533-65C, TGX536-100C-Y and L2-4 were found to perform relatively better under conditions of limited water supply. This suggests that some of the problems of poor yields resulting from lack of cultivars adapted to drought conditions could be minimized if efforts were made to screen available germplasm lines, which may lead to identification of lines that can be put to immediate use.

The genetic nature of cookability and factors affecting this trait have been discussed by Mwandemele *et al.* (6, 7). In the present study water availability during plant growth has been shown to influence the cookability of soybeans. Beans obtained from drought-stressed plants appeared to cook faster, probably due to the reduced size of the beans harvested from these plants (9). Mwandemele *et al.* (7) demonstrated the influence of bean size on the cookability of soybeans, small beans cooking faster than larger ones While it is true that water stress may enhance the cookability of soybeans due to the associated effect on bean size, it cannot be argued that farmers should be encouraged to limit water availability to their soybean crops; if this were to be done, yield would be adversely affected. The best suggestion is that breeders select small to medium beans and high-yielding lines with a wide range of adaptability, even though selection of small bean varieties would appear to go against the tradition of selecting large bean genotypes for vegetable use (1)

Table 2. Mean values of hardness (cookability) after cooking soybean seeds harvested from plants grown under three different water treatments.

Line	Cookability of Seeds (g)			
	$WT_{(5)}$	$W_{I\,(10)}$	$WT_{(14)}$	Line Average
C37	261.4	232.0	208.9	234.1
S8–1	251.6	138.7	167.5	185.9
Hardee	231.2	166.9	184.1	194.1
C34	306.1	344.1	238.7	296.3
S1–8	277.5	202.4	242.2	240.7
SHR–2	316.1	212.5	213.6	247.4
C49	316.1	216.4	171.0	234.5
C26	312.0	264.7	282.1	286.3
C12	327.1	226.9	214.7	256.2
TGX536–02D	285.7	256.6	199.4	247.2
C27	299.7	224.0	223.0	248.9
C41	302.0	181.5	207.5	230.3
C44	336.1	298.0	275.6	303.2
C47	264.4	220.3	230.9	238.5
C9	283.1	233.9	235.7	232.3
C46	290.5	232.2	181.7	234.8
C14	329.7	175.2	187.0	230.6
TGX713-09D	348.3	211.2	267.6	275.7
TGX533–65C	324.3	207.0	214.5	248.6
TGX536–100C-Y	251.1	164.3	165.6	193.6
C51	301.2	180.1	239.4	240.2
Cable	258.0	138.0	192.9	196.3
C48	279.5	207.6	238.4	241.8
L2–4	396.1	292.1	251.2	313.1
S1–2	224.6	208.1	186.7	206.4
S9–2	216.3	127.4	191.8	127.4
S1–5	252.6	181.3	201.6	211.8
Brossier	291.3	248.7	216.8	252.2
L2–3	280.4	190.6	246.6	239.2
S8–2	360.1	226.2	204.2	263.5
Water Treat. Average	292.3	217.6	213.1	–

$WT_{(5)}$, $WT_{(10)}$ and $WT_{(14)}$ indicate treatments for plants watered after every 5, 10, and 14 days, respectively

LITERATURE CITED

1 BRIM, C.A. 1973 Quantitative genetics and breeding. In Soybeans: improvement, production and uses. Ed. by B.E. Caldweld. Madison, American Society of Agronomy.

2. KRAMER, P.J. 1982. Water and plant productivity or yield. In Handbook of Agricultural Productivity. Ed. by M. Rechcigl. Boca Raton, CRC Press. v. 1.

3 MAKKAR, H.P.S.; SHARMA, O.P.; SEGI, S.S. 1982. A method for measuring the firmness of cooked soybean (*Glycine max*) seeds. Journal of Food Science and Technology 19:104-106.

4. MEDERSW, H.J.; JEFFERS, D.L.; PETERS, D.B. 1973 Water and water relations. In Soybeans: improvement, production and uses. Ed. by B.E. Caldweld. Madison, American Society of Agronomy.

5. MILLER, J.R.; BEARD, B.H. 1967. Effects of irrigation management on chemical composition of soybeans in the San Joaquin Valley. California Agriculture 21(10):8-10.

6. MWANDEMELE, O.D.; McWHIRTER, K.S.; CHESTERMAN, C. 1984. Genetic variation in soybean (*Gly-*

cine max (L.) Merril.) for cookability and water absorption during cooking. Euphytica 33:859-864.

7. MWANDEMELE, O.D.; McWHIRTER, K.S.; CHESTERMAN, C. 1984 Improving the quality of soybean (*Glycine max*) for human consumption: Factors influencing the cookability of soybean seeds. Journal of Food Science and Technology 21:286-290.

8. MWANDEMELE, O.D. 1985 Evaluation of soybean germplasm lines for cookability and storing ability. Tanzania Journal of Science v. 11.

9. WIEN, H.C.; LITTLETON, E.J.; AYANABA, A. 1979. Drought stress of cowpea and soybean under tropical conditions. In Stress Physiology in Crops. Ed. by H. Mussell, R.C. Staples. New York. John Wiley.

Descripción Sistemática de la Colección de Pejibaye. I. Determinación del Método de Muestreo, Muestra Mínima, Influencia del Año y Epoca de Cosecha para Características Cuantitativas del Fruto[1]

*J.A. Morera**

ABSTRACT

The study of the minimum sample and of sampling procedures in general in the pejibaye plant (*Guilielma gasipaes* H.B.K.) showed highly significant differences between buds, although not between trunks/buds, clusters on the trunk, positions in the cluster, position of spikes, and fruit on the spike. Apparently, the sampling procedures utilized revealed only genetic variation (buds). Chronology (age in years) was found to be significant for length of fruit, but not for weight and diameter of the seed. Time of harvest proved to be a significant variable in terms of number of clusters per trunk and number of partheno-carpic fruits per cluster. Age in years and time of harvest did not influence seed characteristics; thus, these variables may be useful in distinguishing genotypes within a given population.

COMPENDIO

El estudio de muestreo en pejibaye (*Guilielma gasipaes* H.B.K.) y la muestra mínima para características del fruto, revelaron diferencias altamente significativas entre cepas pero no así entre estípetes (troncos) dentro de cepas, racimos dentro de troncos, posiciones dentro del racimo, espigas dentro de posiciones y frutos dentro de espigas. De esta manera, el muestreo y la muestra mínima delucidaron solamente variación en el factor genético (cepa). Se encontró que existe marcada influencia del año sobre la longitud del fruto, no así para el peso, diámetro del fruto y semilla, respectivamente. Por su parte, la época de cosecha mostró diferencias altamente significativas sobre número de racimos por estípete y número de frutos partenocárpicos por racimo. Así, el año y la época de cosecha no revelaron influencia alguna sobre los carácteres de la semilla; por lo tanto, estos pueden ser factores útiles para diferenciar genotipos en una población dada.

INTRODUCCION

La descripción sistemática juega un papel importante en los bancos de germoplasma. No sólo es un paso esencial en la utilización de los recursos fitogenéticos sino que por medio de ella se obtienen algunas características cuantitativas y cualitativas que permiten conocer y divulgar mejor sobre la expresión fenotípica de una colección dada.

El pejibaye (*Guilielma gasipaes* H.B.K.) es motivo de estudios por investigadores de varios países de América; hoy día ocupa un lugar especial entre las especies americanas no tradicionales con un alto valor nutritivo. El pejibaye es una especie alógama, multiplicada generalmente por semilla. Es poco lo que se conoce de su genética y sus características, así como de sus variaciones dentro y entre cepas. Al respecto, Mora Urpí (4) señala que el pejibaye de fruto grande que se cultiva en la actualidad es una planta de origen reciente, posterior al descubrimiento de la agricultura por nuestros aborígenes y quizás no mayor de los 4 000 años.

1 Recibido para publicación el 14 de julio de 1987.
Parte de la tesis de M.Sc. presentada por el autor al Programa de Estudios de Posgrado en Ciencias Agrícolas y Recursos Naturales de la Universidad de Costa Rica y el Centro Agronómico Tropical de Investigación y Enseñanza. El autor agradece la financiación del Proyecto CATIE/GTZ, así como al M.Sc. Jan Engels por su cooperación en este estudio.

* Fitomejorador. Calles 7 y 9, Avenida O. Alajuela, Costa Rica