SCREENING SWEET POTATOES FOR LOW CO_2 COMPENSATION POINT

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SUMMARY

Sweet potato lines from four populations obtained from Japan, Puerto Rico and the United States were screened for low CO_2 compensation concentration. Some of the tested plants from each of the four populations appear to have lower CO_2 compensation points than others.

RESUME

Des lignées de patate douce apartement à quatre populations et obtenues du Japon, de Porto Rico et des Etats Unis ont été étudiées pour en dégager celles qui présentent une concentration de compensation basse en CO_2. Certaines des plantes tirées des quatre populations et soumises à l'essai paraissent avoir des points de compensation plus bas en CO_2.

RESUMEN

Se seleccionaron líneas de camote procedentes de cuatro poblaciones de Japón, Puerto Rico y los Estados Unidos por baja concentración de CO_2 en el punto de compensación. Algunas de las plantas probadas, de cada una de las cuatro poblaciones parecen tener más bajos puntos de compensación de CO_2 que otras.

INTRODUCTION

Net photosynthetic rates of up to 60 mg CO_2 dm^{-2} hr^{-2} have been reported in maize, sorghum and sugarcane, and they are also known to occur in the Amaranthaceae and Chenopodiaceae.[3] These high rates are almost twice those of temperate zone grasses[3,4]. The lower net photosynthetic efficiency of the temperate species is associated with a higher rate of photo-respiration and high carbon dioxide compensation points[2].

Because of the established correlation over a number of plant species[1,6], between low carbon dioxide compensation concentration and high photosynthetic efficiency, the sweet potato germplasm collection at the International Institute of Tropical Agriculture (IITA) in Nigeria is being screened for low CO_2 compensation concentration with a view to using this characteristic in the breeding programme.

The method of screening is that of Menz *et al.*[6] and is based on the assumption that if plants possessing low and high CO_2 compensation concentration values ('efficient' and 'inefficient' respectively) are grown together in a continuously illuminated gas-tight chamber, then the CO_2 concentration within the chamber will decrease with time and eventually fall below the CO_2 compensation concentration of the 'inefficient' plants. At such low CO_2 concentration, 'inefficient' plants show a net efflux of CO_2 since they respire CO_2 at a rate faster than CO_2 fixation by photosynthesis, and ultimately die. 'Efficient' plants, on the other hand, remained green since they utilize the CO_2 respired by the 'inefficient' plants. Plants surviving in such a system would have low CO_2 compensation points.

MATERIALS AND METHODS

The sweet potato collection of IITA contains some 10,000 plants which were grown from seeds obtained from Japan, Puerto Rico and the United States. Five single-node leaf cuttings from each plant, each with one fully expanded leaf, were excised from sweet potato vines under water and potted immediately in coarse sand and then placed in a humid propagation box. Maize seedlings were planted at the same time in sand. Both maize seedlings and sweet potato cuttings were irrigated with Hoagland solution every two days. Two weeks after planting, the cuttings established good root systems. Axilliary shoots were removed in order to accelerate the screening test by reducing photosynthetic sources and to help overcome differential sink effects. The sweet potatoes and the maize seedlings were transferred to an airtight chamber built

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and used according to Menz *et al.*[6] The ratio of sweet potatoes to maize was 4:1. The chamber was illuminated continuously with a 3:1 mixture of cool and warm flourescent lights giving approximately 18,000 lux at the leaf surface. The test was usually terminated after 1 week at which time the sweet potatoes were removed from the chamber and the five leaves from each parent plant were classified into three categories; green, yellow and dry.

RESULTS AND DISCUSSION

The response of the five replicate cuttings of some of the sweet potato clones was uniform in either remaining green or drying completely by the end of the test. However, non-uniform response was exhibited by some other clones. In order to amplify the presentation of results, the 21 possible combinations of green, yellow and dry leaves in each sweet potato population were divided according to their response into one of three groups:

1. Uniform response, those in which all leaves of a plant responded alike.
2. Partly uniform response, those which showed green and yellow leaves but no dry leaves and those which showed yellow and dry but no green leaves.
3. Non-uniform response, those which showed both green and dry leaves.

The 'expected' frequencies of leaf responses based on a null hypothesis for differences in behaviour between clones, were calculated by the expansion of a trinomial, based on the total observed frequencies for the three reactions. These frequencies were compared with the observed frequencies and it was obvious that the observed cases in which all leaves of a plant responded alike far exceeded the expected values (Table 1).

The lack of leaf uniformity within a clone in its response is not likely to be attributable to genetical differences, since all leaf cuttings were obtained from a single plant. It may thus be speculated that the variability within a clone could have resulted from quantitative differences in food reserves or from micro-climatic differences in the CO_2 concentration around the leaves within the chamber. Neither one of these possibilities has yet been fully determined. The existence of genetic diffferences between clones is supported by the fact that there were significant differences between the four populations. A Chi^2 analysis of the total frequencies of the three leaf responses showed that populations 11 and 12 were virtually identical to each other and had a significantly higher proportion of dry leaves than populations 3 and 4. Although population 4 showed a higher proportion of green leaves than population 3, the number of plants was too small to draw any definite conclusion as to whether this superiority was significant.

The method described in this study proved to be practicable for rapid screening of large populations of plants. Twenty lines of sweet potatoes could be tested each week in one chamber. No attempt, at this time, was made to make direct measurement of the CO_2 compensation concentration of plants that remained green.

Measurements of gas-exchange properties, linked with anatomical and enzymological investigations are being conducted to seek an explanation for the observed survival of some sweet potatoes at low CO_2 concentration.

It also remains to be demonstrated whether selection for efficient photosynthesis, in terms of low CO_2 compensation concentration, is correlated with superior performance of plants in their growth and yield characteristics.

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TABLE 1

Observed and expected frequencies of three classes of leaf response in 4 populations of sweet potatoes

Leaf response	Population							
	3		4		11		12	
	0	E	0	E	0	E	0	E
Uniform	67	7.6	3	0.4	25	1.4	27	1.6
Partly uniform	187	124.5	9	6.9	27	15.1	26	16.4
Non-uniform	64	185.9	3	7.7	23	58.5	22	57.0
Total	318	318	15	15	75	75	75	75

0 = observed
E = expected