

Performance of Cassava Cultivars in an Oxisol in Northwestern Puerto Rico¹

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ABSTRACT

Fifty-five cassava cultivars (*Manihot esculenta*, Crantz) were evaluated for 3 consecutive years in a Coto clay (Oxisol) in northwestern Puerto Rico. The highest yielders, averaged over 3 years, were PI 12902, Jamaica 18, PI 9570 and PI 12003 with 34,345, 29,906, 26,845 and 24,684 kg/ha, respectively. The organoleptic evaluation reveals that all but PI 12903 were found to be acceptable. The hydrocyanic acid content among cultivars was below the moderately toxic levels, (50 p/m). These results are in line with previous work conducted in east central Puerto Rico.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a perennial vegetatively propagated shrub mainly grown for its edible roots. The fresh roots of cassava contain 30 to 40% dry matter, approximately 85% of which is starch. It is a staple in most of the developing countries and ranks fourth as a dietary source of calories in the tropics (1) producing 493 Kcal/lb (4). It is useful as livestock feed (1,6,8).

In the past decade, local production declined; therefore, the demand has to be covered with imports from the Dominican Republic. During 1979-80 local production (3) was reported as 12,733 cwt with a value of \$241,819, while imports were reported as 5,917 cwt. These figures obviously show that demand exceeds local production and suggest the feasibility of increasing the area planted of this crop. Besides, it is well known that cassava has the ability to survive with low fertilizer inputs and under water stress. It is also highly disease- and pest-resistant.

In order to increase our local production a program for testing local selections and introductions has been started. Fifty-five cultivars from the cassava collection were tested for 3 consecutive years. This paper presents the results obtained from field trials in which cassava cultivars were tested as to yielding ability in an Oxisol in northwestern Puerto Rico, and their acceptance by a tasting panel.

MATERIALS AND METHODS

Selections were made from a collection of introductions and local cassava cultivars that seemed to be well adapted to local conditions. Three experiments were conducted at the Isabela Research and Devel-

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opment Center in northwestern Puerto Rico, 128 m above sea level, lat. 18°28' N, where the mean annual minimum and maximum air temperature are 18.9 and 29.4° C, respectively. Mean annual rainfall is 1685 mm. The soil is classified as Coto, a Tropeptic Haplorthox; clayey, kaolinitic, isohyperthermic, with a pH of 5.2 (5).

The experiments were planted in March of each respective year and the roots were harvested about 12 months after planting. The experiments followed randomized complete block designs with three replications. The plots were 4.8 m × 4.8 m with 1.2 m alleys between them. Each plot consisted of four rows 1.2 m apart with plants spaced 1.2 m within the row (6) for a total of 16 plants per treatment per replicate. The four inner plants were harvested for yield data collection. The planting material was derived from mature plant stem cuttings with five or six nodes. The crop received a 6-6-12 fertilizer in a split application at the rate of 800 kg/ha. The first half (56 g/plant) was applied 1 month after planting; the remainder, 2 months later. Supplemental irrigation was applied as needed. The cassava plants were free from insects and diseases throughout the growing season; thus no control measures were necessary. Evaluation of the cultivars was not solely on the basis of yield; due consideration was given to other factors such as growth habit, ability to smother weeds, HCN content and acceptance by tasters. The sensory evaluation was based on a 6-point hedonic scale (7) ranging from 6, "like very much" to 1, "dislike." The cooked samples were evaluated for appearance, flavor, texture and overall acceptability. Some high yielding cultivars were not acceptable because of undesirable characteristics. Because of the large and variable number of cultivars included at the beginning of the experiments data from only the outstanding cultivars are presented in this paper. Rank, based on yields, plus agronomic considerations and acceptance by a tasting panel were determinant factors in the final selection of the outstanding cultivars.

RESULTS AND DISCUSSION

Table 1 shows data on the performance of the 12 outstanding cassava cultivars for three consecutive crops. There were significant differences in yield of edible roots among cultivars. In the 1980-81 trial, 55 cassava cultivars were tested. The cultivars that yielded over 22,000 kg/ha were kept for further trials. In this first trial, cvs. PI 12902, Jamaica 18, PI 9570 and PI 12903 yielded 39,921, 31,104, 28,100 and 23,220 kg/ha of edible roots, respectively. Although there were no significant differences among the four cultivars, the yields are in line with values reported previously by Ramírez et al. (8) and surpassed the averages reported for Africa (7 t/ha) and South America (14 t/ha). Also, the yield values are

in agreement with the goal of 34 t/ha suggested in the Agricultural Experiment Station guide for the production of starchy food crops (2).

In the 1981–82 trial, 30 cultivars were tested. The yield ranged from a low of 4,628 to a high of 28,887 kg/ha. Cvs. PI 12902, Jamaica 18, PI 9570, and PI 12903, however, ranked 4th, 3rd, 7th, and 8th with yields of 27,794, 28,100, 25,252 and 25,175 kg/ha, respectively. Although the yields were lower than those obtained in the previous year, these cultivars have been consistently good yielders.

In the 1982–83 trial, the 12 outstanding cultivars from previous trials were compared. Cultivars PI 12902, Jamaica 18, PI 9570 and PI 12903 yielded 35,322, 30,515, 27,184 and 25,658 kg/ha, respectively. These four

TABLE 1.—*Mean yields of the 12 outstanding cassava cultivars planted during three consecutive years at Isabela, Puerto Rico*

Cultivar	1980–81		1981–82		1982–83	
	kg/ha	Rank	kg/ha	Rank	kg/ha	Rank
PI 9608	25430	9	28888	1	24438	7
PI 1290	26373	10	28507	2	25023	6
Jamaica 18	31104	4	28100	3	30515	2
PI 12902	39921	1	27794	4	35322	1
Brava	29756	5	27718	5	25480	5
Mc22	23980	24	27489	6	14546	12
PI 9570	28100	7	25252	7	27184	3
PI 12903	23220	25	25175	8	25658	4
Brazil	24034	11	23344	9	19530	10
Pana	24644	10	23217	10	19886	9
PI 9569	25865	13	23065	11	22403	8
Jordan	28204	6	22963	12	18769	11
Cultivars	55		30		12	
LSD .01	24799		18842		24805	
.05	19462		14306		18243	

cultivars were consistently superior in yield throughout the 3-year testing period. There were no significant differences in yield among them; however, cv. PI 12902 yielded significantly more than the other 11 cultivars tested.

The highest yielding cultivars in terms of total number of edible roots, were Brazil with 71,759/ha; PI 12902, with 63,350; and Jamaica 18, with 60,547 roots (table 2). Cultivars 12902, Jamaica 18, PI 9570, and PI 12903 did not differ statistically as to number of total or marketable roots. These four cultivars yielded 81, 70, 76, and 76% of marketable roots, respectively. These values are in line with those reported previously by Ramírez et al. (8).

The HCN content (table 3) of the 12 tested cultivars ranged from 0 to

TABLE 2.—Mean number of roots per cv. per hectare, 1982–83 crop

Cultivar	Roots per hectare	
	Total number	Percent marketable
PI 12902	63350 ab ¹	81.10 ab
Jamaica 18	60547 abcd	71.52 ab
PI 9570	48213 bcd	75.41 ab
PI 12903	52138 bcd	77.02 ab
Brava	61668 abc	66.51 ab
PI 12900	44289 cd	71.80 ab
PI 9608	56062 abcd	75.10 ab
PI 9569	43728 d	82.19 a
Pana	45410 cd	77.65 ab
Brazil	71759 a	59.64 bc
Jordan	42046 d	66.14 ab
Mc22	49895 bcd	55.65 c

¹ Means followed by one or more letters in common do not differ significantly at $P = 05$, according to Duncan's multiple range test.

TABLE 3.—Hydrocyanic acid (HCN) content and sensory evaluation of 12 cassava cvs

Cultivar	HCN ¹	Mean values ²			
		Appearance cooked	Flavor	Texture	Overall acceptability
	p/m				
PI ³ 6569	10	3.65	3.41	2.74	2.85
PI 9570	0	3.50	3.87	3.76	3.85
PI 9608	0	4.25	2.62	4.16	2.71
Brazil	0	4.37	3.55	3.41	3.23
Brava	20	3.67	1.35	2.81	1.33
PI 12900	0	4.65	4.87	4.65	4.85
PI 12903	10	4.92	2.50	3.65	2.58
Pana	0	4.36	4.40	4.16	4.27
Mc22	0	4.25	4.84	4.49	4.94
Jordan	10	4.89	3.80	4.53	4.01
PI 12902	10	4.87	4.25	4.11	4.03
Jamaica 18	0	4.77	4.05	3.41	3.53

¹ Values below 50 mg, HCN/kg fresh peeled root are considered safe.

² 6-point hedonic scale (6—liked very much; 5—liked; 4—liked moderately; 3—neither liked or disliked; 2—disliked a bit; 1—disliked).

³ University of Puerto Rico, Agricultural Experiment Station, plant introduction number.

20 p/m; i.e., they are below the moderately toxic level considered to range between 50 to 100 p/m, in fresh, peeled roots (7).

Table 3 also presents data on the sensory evaluation of the 12 cassava cultivars. All cultivars had acceptable appearance after being cooked. Cultivars PI 12903, Jordan, PI 12903 and Jamaica 18 were among the four most attractive ones. Cultivars PI 12902 and Jamaica 18 were rated

TABLE 4.—Description of 12 cassava cultivars

Cultivar	Stem color	Leaf		Root mean ¹		Color		Pulp
		Color	# lobules	Length	Width	Exodermis	Endodermis	
				cm.	cm.			
PI 9608	Dark green	Green	7	38.6	6.50	Dark brown	White	White
PI 12900	Reddish brown	Dark green	5	24.2	6.36	Yellowish brown	White	White
Jamaica 18	Brown	Green	5	36.0	5.04	Brown	Brown	White
PI 12902 ²	Reddish brown	Light green	5	40.2	6.30	Brown	White	White
Brava	Brown	Dark brown	5	33.6	7.36	Brown	Cream	White
Mc22	Cream	Dark green	5	39.0	5.60	Light brown	White	White
PI 9570	Light gray	Green	5	43.4	5.22	Light brown	Cream	Cream
PI 12903 ³	Cream	Dark green	5	27.5	6.78	Cream	White	White
Brazil	Reddish brown	Dark green	7	35.6	5.62	Brown	White	Cream
Pana	Cream	Dark green	7	28.8	4.68	Brown	Violet	White
PI 9569	Cream	Green	5	51.4	6.54	Light brown	Cream	Yellow
Jordan	Cream	Dark green	5	33.2	4.86	Light brown	Cream	Yellow

¹ Average of 10 roots.² cv. IAC Mantequeira.³ cv. SRT 59B- Sta. Catarina.

by the panel as "liked moderately" for flavor; however, cv. PI 12903 had a rating of 2.50 in the hedonic scale of 1 to 6, where 6 is "liked very much." As for texture, cvs. PI 12902, Jamaica 18, PI 12903, and PI 9570 all were rated above 3.41. All these cultivars were generally acceptable except cv. PI 12903. Cv. Brava had the lowest overall acceptability rate.

A striking feature of cv. PI 12900 is its consistent performance as a high yielder throughout the 3-year period. It rated second in overall acceptability with a value of 4.85, thus coming very close to being "liked." Cv. Jordan, although with acceptable flavor and appearance after cooking, continues declining in yield throughout the years.

The description of 12 cultivars in table 4 may help in their identification. There are differences, as expected, in stem and leaf color and in number of lobules/leaf. Cv PI 12903 has a short (27.5 cm) but thick (6.78 cm) root, whereas PI 9570 has a very long (43.4 cm) but thin (5.22 cm) root. There are also differences in peel color which might or might not match with the pulp color. Cultivars Jamaica 18 and PI 12902 are brown externally but have white pulp; cv. PI 9570 has a light brown peel and a cream colored pulp.

According to the data on yield, overall acceptability, percentage of marketable roots and root description, cvs. PI 12902, Jamaica 18, and PI 9570 are outstanding. These cultivars, except PI 9570, were also outstanding on a previous trial conducted by Ramírez et al. (8) in the Corozal area. Cultivars PI 12903 and Brava are consistently high yielders, but their acceptability for the fresh market is low. However, they may be promising for livestock feeding and for industrial purposes.

RESUMEN

Se hicieron tres experimentos de campo en un suelo Coto arcilloso (Oxisol) en Isabela, para evaluar cultivares de yuca de una colección de 55 especímenes. Un grupo de catadores comparó las cultivares para rendimiento y aceptación. Las de baja producción y de características agronómicas indeseables o de poca aceptación se eliminaron. Por tal razón, el primer año se compararon 55 cultivares; el segundo año, 30; y el tercero, 12. Se utilizó un diseño experimental de bloques distribuidos al azar con tres repeticiones.

Las cultivares PI 12902, Jamaica 18, PI 9570 y PI 12900 fueron las de mejor rendimiento los 3 años, además de ser las más aceptables para los catadores. Los rendimientos medios están sobre 26,600 kg/ha, los que se consideran aceptables. Las cultivares Brava y PI 12903, aunque de altos rendimientos, no se juzgaron aceptables como producto en fresco, pero parecen tener potencial para usos industriales o como alimento para animales.

Luego de tomar en consideración los rendimientos, el porcentaje de raíces comerciales y la estimación de los catadores, las cv. PI 12902, Jamaica 18 y PI 9570 parecen ser las más prometedoras para consumo en fresco y las cv. PI 12903 y Brava posiblemente para otros usos.

LITERATURE CITED

1. Cock, J. H., 1982. Cassava: A Basic Energy Source in the Tropics, *Science*, 218: 755-62.
2. Conjunto Tecnológico para la Producción de Cosechas Farináceas, 1976. Publ. 101, Esta. Exp. Agric. Univ. P.R.
3. Facts and Figures on Puerto Rico's Agriculture 1979-80, Commonwealth of Puerto Rico, Dep. Agric., Office of Agricultural Statistics, Santurce, P.R.
4. Guerney, J. M., 1976. Nutritional considerations regarding staples, Paper presented at the 12th Annu. Meet. Caribb. Food Crops Soc., Kingston, Jamaica.
5. Lugo-López, M. A. and Rivera, L. H., 1977. Updated Taxonomic Classification of the Soils of Puerto Rico, Univ. P.R. Agric. Exp. Stn. Bull. 258.
6. Montaldo, A., 1972. Cultivo de Raíces y Tubérculos Tropicales, Inst. Int. Cienc. Agric., OEA, Lima, Perú.
7. Pergam, D. R. and Pilgrin, F. J., 1957. Hedonic scale method for measuring food preferences, *Food Technol.* 11 (9): Insert 9.
8. Ramírez, O. D., Green, J. J., and Caloni, I. B., 1983. Evaluation and acceptability of cassava cultivars, *J. Agric. Univ. P.R.* 67 (1): 16-21.