TARC Note

Some Findings in Leaf Characters of Cassava Varieties

Comparisons among tropical crops have shown a great potential of cassava as a source of carbohydrate (de Vries et al., 1967), which may be further increased by improving varieties and cultural practices. Cassava has also acquired the reputation that it can yield more under dry and less fertile soil conditions than other crops.[9]

However, the majority of the world's cassava are grown without irrigation and fertilizer application in tropical areas with pronounced dry period. It has been observed that the decrease of tuber production is caused mainly by marked decrease of leaf area. As a result, many researchers[1,2,10] have reported that the leaf area development and maintenance are closely correlated with dry matter and tuber production. Accordingly, for increasing tuber production, it will be necessary to investigate the factors which control the quantity and quality of leaf.

The present paper deals with some physiological and morphological characters of cassava leaves in relation to their quality. Materials used in the present study included the local and recommended/promising varieties collected in Indonesia. Several other summer crops were also used to compare with cassava. Measurements were made on stomatal diffusion resistance (by Transient Porometer LI-700, LI-COR, USA), chlorophyll content (by Green Meter GM 1, Fuji Film, Japan) and distribution and density of stomata in fully expanded leaves in the upper canopy. In addition, the inner structure of cassava leaves was observed by using microscope.

Photosynthesis is represented as a system of CO_2 diffusion from the atmosphere to the inside of leaves. This system involves three successive resistances to CO_2 diffusion: boundary layer resistance ($ra \cdot CO_2$), stomatal resistance ($rs \cdot CO_2$) and mesophyll resistance ($rm \cdot CO_2$). The lower the diffusion resistances, it is known, the higher is the photosynthetic rate. It is also known that the response of photosynthetic rate to $rs \cdot CO_2$ and $rm \cdot CO_2$ differs between C_3 and C_4 plants.[5] However, in dealing with varieties of a given species, measurement of $Rs \cdot CO_2$ which tends to be influenced by growth conditions is useful for estimating photosynthetic rate indirectly.[6–8] Since there exists a close correlation between $rs \cdot CO_2$ and $rs \cdot H_2O$ (stomatal resistance to water diffusion), as shown by the equation: $rs \cdot H_2O = 1.56\ rs \cdot CO_2$, the $rs \cdot H_2O$ was measured by using porometer, insted of measuring $rs \cdot CO_2$, and refered to as rs in this study.

Table 1 shows the rs (both surfaces), rs·ad (adaxial surface), rs·ab (abaxial surface) and stomatal density in both surfaces. The rs·ad of cassava was $+\infty$ since cassava has very few stomata on the adaxial surface (Plate 1–1). It seems reasonable to suppose that the low density of stomata on the adaxial surface of cassava leaves might directly influence the photosynthetic rate by limiting CO_2 diffusion. In contrast, rs·ab was lower in cassava than in other summer crops except sweet potato. The low value of rs·ab of cassava was associated with a greater number of stomata found on the abaxial surface of cassava leaves as compared with other crops except rice which has small stomata (Table 1). In addition, significant varietal differences in rs·ab was found as given in Table 2.[3] The recommended/promising varieties tend to have lower rs·ab than the local varieties.

Plate 1–2 demonstrates the abaxial leaf surface of cassava (variety: L 195). Stomata are distributed with high density on the entire surface. On the other hand, it has been reported that the adaxial leaf surface of cassava has no stomata.[3,11] The present observation, however, revealed the presence of stomata on both sides of large veins on the adaxial surface (Plate 1–1). The size of the stomata on the adaxial surface was almost similar to that on the abaxial surface, showing the length of guard cells, about 28 μm, in both cases.

Plate 1–3 demonstrates the transection of a cassava leaf. It may be said that cassava is a sun-loving crop since it has a well-developed palisade tissue. But it seems that cassava has two disadvantages in CO_2 diffusion from the air

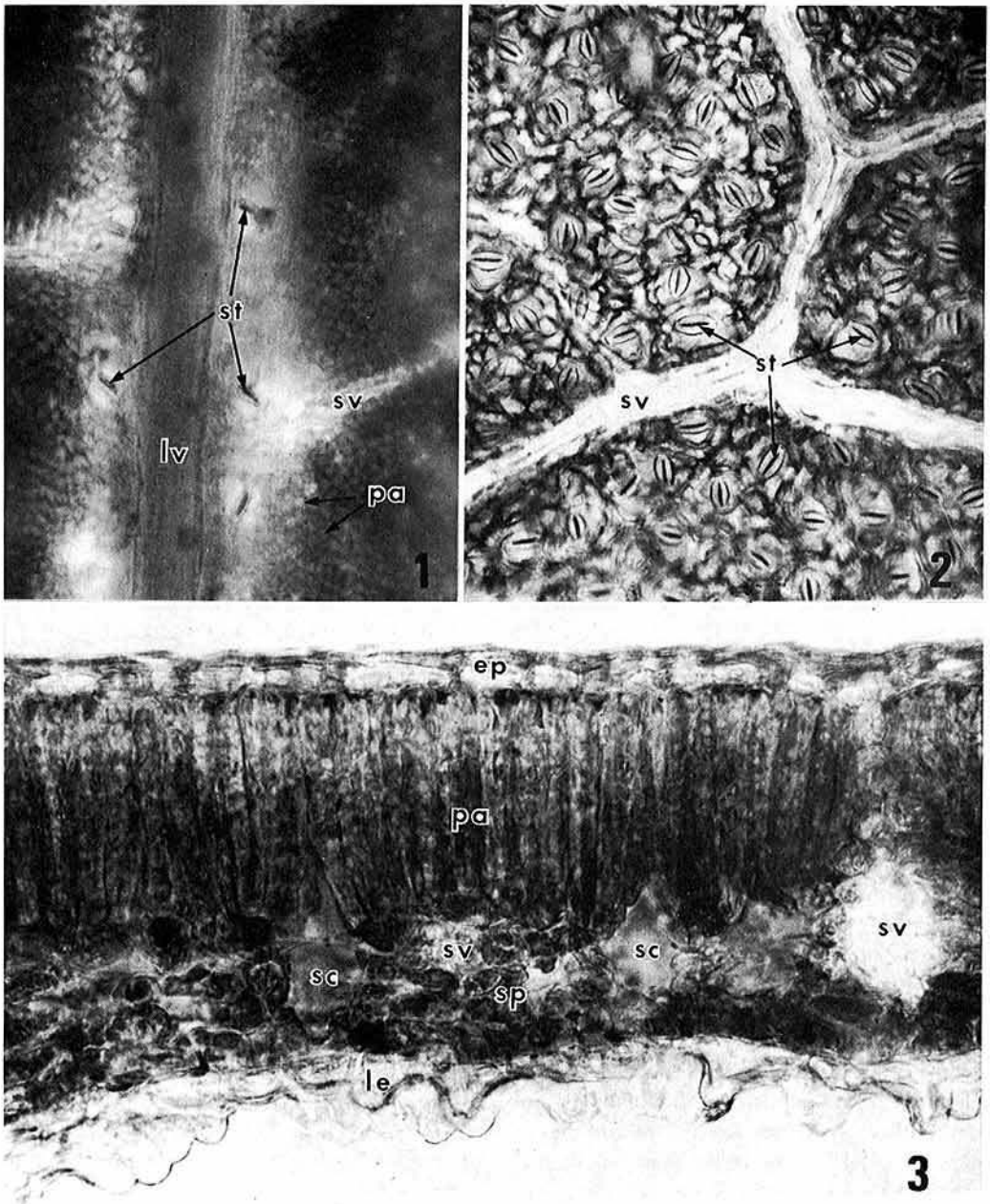

Plate 1. Photomicrographs of the surface and the transectional view of the leaf blade of cassava
1) Adaxial (upper) surface showing a number of stomata located on both sides of the outer surface of a large vein (×210).
2) Abaxial (lower) surface showing a large number of stomata (×210).
3) Transection of the leaf blade, showing the congested thick palisade and thin spongy tissues (×520).
Abaxial epidermal cells have conspicuous protuberances.

Abbreviations : 1e, lower epidermis; 1v, large vein; pa, palisade cell and tissue; sc, sub-stomatal chamber; sp, spongy tissue; st, stoma; sv, small vein.

Table 1. Comparison of stomatal diffusion resistances and number of stomata among several summer crops

Crop (Variety)	Diffusion resistance (sec/cm)			No. of stomata (/mm²)	
	rs	rs·ad	rs·ab	Adaxial	Abaxial
Cassava (Izu-kei)	——	——	1.64	few	331
Sweet potato (Koganesengan)	1.12	3.94	1.59	65	215
Rice (Suwon 258)	1.14	2.24	2.41	536	601
Soybean (Kurosengoku)	1.60	5.73	2.28	107	123
Peanut (Azumayutaka)	1.65	4.94	2.57	138	107
Sugarcane (NCO 310)	2.06	8.02	2.83	106	208

Note : rs·ad and rs·ab indicate stomatal diffusion resistances on adaxial and abaxial leaf surface, respectively.
$1/rs = 1/rs \cdot ad + 1/rs \cdot ab$.

Table 2. Comparison of stomatal diffusion resistance on the abaxial leaf surface of cassava varieties in Indonesia

Variety	Diffusion resistance(rs·ab, sec/cm)					
Adira 1	1.43	a				
CMC 84	1.43	a				
Ambon	1.45	a	b			
W1510	1.48	a	b	c		
L 188	1.51	a	b	c	d	
L 201	1.55	a	b	c	d	e
L 195	1.67			c	d	e
L 190	1.74					e

Note: Figures (mean values) followed by a common letter are not significantly different at the 5% level (LSD 5%=0.223). L 188, L 201, L 195 and L 190 are local varieties. Adira 1, CMC 84, Ambon and W 1510 are recommended/promising varieties.

to the mesophyll: only few stomata on the adaxial surface and markedly compact arrangement of palisade cells. So far as the improvement of photosynthetic rate is concerned, it is considered to be important to have more stomata on the adaxial surface and more loose arrangement of palisade cells from the viewpoint of morphology and function of leaf. It will be necessary to search for such leaf characters. We have a plan to examine these leaf characters using more number of cassava varieties collected in Indonesia.

Chlorophyll contents of cassava varieties measured at Muara Experimental Station in Indonesia are shown in Table 3. It is clear that there are large varietal differences in chlorophyll content. The varietal differences are significant at 1% level among varieties, particularly between

Table 3. Chlorophyll contents of local and recommended/promising varieties in Indonesia

Local variety	Chlorophyll content (mg/dm²)	Recommended/ Promising variety	Chlorophyll content (mg/dm²)
L 178	3.47	A 5	3.45
L 188	2.76	Adira 1	4.73
L 190	2.23	Adira 2	4.61
L 195	2.76	Ambon	3.51
L 201	3.60	CM 40	3.89
L 244	3.43	CMC 84	3.28
L 257	3.36	H 121—4	3.42
L 265	3.65	K 122—3	3.44
L 266	3.38	K 125—2—9	3.92
L 268	3.35	W 1056	3.84
L 271	3.16	W 1087	4.21
L 278	3.39	W 1166	4.44
L 283	3.33	W 1435	3.95
L 284	3.16	W 1548	3.57
L 285	4.05	W 1705	3.71
Mean	3.27	Mean	3.86

local and recommended/promising varieties (Table 4). Further analysis indicated that there is no difference in chlorophyll content among different leaf positions except expanded top leaf and yellowish bottom leaves (Table 5). According

Table 4. Analysis of variance for chlorophyll content between local and recommended/ promising varieties in Indonesia

SV	df	SS	MS	F
Variety	29	56.83	1.96	56.4**
Varietal group	1	18.47	18.47	527.7**
Error	180	6.25	0.035	
Total	209	63.08		

Note : **significant at the 1% level.

Table 5. Change of chlorophyll content with respect to leaf position in cassava

Leaf position	Variety	
	Adira 1	Ambon
Top	2.29 mg/dm²	2.63 mg/dm²
5	3.74	3.89
10	4.00	4.22
15	3.62	4.11
20	4.07	4.37
25	4.11	4.37
30	4.22	4.51
35	4.26	4.07
40	4.26	3.18
45	3.29	——

to Connor and Palta (1981), individual cassava leaves remain photosynthetically active for more than 100 days. Since the decrease in physiological activity of leaves by aging is less in cassava, as compared with other crops, cultural methods to increase and maintain its leaf area may be effective in increasing yields.

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