CASSAVA LEAF PRODUCTION RESEARCH IN CHINA

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ABSTRACT

Cassava leaves are a very important protein source, and the yield of fresh stems and leaves can be as high as that of fresh roots in many varieties. How to increase cassava leaf production and use it as a forage for animal feeding? Eleven high-yielding clones that have been recommended for root production were evaluated to select the best cassava varieties for forage use. In addition, various agronomic practices were also evaluated using the orthogonal experimental method.

The results showed that two new clones, ZM9036 and ZM8639, were equal to, and/or exceeded, the control variety SC 205 in the main agronomic characteristics, such as the yield of roots, young stems and leaves, their crude protein content, as well as wind-resistance. Pruning during the crop cycle (at 4-8 months after planting) had a significant negative effect on cassava root yield. The earlier the plants were pruned, the lower the root yield. However, pruning not only increased substantially the dry matter and crude protein yield of young stems and leaves, but it also improved the wind resistance of the plants.

INTRODUCTION

Cassava is the fifth most important crop in southern China, following rice, sweetpotato, sugarcane and maize. It is used mainly as animal feed and for starch manufacturing, which both play an important role in the upland agricultural economy. Also, cassava leaves are a very important protein feed resource, the fresh yield of young stems and leaves is often equal to the fresh root yield in many varieties. However, cassava leaves are seldom used in China. The objective of the research, therefore, was to find ways to increase cassava leaf production and to use it as a forage for animal feeding by evaluating a number of cassava varieties for forage production.

MATERIALS AND METHODS

Varieties and breeding lines were selected from the existing clones with high root yield and high total biomass production, in comparison with the local variety, SC 205:

V_1 = ZM 8229	V_5 = SM 1592-3	V_9 = SM 1860
V_2 = ZM 9111	V_6 = SM 1595-2	V_{10} = ZM 9266
V_3 = ZM 9036	V_7 = SM 1113-1	V_{11} = ZM 9057
V_4 = ZM 8639	V_8 = SM 1542-3	V_{12} = SC 205(check)

These 12 clones were planted in 72 plots using an orthogonal experimental design with three plant spacings:

S_1 = 60x60 cm
S_2 = 80x80 cm
S_3 = 100x100 cm

Combined with three levels of application of 15:15:15 compound fertilizers:

F_1 = 225 kg/ha
F_2 = 450 kg/ha
F_3 = 900 kg/ha

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And three dates of pruning of young stems with leaves and petioles (hereafter called "leaves")

P_1 = at 4 months after planting
P_2 = at 5 months after planting
P_3 = at 8 months after planting (just before root harvest);

This resulted in 36 treatments with 2 replications. The plot size was 4x5m.

RESULTS

Statistical analysis of the results, shown in **Tables 1, 2** and **3,** indicate that there were no significant differences among cassava varieties in terms of fresh root yield, dry root yield or crude protein content of "leaves", but there were highly significant differences among varieties in terms of root dry matter content, dry leaf yield and crude protein yield of those "leaves". Time of pruning had a significant effect on cassava fresh and dry root yields, but not on the dry matter content of the roots; the earlier plants were pruned, the lower the fresh and dry root yields. For practically all varieties, highest root yields were obtained when plants were pruned just before the root harvest at 8 months after planting (MAP). For some varieties pruning at 4 MAP had very little effect on final root yield, but for other varieties root yields were reduced as much as 60%. On average, fresh root yields were reduced by 37% when plants were pruned at 4 MAP, and by 24% when pruned at 5 MAP. However, pruning at either 4 or 5 MAP significantly increased the dry "leaf" yield, the crude protein content of those "leaves" and the crude protein yield of the "leaves". Pruning at 5 MAP produced the highest dry "leaf" yields and protein yields, but the protein content were slightly higher in "leaves" harvested at 4 MAP. Pruning plants just before the root harvest resulted in "leaves" with very low protein contents, and thus a low protein yield.

Data shown in **Table 3** indicate that plant spacing had only a statistically significant effect on the "leaf" protein content and protein yield. The intermediate spacing of 80x80 cm resulted in the highest "leaf" protein content and protein yield. Other measured yield parameters were not significantly affected by plant spacing. The rate of application of 15-15-15 fertilizers had a signification effect on the dry "leaf" yield, "leaf" protein content and protein yield, but not on any of the three measured root yield parameters. The intermediate level of 450 kg/ha of 15-15-15 fertilizers produced the highest " leaf" yield, protein content and protein yield; this was followed by the highest level of application of 900 kg/ha of 15-15-15 (**Table 3**).

All factors also had a significant effect on plant wind resistance. However, pruning time had the closest relation to wind resistance.

DISCUSSION

1. The results showed that two new clones, ZM9036 and ZM8639, were equal to and/or exceeded the control variety SC205 in the main agronomic characteristics, such as yield of roots and young stems and leaves, "leaf" crude protein content, and wind-resistance.
2. Pruning at 4 or 5 MAP significantly reduced cassava root yields. The earlier the plants were pruned, the lower the root yields. However, pruning not only increased substantially the yield of young stems and leaves and their crude protein contents, but also improved the

wind resistance of the plants.
3. This trial is a preliminary study, there are many tests to be done in the future.

Table 1. Effect of cassava variety (V) and time of pruning (P) of young plant tops on the fresh and dry root yield and root dry matter content in a leaf production experiment conducted at CATAS, Danzhou, Hainan, China in 2000/01.

	Fresh root yield (t/ha)				Root DM content (%)				Dry root yield (t/ha)			
Variety	P_1 [1)]	P_2 [1)]	P_3 [1)]	**Av.**	P_1	P_2	P_3	**Av.**	P_1	P_2	P_3	**Av.**
V_1	12.5	9.5	15.3	**12.4**	31.9	31.8	31.4	**31.7cd**	3.99	3.02	4.81	**3.94**
V_2	31.3	30.8	42.8	**35.0**	31.7	30.3	30.0	**30.7cd**	9.91	9.34	12.85	**10.70**
V_3	15.0	16.3	32.5	**21.3**	31.4	32.3	33.6	**32.4bc**	4.72	5.27	10.91	**6.97**
V_4	15.8	33.8	40.5	**30.0**	26.9	28.8	25.7	**27.2cd**	4.25	9.74	10.42	**8.14**
V_5	27.0	24.5	29.3	**26.9**	32.8	31.3	32.9	**32.3bc**	8.86	7.67	9.63	**8.72**
V_6	18.5	18.0	33.3	**23.3**	32.3	30.2	30.4	**31.0cd**	5.97	5.45	10.12	**7.18**
V_7	14.3	14.8	22.3	**17.1**	35.0	30.9	34.6	**33.5abc**	5.00	4.57	7.72	**5.76**
V_8	20.3	24.8	37.8	**27.6**	32.2	35.5	33.8	**33.8abc**	6.53	8.82	12.78	**9.38**
V_9	19.8	20.3	23.3	**21.1**	32.7	31.0	31.4	**31.7cd**	6.48	6.30	7.32	**6.70**
V_{10}	15.8	23.5	24.0	**21.1**	33.4	34.0	34.8	**34.0abc**	5.28	7.98	8.34	**7.20**
V_{11}	14.5	29.5	28.5	**24.2**	30.3	31.3	31.3	**31.0cd**	4.40	9.23	8.93	**7.52**
V_{12}	15.3	24.8	30.5	**23.5**	34.0	33.3	32.4	**33.2abc**	5.20	8.25	9.89	**7.78**
Av.	**18.3bc**	**22.6bc**	**30.0a**	**23.6**	**32.0**	**31.7**	**31.9**	**31.9**	**5.88c**	**7.14b**	**9.48a**	**7.50**
f-test Variety (V)				NS				**				NS
Pruning time (P)				*				NS				*

[1)] P_1 = young tops pruned at 4 MAP; P_2 = at 5 MAP; P_3 = at 8 MAP (before root harvest).

Table 2. Effect of cassava variety (V) and time of pruning (P) of young plant tops on the dry yield of young stems and leaves, their crude protein content and the protein yield in a leaf production experiment conducted at CATAS, Danzhou, Hainan, China in 2000/01.

	Dry yield of leaves+stems (t/ha)				Protein content (%)				Protein yield (t/ha)			
Variety	P_1 [1)]	P_2 [1)]	P_3 [1)]	**Av.**	P_1	P_2	P_3	**Av.**	P_1	P_2	P_3	**Av.**
V_1	2.37	5.00	2.96	**3.44bcd**	18.69	17.39	12.90	**16.33**	0.43	0.87	0.39	**0.56bc**
V_2	2.02	2.65	1.80	**2.16cd**	17.30	20.24	15.76	**17.77**	0.37	0.54	0.28	**0.40c**
V_3	4.05	5.36	3.94	**4.45abcd**	17.50	18.88	12.50	**16.29**	0.73	1.01	0.56	**0.76abc**
V_4	3.60	6.78	4.99	**5.12abcd**	16.54	17.51	12.47	**15.51**	0.59	1.17	0.66	**0.81abc**
V_5	2.93	5.44	1.84	**3.40bcd**	16.93	14.05	15.88	**15.62**	0.53	0.73	0.32	**0.53bc**
V_6	2.47	3.33	1.75	**2.52cd**	20.11	19.11	15.46	**18.23**	0.47	0.50	0.26	**0.41c**
V_7	1.62	2.24	1.79	**1.88cd**	21.30	19.81	13.20	**18.10**	0.32	0.56	0.25	**0.38c**
V_8	1.94	3.16	1.78	**2.29cd**	20.63	16.83	15.50	**17.65**	0.40	0.51	0.27	**0.39c**
V_9	2.67	2.99	2.24	**2.63bcd**	18.84	18.97	13.98	**17.26**	0.50	0.53	0.29	**0.44c**
V_{10}	3.12	2.93	1.64	**2.56cd**	20.91	19.85	11.62	**17.46**	0.65	0.56	0.20	**0.47bc**
V_{11}	2.50	3.28	3.08	**2.95bcd**	16.27	17.55	14.26	**16.03**	0.43	0.55	0.43	**0.47bc**
V_{12}	2.44	2.60	1.17	**2.07cd**	16.85	18.74	11.75	**15.78**	0.41	0.49	0.14	**0.35c**
Av.	**2.64bc**	**3.81ab**	**2.42c**	**2.96**	**18.49ab**	**18.24ab**	**13.77c**	**16.84**	**0.49ab**	**0.67ab**	**0.34b**	**0.55**
f-test Variety (V)				**				NS				**
Pruning time (P)				**				**				**

[1)] P_1 = young tops pruned at 4 MAP; P_2 = at 5 MAP; P_3 = at 8 MAP (before root harvest).

Table 3. Effect of plant spacing (S) and fertilizer rates (F) on dry yield of cassava leaves + stems, on crude protein content and on protein yield in a leaf production experiment conducted at CATAS, Danzhou, Hainan, China in 2000/01.

Spacing	Dry "leaf" yield (t/ha)	"Leaf" protein content (%)	"Leaf" protein yield (t/ha)	Fertilizer	Dry "leaf" yield (t/ha)	"Leaf" protein content (%)	"Leaf" protein yield (t/ha)
S_1	2.95	15.45 c	0.46 a	F_1	2.65 de	15.82 c	0.42 b
S_2	3.04	17.95 abc	0.54 a	F_2	3.27 abc	17.74 abc	0.57 b
S_3	2.88	17.10 bc	0.49 a	F_3	2.96 c	16.95 bc	0.51 b
f-test	NS	**	**		**	*	**

REFERENCES

Moore, C.P. 1985. Cassava Foliage. Tropical Agriculture 62(2):45-47.

Villamayor, F.G. Jr., A.G. Dingal, F.A. Evangelio, J.C. Ladera, A.C. Medellin, G.E. Sajise Jr. and G.B. Burgos. Recent progress in cassava agronomy research in the Philillines. *In*: R.H. Howeler (Ed.). Cassava Breeding, Agronomy and Utilization Research in Asia. Proc. Third Regional Workshop, held in Malang, Indonesia. Oct. 22-27, 1990. pp. 245-259.

Villamayor, F.G. Jr. 1988. Agronomic research on cassava in the Philippines. *In*: R.H. Howeler and K. Kawano (Eds.). Cassava Breeding and Agronomy Research in Asia. Proc. Regional Workshop, held in Rayong, Thailand. Oct. 26-28, 1987. pp. 261-290.