植保會刊 23：137-141 (1981)
Plant Prot. Bull. (Taiwan, R. O. C.) 23：137-141 (1981)

EFFECT OF VIRUS INFECTION ON THE YIELD AND QUALITY OF SWEET POTATOES

Mei-lie Chung[1] Chia-hsin Liao[1] and Liang Li[1]

(Accepted for publication June 29, 1981)

ABSTRACT

On the basis of fleshy roots, field-collected, virus-infected plants the sweet potato cultivars Tainung 63 and Okinawa 100 yielded 34.2% and 55.9% less in a nethouse experiment than the healthy control plants derived from shoot tip culture, respectively. Virus-infected plants gave yield reduction of 24.5%, 30.5%, 31.8% and 35.6% for cultivars Tainung 57, Okinawa 100, Hung-hsin-wei and Tainung 63 in the field test, respectively. The dry matter content, crude protein content and sugar refractometer reading of virus-infected plants were significantly higher than the healthy control under field conditions but there were no such differences in the nethouse test for crude protein content and sugar refractometer. No internal corking of fleshy roots was detected in the virus-infected materials used in this study. On the basis of stem and leaf, the virus-infected plants gave a significantly lower yield than the healthy under the nethouse condition and the leaf size was also reduced. But in the field test, the yield showed no difference. The dry matter content was increased and crude protein content decreased significantly in infected plants.

(Key words: virus, quality, yield loss)

INTRODUCTION

Several virus or virus-like diseases have been reported on sweet potato from various parts of the world[1,12], but information on their effect on yield or quality of sweet potatoes is still limited. During the past ten years, high yielding sweet potato varieties have been released from time to time for commercial cultivation in Taiwan, however, the unit area yield of sweet potatoes, now at about 16.6 tons/ha, has shown no significant increase. Furthermore, a varietal decline has been noted in several important sweet potato cultivars, including Okinawa 100, and at least two sweet potato viruses, SPV-A and SPV-N, have been detected[8]. Recently, elimination of these viral pathogens from sweet potato varieties by shoot tip culture combined with heat treatment has been succeeded[9]. The yield and some other characteristics of these healthy materials were studied and comparisons of these with virus-infected plants were made. The results are reported in this paper.

MATERIALS AND METHODS

The healthy plants of sweet potato cultivars Tainung 57, Tainung 63, Okinawa 100 and Hung-hsin-wei were derived from shoot tip cultures and were

1. Department of Agronomy, Chiayi Agricultural Experiment Station, Chiayi, Taiwan 600, Republic of China.

indexed free from virus symptoms on indicator plants[9]. The virus-free stocks were propagated in a nethouse which was sprayed weekly with 1:1000 dilution of both 90% Lannate w.p. and 50% Benlate w.p. for the control of insects and fungal diseases. Virus-infected plants of the sweet potato cultivars Tainung 57 and Tainung 63 were from a field collection. They carried both SPV-A and SPV-N and showed interveinal chlorotic spotting on mature leaves. The infected plants of Okinawa 100 exhibited mosaic symptoms and leaf deformity in the winter and the symptoms became masked in the summer. Virus-infected plants of Hung-hsin-wei were symptomless in the summer but showed ring symptoms in other seasons. Although SPV-A and SPV-N had been isolated from leaves of infected Okinawa 100 and Hung-hsin-wei, we were unable to induce the same symptoms by inoculating healthy plants with these two viruses.

Experiments to compare the healthy with the virus-infected sweet potatoes were carried out in the nethouse during August 1978 to February 1979 and in the field during August 1979 to February 1980. The nethouse was roofed with fiber glass and the light intensity was about 75% as compared to day light. In a randomized complete block design, the sweet potatoes were planted on ridges 100 cm apart and 25 cm between plants. Each plot, 6m x 1m, had a single ridge with 24 plants. Six replications were provided. One day before planting, 7,000 kg/ha of manure, 30 kg N/ha, 30 kg P/ha, 90 kg K/ha and 30 kg/ha of 5% Dursban G. were applied. Thirty days after planting, additional 30 kg N/ha and 90 kg K/ha were applied. For insect and disease control, the test plants were sprayed with Lannate and Benlate at 2-3 week intervals. The fleshy roots were harvested 160 days after planting. The following data were collected: 1) yield of stems and leaves; 2) yield of fleshy roots; 3) leaf size; 4) sugar refractometer reading; 5) dry matter content and 6) crude protein content on a dry basis. Dry matter content was determined by weighing 500g fleshy root chips and 300g of stems and leaves after they had been placed at 70°C for 2 hours and then 60°C for 22 hours. The crude protein content was determined by the Micro-Kjeldahl procedure. The crude protein on a dry basis was the percentage of nitrogen in dry matter x 6.25. The other data were the mean values of ten plants.

RESULTS

The results of comparison between healthy and virus-infected sweet potato cultivars are summarized in Tables 1 and 2. The yield obtained in the nethouse experiment was considerably lower than that in the field, probably because of the reduced light intensity under the nethouse. However, there was a consistently lower fleshy root yield in virus-infected plants as compared to healthy plants. In the nethouse experiment, Tainung 63 yielded 34.2% and Okinawa 100 yielded 55.9% less than the healthy control.

In the field experiment, the virus-infected plants of Tainung 57, Okinawa 100, Hung-hsin-wei and Tainung 63 yielded 24.5%, 30.5%, 31.8% and 35.6% less, respectively, than the healthy controls, on the basis of fleshy roots. Interestingly, the dry matter content, crude protein and sugar refractometer reading of virus-infected plants were higher than the healthy controls. The analysis of variance also indicates a significant difference between healthy and virus-infected plants for the dry matter content, crude protein content and sugar refractometer reading in the field experiment, but there were no such differences in the nethouse test for crude protein content and sugar refractometer reading. The color and shape of fleshy roots were not affected by virus infection. The roots from infected plants from each replication were stored at 25°C,

Table 1. Comparison between healthy and virus-infected sweet potato cultivars in the nethouse test from August 1978 to February 1979

Items of measurement	Tainung 63		Okinawa 100	
	Healthy	Infected	Healthy	Infected
Fleshy root				
Yield (tons/ha)	19.6	12.9	14.5	6.4
Yield index (%)	100	65.8	100	44.1
Dry matter content (%)	25.1	28.2	32.6	31.6
Crude protein content (% dry weight)	8.5	8.3	7.8	8.8
Sugar refractometer reading	10.1	10.8	9.4	10.3
Stem and leaf				
Yield (tons/ha)	9.2	7.5	7.9	6.4
Yield index (%)	100	81.5	100	80.0
Average leaf size (cm^2)	72.7	46.2	63.2	22.6

Table 2. Comparison between healthy and virus-infected sweet potato cultivars in the field test from August 1979 to February 1980

Items of measurement	Tainung 57		Tainung 63		Okinawa 100		Hung-hsin-wei	
	Healthy	Infected	Healthy	Infected	Healthy	Infected	Healthy	Infected
Fleshy root								
Yield (tons/ha)	28.1	21.2	25.3	16.3	20.2	14.1	49.3	33.7
Yield index (%)	100	75.5	100	64.4	100	69.5	100	68.3
Dry matter content (%)	29.6	30.8	20.3	23.5	30.8	29.7	20.8	20.9
Crude protein content (% dry weight)	3.6	4.2	5.8	6.0	5.0	5.7	3.4	3.2
Sugar refractometer reading	8.5	8.9	8.7	8.8	8.7	9.2	7.6	8.2
Stem and leaf								
Yield (tons/ha)	10.7	11.5	8.8	7.6	7.7	6.7	14.7	16.8
Yield index (%)	100	106.8	100	86.8	100	86.5	100	114.7
Dry matter content (%)	15.1	16.6	16.8	17.6	16.1	17.2	17.0	20.0
Crude protein content (% dry weight)	19.3	17.4	20.0	20.3	19.5	18.4	20.1	18.5
Average leaf size (cm^2)	26.2	24.2	29.5	29.2	22.5	14.5	23.0	19.7

sliced and examined for the symptom of internal cork at time intervals up to 3 months. No corking of fleshy root was detected. It appears that SPV-A and SPV-N do not greatly impair the eating quality of sweet potatoes.

On the basis of stem and leaf measurements, the healthy plants gave a significantly higher yield over the virus-infected in the nethouse test but there was no such difference under field conditions. The crude protein content of the stems and leaves was significantly higher in the healthy than in the virus-infected. The healthy plants also had larger leaf size and lower dry matter content than the virus-infected.

DISCUSSION

A number of virus diseases have been reported on sweet potatoes[2,3,10,11,14,15,16]. A vein-clearing virus was found to cause severe yield reduction in sweet potatoes in Israel[10] while as much as 57% yield loss was caused by a mosaic disease in Uganda[13]. The tuber yield was reduced by 78% in plants showing virus symptoms in Nigeria[4]. But internal cork did not appreciably affect the yield of Unit 1 Porto Rico sweet potatoes, though it severely affected the quality[7]. In our test, mixed infections with two sap transmissible viruses caused reduction in fleshy root yield by 24.5-55.9% depending on cultivars and test conditions. However, virus infection did not greatly affect quality of fleshy roots.

Under the field conditions, mixed infections of sweet potatoes with different viruses has been rather common[1,5,6]. There are no reliable data about how much an individual virus may affect the sweet potato yield. It is possible, that the yield reduction from virus infection as observed in this study for cultivars Tainung 57, Tainung 63, Okinawa 100 and Hung-hsin-wei would be less if the test plants carried a single virus, rather than being mixedly infected. Further studies on this aspect are in progress.

ACKNOWLEDGEMENT

Contribution No. 988 from the Taiwan Agricural Research Institute. This study was supported by a grant from the Council for Agricultural Planning and Development, Excutive Yuan. The authors wish to express their thanks to Dr. R. J. Chiu for his critical comments on the manuscript.

LITERATURE CITED

1. Campbell, R. N., D. H. Hall and N. M. Mielinis. 1974. Etiology of sweet potato russet crack disease. Phytopathology 64:210-218.
2. Daines, R. H. and W. J. Martin. 1964. Russet crack, a new virus disease of sweet potatoes. Plant Dis. Reptr. 48:149-151.
3. Girardeau, J. H. 1958. The sweet potato whitefly, *Bemisia inconspicua* (Q), as a vector of a sweet potato mosaic in South Georgia. Plant Dis. Reptr. 42:819.
4. Hahn, S. K. 1979. Effects of viruses (SPVD) on growth and yield of sweet potato. Expl. Agric. 15:253-256.
5. Hildebrand. E. M. 1958. Two syndromes caused by sweet potato viruses. Science 128:203-204.
6. Hildebrand, E. M. 1960. The feathery mottle virus complex of sweet potato. Phytopathology 50:751-757.
7. Kantack, K. J. and W. J. Martin. 1958. Effect of internal cork on yield and grade of sweet potato roots. Phytopathology 48:521-522.
8. Liao, C. H., I. C. Chien, M. L. Chung, R. J. Chiu and Y. H. Han. 1979. A study of sweet potato virus diseases in Taiwan. I. Yellow spot. Jour. Agri. Res. China (Taiwan, R. O. C.) 28:127-138. (in Chinese with English summary)
9. Liao, C. H. and M. L. Chung. 1979. Shoot tip culure and virus indexing in sweet potato. Jour. Agri. Res. China (Taiwan, R. O. C.) 28:139-

144. (in Chinese with English summary).
10. Lobenstein, G. and L. Harpaz. 1960. Virus diseases of sweet potatoes in Israel. Phytopathology 50:100-104.
11. Moyer, J. W. and G. G. Kennedy. 1978. Purification and properties of sweet potato feathery mottle virus. Phytopathology 68:998-1004.
12. Mukiibi, J. 1977. Synonymy in sweet potato virus diseases, *in* Proceedings of the Fourth Symposium of the International Society for Tropical Root Crops (J. Cock, R. MacIntyre and M. Graham, eds.), p. 163-168. International Development Ressearch Center (IDRC). Ottawa, Canada.
13. Mukiibi, J. 1977. Effect of mosaic on the yield of sweet potatoes in Uganda, *in* Proceedings of the Fourth Symposium of the International Society for Tropical Root Crops. (J. Cock, R. MacIntyre and M. Graham, eds.) p. 169-170. IDRC. Ottawa, Canada.
14. Nome, S. F. 1973. Sweet potato vein mosaic virus in Argentina. Phytopathol. Z. 77:44-54.
15. Schaefers, G. A. and E. R. Terry. 1976. Insect transmission of sweet potato disease agents in Nigeria. Phytopathology 66:642-645.
16. Sheffield, F. M. L. 1957. Virus diseases of sweet potato in East Africa. I. Identification of the viruses and their insect vectors. Phytopathology 47:582-590.

毒素病對甘藷產量及品質之影響

鐘美麗[1] 廖嘉信[1] 李 良[1]

摘 要

熱處理配合莖頂組織培養所得到的無病毒甘藷台農57號，冲繩100號，紅心尾及台農63號與田間複合感染甘藷病毒之病株，在田間或防虫網室內分別進行農藝性狀比較結果顯示：田間試驗，上述四品種自然感染病毒者，塊根產量分別降低24.5%，30.5%，31.8%和35.6%。網室試驗，台農63號及冲繩100號感染病毒之植株塊根產量比健株分別降低34.2%及55.9%。乾物率及曲折計示度均以病株爲高。田間試驗結果，病株粗蛋白質含量雖顯著提高，但網室試驗結果差異不顯著。病毒對莖葉產量之影響，在田間試驗爲不顯著，但網室內，病株較低，達顯著標準。

（關鍵字：病毒、品質、產量損失）

1. 嘉義農業試驗分所農藝系