

## Comparative Cruciferous Host Symptoms of Turnip Mosaic Virus Isolated in Taiwan<sup>1</sup>

C. C. Lin and L. S. Lian<sup>2</sup>

**Abstract :** Turnip mosaic virus (TuMV) were recovered from cruciferous vegetables in the central and southern part of Taiwan. Using mechanical transmission to *Brassica spp.* and other test plants, different symptoms were produced by different strains of TuMV. Host reactions of TuMV which infected *Brassica spp.* and *Raphanus sativus*, producing mottle, mottle, mosaic to black ringspot symptoms. TuMV did not infect the following test plants: *Datura stramonium*, *Lycopersicum esculentum*, *Cucurbita moschata*, *Cucumis melo*, *Lactuca sativa* var. *crispa*, *Phaseolus vulgaris*, *Vigna radiata*, *V. sesquipedalis*, *Capsicum annum* cv. Hsin-Hsin and *C. frutescens* cv. Chieng-Hsiang. The radish strain of TuMV did not infect *Brassica oleracea* var. *acephala*, *B. O.* var. *botrytis*, *B. O.* var. *capitata* and *B. O.* var. *italica*. More details of different symptoms on cruciferous vegetables were discussed.

Turnip mosaic virus (TuMV) is widely distributed around the world <sup>(1,2,4,10,14,15,19)</sup>. In Taiwan, cauliflower, sprouting broccoli and other cruciferous plants were found to be seriously infected by TuMV and their quality and production were affected. This research is concerned with studying the host range and symptoms for comparing different strains of TuMV. This information is hoped to be of value for breeding of TuMV resistant varieties of cruciferous vegetables.

### Materials and Methods

TuMV isolates were isolated from cabbage, Chinese cabbage, cauliflower, sprouting broccoli, kohlrabi, pei-tsao and edible mustard. All isolates were subjected to three successive single local lesion transfer on *Chenopodium amaranticolor* and then transferred to *Chenopodium quinoa*. The pure isolates were maintained in *Petunia hybrida* as inoculum sources.

Healthy test plants were sown in an insect free greenhouse. For mechanical inoculation, virus infected tissue was macerated in 0.1M phosphate buffer, pH 7.0, and rubbed gently on carborundum (600 mesh) dusted cotyledon of 2-3 week old test plants. After inoculation, the test plants were kept in the greenhouse for 30 days for observation. All

1. Contribution No. 1135 from Taiwan Agricultural Research Institute.

2. Respectively, Plant pathologist and assistant of Fengshan Tropical Horticultural Experiment Station, TARI, Fengshan, Kaohsiung, Taiwan 830, ROC.

symptomless test plants were back inoculated to *Chenopodium amaranticolor* to confirm the results.

### Results

TuMV can mechanically be transmitted to the following test plants : *Impatiens balsamina* (Garden balsam), *Brassica campestris* (Field mustard), *B. chinese* (Pak-choi), *B. juncea* (Leaf mustard), *B. nigra* cv. Bing, *B. oleracea* var. *capitata* (Cabbage), *B. oleracea* var. *acephala* (Common kale), *B. O.* var. *botrytis* (Cauliflower), *B. O.* var. *italica* (Sprouting broccoli), *B. O.* var. *caulorapa* (Kohlrabi), *B. pekinensis* (Chinese cabbage), *Raphanus sativus* cv. Mei-Nung-Tsao-Sheng ; cv. Kan-Na-Chi 60day ; cv. Kan-Na-Chi 40 day ; cv. Kan-Na-Chi-Long and cv. Ta-Mei-Hua, *Nicotiana rustica*, *Petunia hybrida*. In these plants, systemic mosaic symptoms were produced.

In other test plants, chlorotic or necrotic local or systemic lesion were produced by TuMV : *Amaranthus mangostanus*, *Gomphrena globosa*, *Chenopodium amaranticolor*, *C. quinoa*\*, *Nicotiana debneyi*, *N. glutinosa*\*, *N. rustica*\*, *N. tabacum* cv. Havana-425 ; cv. Hicks ; cv. Samsun and cv. TT-5, *Solanum melongena* cv. Ping-tung Long. (\* : systemic lesion)

Plants not infected by TuMV are *Cucurbita moschata*, *Cucumis melo*, *Lactuca sativa* var. *crispa*, *Phaseolus vulgaris* (Snap bean), *Vigna radiata* (Mungbean), *V. sesquipedalis* (Asparagus bean), *Capsicum annuum* cv. Hsin-Hsin (Sweet pepper), *C. frutescens* cv. Chieng-Hsiang (Hot pepper), *Datura stramonium*, *Lycopersicum esculentum*.

The symptoms produced on cruciferous vegetables by different strains of TuMV are listed as Table 1.

Table 1. Reactions of TuMV Strains on *Brassica* species and *Raphanus sativus* cultivars

Host	Strain					
	TuMV-1 <sup>1</sup> /	TuMV-2 <sup>2</sup> /	TuMV-3 <sup>3</sup> /	TuMV-4 <sup>4</sup> /	TuMV-5 <sup>5</sup> /	TuMV-6 <sup>6</sup> /
<i>B. oleracea</i> var. <i>capitata</i> cv. Hsia-Chio	—	—	M	M	SM	SM*
SueHiro	—	—	VC	VC. M	M	SM
Goleji	—	—	VC	M	M	—
Okina	—	—	SM	VC	SM	M
YR-Lanbou	—	—	SM	—	—	SM
<i>B. O.</i> var. <i>acephala</i> cv. Yellowflower (YF)	—	m	M, ns	M. ns	SM, ns	—
Savoy (YF)	#	—	M	SM	—	—
White flower (WF)	—	—	SM	SM	M	—
Savoy (WF)	CS <sup>2</sup>	—	SM	M	—	—
Round leaf (WF)	—	—	VC	M	M	—

Continue

Host	Strain					
	TuMV-1 <sup>1/</sup>	TuMV-2 <sup>2/</sup>	TuMV-3 <sup>3/</sup>	TuMV-4 <sup>4/</sup>	TuMV-5 <sup>5/</sup>	TuMV-6 <sup>6/</sup>
<i>B. O. var.</i>						
<i>italica</i>	m	—	SM	SM	SM	—
<i>botrytis</i>	—	—	M*	M*	m	SM*
<i>caulorapa</i>	m*	—	m	M	m	—
<i>B. campestris</i> (field mustard)	SM, ns	—	SM	SM, ns	SM	M, ns
<i>B. juncea</i> cv.						
Leafy-type	SM	SM	SM	SM	SM	SM
head-type	SM	—	SM	SM	SM	SM
<i>B. nigra</i> -Bing	ns	ns	ns	SMN	SM	SM
<i>B. chinense</i>	SMN	SM	SMN	SM	SM	SM, ns
<i>B. pekinensis</i> cv.						
Tropical Delight	SMN	SM	SMN	SMN	SMN	SM
Crusader	—	m*	SM	SM	SM	ns
<i>Raphanus</i>						
<i>salivus</i> cv.						
Ta-Mei-Hua	M	—	—	SL	SL	SM <sup>z</sup>
Kan-Na-Chi 60 day	—	—	—	—	M, ns	VC
Kan-Na-Chi 40 day	—	—	—	—	M	M
Kan-Na-Chi Long	SM	SM	—	SL	SL	m
40 day Pin-Tins	SM	SM	m	M	SL	SL
Mei-Nung-Tsao-Sheng	SM	SM	—	M	SM	SM

1/ : TuMV isolated from radish

2/ : TuMV isolated from Pei-tsao

3/ : TuMV isolated from cauliflower

4/ : TuMV isolated from sprouting broccoli

5/ : TuMV isolated from cabbage

6/ : TuMV isolated from mustard

CS : chlorotic spot ; m : mottle ; ns : necrotic lesion ;

M : mosaic ; SL : symptomless infection ; VC : vein clearing ;

SM : severe mosaic ; SMN : severe mosaic and death ; # : not test ;

— : no infection ; \* : host at first developed symptoms and then became symptomless.

Z : symptoms confined to outer leaves

### Discussion

Two major viruses, turnip mosaic virus and cauliflower mosaic virus are known to infect vegetables<sup>(4)</sup>. In a preliminary field survey it was found that cruciferous vegetables in Taiwan were seriously infected by turnip mosaic virus. Radish viruses isolated by Kou<sup>(7)</sup> and Yang<sup>(20)</sup> and rape mosaic by Ling<sup>(11)</sup> may be strains of TuMV. They did not infect cabbage and cauliflower. Table 1 showed that radish and pei-tiao strains of TuMV did not infect these plants. However, other strains could infect cabbage and cauliflower and produced chlorotic spot and/or severe mosaic symptoms on new leaves. None produced necrotic lesions or black ringspot symptom on cabbage. The former strains had avirulent on cabbage and virulent on radish.

Iris and pea strains of TuMV showed different symptoms on different cultivars of radish<sup>(6,13)</sup>. In Taiwan, the radish strain of TuMV produced mottle and/or mosaic symptoms on the new leaves of 3 radish cultivars and the cauliflower strain usually showed no symptom or mild mottle on old leaves. Strains of TuMV isolated from cruciferous vegetables with different severity in Taiwan.

Besides radish and cabbage, common kale was also infected by TuMV and produced severe mosaic, vein necrosis or necrotic lesions. The radish and pei-tiao strains did not infect common kale severely, developing chlorotic spots confined to outer leaves and/or mottle symptoms on new leaves. The mustard strain could not infect common kale.

According to chromosomal number, cruciferous vegetables had a genomic relation to viral susceptibility<sup>(18)</sup>. Table 1 showed *Brassica chinensis* and *B. pekinensis* cv. Tropical Delight were severe mosaic and death, *B. juncea* produced severe mosaic symptoms and *B. oleracea*, var. *acephala*; *B. O.* var. *italica*; *B. O.* var. *botrytis*; *B. O.* var. *caulorapa* produced milder symptoms.

TuMV also infected Solanaceous plants. In *Nicotiana glutinosa*, systemic chlorotic spots<sup>(7,8,9,17)</sup>/mosaic<sup>(21)</sup> or symptomless infection<sup>(3,10,18)</sup> were produced. In *N. rustica*, systemic mottling/necrotic or chlorotic rings were produced<sup>(5,7,8,9,12)</sup>. In *Petunia hybrida*, systemic mottle to mosaic symptom was produced<sup>(3,4,9,16)</sup>.

Yoshii<sup>(21)</sup> distinguished 2 strains of TuMV, the ordinary and the cabbage strain; Sako<sup>(16)</sup> differentiated TuMV as 3 groups. All our TuMV strains which infected *N. glutinosa* showed systemic ring-spots and in *N. rustica*, necrotic or chlorotic spots on inoculated leaf and then systemic mottling were produced. In *P. hybrida*, all strains produced severe mosaic symptoms except cauliflower strain produced necrotic lesions and severe mosaic symptoms.

As indicated above, TuMV strains can be differentiated into 2 groups by different host reactions on cabbages, common kales and radishes. Group A was more virulent on cabbage and common kale than on radish. Contrarily, group B had reached the opposite. From the reaction on cabbage, 2 strains of TuMV appeared to be of the ordinary strain. This information may be of value for breeding TuMV resistant cruciferous vegetables.

### Acknowledgement

The authors are thankful for Mr. T. F. Sheen, Director of Fengshan Tropical Horticultural Experiment Station, TARI; Dr. S. K. Green, Associate Plant Pathologist, AVRDC, for their suggestions and revision.

### Literature Cited

1. 陳脈紀・1975・十字花科蔬菜嵌紋病之電子顯微鏡研究・植保會刊17: 319—328・
2. 澤村健三・1957・東北地方主要蔬菜のウイルス病に関する研究・  
I・十字花科植物のウイルス病第1報ウイルスの種類・  
東北農業試験場研究報告11: 79—83・
3. 栃原比呂志・1959・ダイエンモザイク病ウイルスに関する研究  
1・ダイエンPウイルスの諸性質と形態・日植病報24(5): 287—295・
4. Broadbent, L. 1937. Investigation of virus diseases of *Brassica* crops. pp. 94 Cambridge University press.
5. Horton, J. C., G. S. Pound and T. P. Pirone. 1961. Radish mosaic virus. *Phytopathology* 51: 434-440.
6. Inouye, N. and K. Mitsuhashi. 1978. Studies on the viruses of bulbous ornamental plants in Japan. (in Japanese) *Nogaku Kenkyu* 57: 1-16.
7. Kou, T. T. 1961. A mosaic disease of radish. *Bot. Bull. Acad. Sinica* 2: 51-61.
8. Larson, R. H. and J. C. Walker. 1938. Properties and host range of a cabbage mosaic virus. *Phytopathology* 28: 13 Abstract.
9. Larson, R. H. and J. C. Walker. 1941. Ring necrosis of cabbage. *J. Agr. Res.* 62: 475-491.
10. Lee, S. H., K. W. Lee, and B. J. Chung. 1978. Investigations on the virus diseases in spinach. (*Spinacia oleracea* L.) I. Identification of turnip mosaic virus occurring spinach. *Kor. J. Pl. Prot.* 17(1): 33-35.
11. Ling, L. and J. Y. Yang. 1940. A mosaic disease of rape and other cultivated crucifers in China. *Phytopathology* 30: 338-342.
12. Pound, G. S. and J. C. Walker. 1945. Differentiation of certain crucifer viruses by the use of temperature and host immunity reactions. *J. Agr. Res.* 71: 225-278.
13. Provvidenti, R. 1978. A mosaic of *Pisum sativum* caused by a strain of turnip mosaic virus. *Plant. Dis. Rptr.* 62: 482-485.
14. Provvidenti, R. 1980. Evaluation of Chinese Cabbage cultivars from Japan and the People's Republic of China for resistance to turnip mosaic virus and cauliflower mosaic virus. *J. Amer. Soc. Hort. Sci.* 105(4): 571-573.
15. Purcifull, D. E. 1968. Occurrence of a turnip mosaic virus in Florida. *Plant Dis. Rptr.* 52: 759-760.
16. Sako, N. 1981. Virus diseases of Chinese cabbage in Japan. in Chinese Cabbage Proceedings of the 1st International Symposium p.129-141. AVRDC, Taiwan. ROC.
17. Smith, K. M. 1935. A virus disease of cultivated crucifers. *Ann. appl. Biol.* 22: 239-242.
18. Takahashi, W. N. 1949. The morphology and host range of *Brassica nigra* virus. *Amer. J. Bot.* 36: 533-535.
19. Weide, V. H. L. 1981. Virusbedingte Innenblattnekrosen bei Weisskohl. *Nachrichtenbl. Deutsch. Pflanzenschutzd.* 33(2): 17-20.

20. Yang, S. J. 1971. Studies on virus diseases of radish in Taiwan. Msc. Thesis, National Taiwan University pp. 84. (in Chinese)
21. Yoshii, H. 1963. On the strain distribution of turnip mosaic virus. Ann. Phytopathol. Soc. Japan, 28(4) : 221-227.

## 臺灣蕪菁嵌紋病毒對十字花科蔬菜病徵之比較<sup>1</sup>

林正忠      連麗仙<sup>2</sup>

### 摘 要

從臺灣南部及中部地區分離十字花科蔬菜嵌紋病得到數個蕪菁嵌紋病毒 (TuMV) 系統。利用機械接種各病毒系統於十字花科蔬菜及其他寄主，比較各病毒系統間之差異性，發現蕪菁嵌紋病毒在野生菸草 *Nicotiana glutinosa* 上皆形成系統性黃化型輪斑，*N. rustica* 上出現嵌紋及系統性局斑；千日紅，菸草栽培品種 Samsun；喜國土，哈瓦那—425，臺菸 5 號及 *N. debneyi* 的接種葉形成黃化斑或壞疽局斑。在十字花科蔬菜上，各病毒系統間病徵變化差異大，從免疫，系統性壞疽斑，輕微嵌紋，嚴重嵌紋到全株死亡等不同病徵出現。此外蕪菁嵌紋病毒不能感染下列植物即曼陀羅、蕃茄、南瓜、萵苣、豇豆及綠豆等。蘿蔔及白菜系統蕪菁嵌紋病毒不能感染芥藍、花椰菜、甘藍及青花菜等作物。

1. 臺灣省農業試驗所 研究報告第 1135 號。

2. 本所鳳山熱帶園藝試驗分所植物保護系副研究員、計畫助理。臺灣省 高雄縣 鳳山市。