Collection of Solanaceous Plants in Malaysia and Screening for Disease Resistance

By TOMOAKI NARIKAWA*, YOSHITERU SAKATA, SHOJI KOMOCHI, MELOR REJAB**, HENG CHING KOK** and JUMALI SURATMAN**

Department of Breeding, National Research Institute of Vegetables, Ornamental Plants and Tea (Ano, Mie, 514-23 Japan)
** Malaysian Agricultural Research and Development Institute (P.O. Box 2301, GPO Kuala Lumpur, Malaysia)

In cultivation of Solanaceous vegetable crops, such as tomato, eggplant and pepper, bacterial wilt (*Pseudomonas solanacearum* Smith), Verticillium wilt (*Verticillium dahliae* Klebahn) and Fusarium wilt (*Fusarium oxysporum* Schlechtendahl), which are extremely difficult to be controlled by chemicals, cause serious crop damage not only in Asian countries but also in others, although several breeding materials resistant to these diseases have been found or developed. The exploration for more stable resistant materials is greatly demanded in breeding procedure. With an aim of collecting local varieties of Solanaceous vegetables and their relatives in tropical countries and screening them for the disease resistance to be used for breeding, a collaborative study between National Research Institute of Vegetables, Ornamental Plants and Tea (NIVOT) and Malaysian Agricultural Research and Development Institute (MARDI) was carried out to collect Solanaceous plants in Malaysia and to screen them for the resistance to the three kinds of wilt listed above. In the present paper, the result of the screening of cultivars of *Solanum torvum* collected is presented.

This study was supported by the Science and Technology Agency of Government of Japan.

Present address:
* Second Crop Division, Hokkaido National Agricultural Experiment Station (Hitsujigaoka, Toyohira, Sapporo, 004 Japan)

Exploration and collection of Solanaceous plants in Malaysia

1) Outline of collection methods

The collection trips were performed three times in collaboration with MARDI. The first trip was done in the western part of Peninsula Malaysia from March 26 to April 25, 1985 by Shoji Komochi, the second trip in the eastern part of Peninsula Malaysia was done from February 28 to March 25, 1986 by Yoshiteru Sakata, and the third trip was done in eastern Malaysia from October 9 to October 17, 1986 by Tomoaki Narikawa.

The base sites for collection are shown in Fig. 1.

The ways of exploration and collection were as follows:

(1) In rural areas, we asked the farmers to give us some of the matured fruits obtainable in their fields or backyards.

(2) At the roadside or in the fields, we looked for relative species and collected their fruits.

(3) In rural areas or in the jungles, information of Solanaceous plants and their fruits were collected from village people. If necessary, we asked them to guide us to the stand of plants or to bring the fruits from the jungle.

(4) In the local markets, we collected seeds or matured fruits of Solanaceous vegetables.

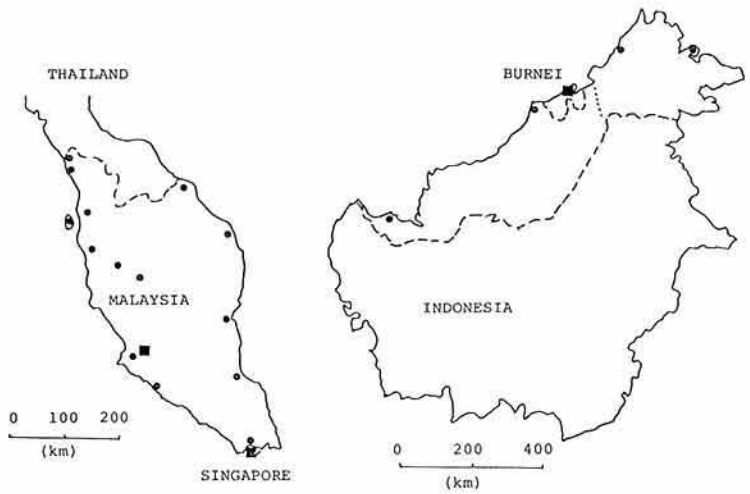

Fig 1. Base sites for the collection in Malaysia

From the matured fruits collected, their seeds were obtained in the evening of the day of collection. After squeezing the fruits, their seeds were put in nylon meshes and washed thoroughly. Then, the nylon meshes with seeds were dried with dehumidified air overnight.

The half volume of each of all the collections was kept in MARDI with brief notes. The other half was sterilized with chemicals. After passing through the Japanese plant quarantine, the seed samples were arranged and preserved for various kinds of evaluation.

2) *Results of exploration and collection*

The total number of collected samples was 326 as shown in Table 1. It is widely said that eggplant (*S. melongena*) and its close relatives (ex. *S. incanum*) originated in India, so that they have wide variations in India and ASEAN countries. In fact, various types of eggplant and its relatives were found and collected in Malaysia. Details of the collections were as follows:

(1) Eggplant (*S. melongena*): Fifty-one samples of local and exotic varieties were collected. The fruit shape varied from round to very long and the size also varied. The color of fruitskin was blackpurple, redpurple, green, and white. In the backyards, various variations in shape, size and color of fruit were observed. In commercial cultivation, most of Chinese-Malaysian farmers were growing long-shaped fruit with redpurple skin. On the other hand, most of native Malaysian were growing round fruit with black-purple skin. In every field tremendous damages of fruit and stems of eggplants caused by the fruitborers and spidermites were observed. On the contrary, there were very few plants damaged by bacterial wilt. In Malaysia with the tropical rain forest climate, the eggplants are always cultivated under the conditions of hot and humid climate which is very similar to the summer climate of Japan. In Japan, eggplants are wilted and

Table 1. Solanaceous plants collected in Malaysia by the collaborative work between NIVOT and MARDI

Name	Number of samples collected in			Total
	1st trip	2nd trip	3rd trip	
Egg plant	20	21	10	51
Chilli pepper	44	15	14	73
Tomato	30	9	21	60
Solanum spp.	81	40	18	139
The others	1	2	0	3
Total	176	87	63	326

died by bacterial wilt. It seems that the Malaysian eggplants have been selected naturally for higher resistance.

(2) Wild species related to eggplant (*Solanum* spp.): One hundred and thirty nine samples were collected. They were classified into four big groups, (a) closely similar to eggplant, (b) *S. torvum* group, (c) *S. ferox* group and (d) others. Most of them are used for food or for medicine.

(a) This group could be divided into three types. The first type was identified as *S. incanum* whose fruit was small and round (3 cmϕ). The fruit was pale green with green-shoulder and turned to yellow at the ripening stage. The second type was thought to be the hybrids between eggplant and *S. incanum*. The third type was identified as *S. indicum* whose fruit was small and round (1 cmϕ). The fruit was pale green with green-shoulder and turned to red at the ripening stage.

(b) The population density of spontaneously growing *S. torvum* was not high, but this species was found and collected throughout Malaysia. The plant of *S. torvum* was completely different from eggplant in plant type, with plant height of ca. 2 m, white flowers, and green small fruit (Plate 1). Its immature fruit with a little bitter taste was sometimes found on local markets.

(c) Plants belonging to the *S. ferox* group are very hairy. The hair covers not only leaves, stems, calyx but also fruit. Their fruit tasted very sour. The samples were thought as *S. ferox* or *S. aculentissimum*.

(d) *S. jamaicense*, *S. macrocarpon*, *S. mammosum* etc. were confirmed.

(3) Tomato: Sixty samples of local or exotic varieties were collected. From the view point of temperature, varieties with big and good quality fruit were considered to be cultivated only in the highland, although their seeds were mostly imported from abroad, i.e., Taipei or Thailand. Thus no local varieties were found in the highlands. On the contrary, tomatoes with small-fruit (2–3 cmϕ) were sometimes found on local markets in old villages in the lowland. It is said that some of these small-fruited tomatoes are highly resistant to bacterial wilt.

(4) Chilli pepper: Seventy three samples of local or exotic chilli peppers were collected. Two species, *Capsicum annuum* and *C. frutescens* were identified. The fruit shape of *C. annuum* was divided into six types described in Fig. 2. The immature fruit color was green or pale green. Generally speaking,

Plate 1. The fruit of *S. torvum*

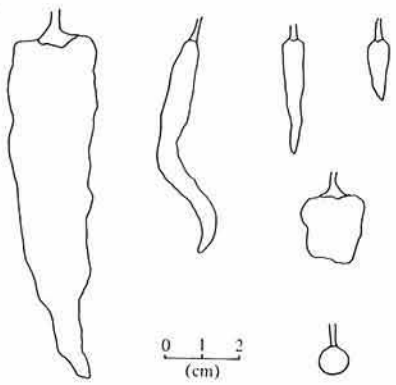

Fig. 2. Various fruit-shapes shown by *C. annuum*

big-fruited peppers were not so hot. The fruit shape of *C. frutescens* was a standard type or a semi-long type.

In Malaysia, chilli peppers are regarded as the most profitable vegetable for farmers. But severe virus diseases spread in all fields made the cultivation difficult. To find out the resistant chilli peppers to virus diseases seemed very difficult in Malaysia.

(5) Other Solanaceous crops: Tree tomato (*Cyphomandra betatea*), *Datura metal* and *Physalis* spp. were collected.

Screening of collected *S. torvum* for the resistance to bacterial wilt, Verticillium wilt and Fusarium wilt

1) Materials and methods

Eighteen lines (14 lines collected in Malaysia and 4 lines from other countries) of *S. torvum* and five cultivars (2 cultivars of *S. melongena* and 3 hybrids for rootstock) were used for the screening tests.

Resistance to bacterial wilt, Fusarium wilt and Verticillium wilt, was screened separately at an adequate stage and under suitable temperature condition.

The root-dipping and soil-inoculation methods were adopted for these three diseases. The seeds treated with 100 ppm of Gibberellin were sown in the medium (soil: perlite=1 : 1 in volume) and grown in a greenhouse. About 40 days after sowing, roots of the seedling were washed, cut off by two-thirds length, and dipped into the inoculum suspension before transplanting. The inoculum suspension was poured into the plastic pots about 10 m*l* per plant after transplanting. The inoculum suspensions were prepared as follows:

(1) bacterial wilt: Two strains, E8323 (group III) and E8101 (group IV), isolated by Ozaki[1], were incubated in the Wakimoto medium for 2 days at 30°C. And the bacterial suspension was diluted with water to one-tenth.

(2) Verticillium wilt: Two strains, No. 5 and No. 41, isolated by Takeuchi[2], were incubated in modified PG medium (20 g/*l* of mashed potato, 20 g/*l* of glucose, 3 g/*l* of yeast extracts and 1 g/*l* of potassium phosphate, Dibasic) for 10 days at 25°C. The suspension was centrifuged to gather the spores, and the spores were diluted to the density of $2\text{–}5\times10^7$ spores/m*l*.

(3) Fusarium wilt: A strain (No. 7) kept in NIVOT was incubated in PS medium for 10 days at 25°C. The subsequent procedure was the same as in Verticillium wilt.

The inoculated plants were grown for 2–4 weeks (bacterial wilt) or 1–1.5 months (Verticillium and Fusarium wilt) in the greenhouse, until the susceptible cultivars had completely damaged.

The evaluation of resistance was scored with the observation of the symptom. The degree of infection was rated on 0–4 scores as follows:

(1) bacterial wilt: 0=no visible symptom, 1=a little parts wilting, 2=half parts wilting, 3=most parts wilting, 4=completely wilting or dead.

(2) Verticillium wilt, and Fusarium wilt: 0=no visible symptom, 1=lower parts chlorosis or wilting, 2=half parts chlorosis or wilting, 3=most parts chlorosis or wilting, 4=completely wilting or dead.

2) Results of the screening

S. torvum is known as a resistant species to bacterial wilt, Fusarium wilt and Ver-

Table 2. Varietal differences of *S. torvum* in the resistance to three diseases

Arranged no. (cv.)	Verticillium wilt		bacterial wilt		Fusarium wilt
	No. 5	No. 41	E8323	E8101	No. 7
LS 1843	0.84	0.25	—	—	0
LS 1878	0.45	0.35	—	—	0
LS 1880	0.70	0.10	0.14	0.75	0
LS 1881	0.58	0.25	0.25	0.86	—
LS 1898	0.44	0.55	0.25	1.50	0
LS 1915	1.61	0.15	0.45	0.75	0
LS 1921	0.65	0.25	0.27	0.82	—
LS 1922	1.00	0.25	0	1.00	—
LS 1928	0.90	0.25	—	—	—
LS 1947	1.26	0.30	0.24	0.28	0
LS 1948	1.15	0.35	0	0.46	0
LS 1955	0.17	0	—	—	—
LS 1957	0.37	0.30	0	1.64	0
LS 1964	0.50	0.15	0.29	0.54	0
LS 1196[a)]	0.70	0.35	0.14	1.42	—
LS 1783[a)]	0.80	0.30	0.27	0.83	—
MT-7[a)]	0.85	0.25	0	1.25	—
Torvum vigor[a)]	0.90	0.30	0.27	0.88	—
Meet[b)]	1.25	0.89	0.08	0	—
Taibyo-VF[b)]	3.16	1.85	—	—	—
Asist[b)]	1.80	1.84	0	0	—
D. M. P.[c),d)]	3.94	2.55	0.23	0	—
Nakateshinkuro[d)]	3.85	1.80	2.62	2.18	4.00

a) : *S. torvum* from other countries, b) : hybrid for rootstock,
c) : Dingaras multiple purple, in the Philippines, d) : *S. melongena.*

ticillium wilt (Yamakawa)[3]. Recently one selected line from Puerto Rico registered as 'Torvum vigor' is often used as a rootstock for eggplant in Japan. But even Torvum vigor is attacked by these diseases due to the increase of the pathogen density or the appearance of a new virulent race. The demand for a new rootstock which has stronger resistance to bacterial wilt and Verticillium wilt has arisen.

Fortunately many lines of *S. torvum* were collected in Malaysia. They gave the good opportunity of screening for the disease resistance in NIVOT.

The results are shown in Table 2. All the lines of *S. torvum* were more resistant to Fusarium wilt and Verticillium wilt compared with susceptible cultivars. Especially to Fusarium wilt, every line had the absolute resistance. Judging from the growth of inoculated plants, LS1878, LS1921 and LS1957 were regarded as highly resistant to Verticillium wilt.

All the *S. torvum* lines showed high resistance to the strain E8323 of *Pseudomonas solanacearum.* On the other hand, there were some lines which were attacked by the other strain E8101 severely. The strain E8101 was isolated as the virulent strain to Torvum vigor. Nevertheless LS1947 and LS1948 were found to have high resistance to both strains.

Conclusion

In the collaborative study between NIVOT and MARDI, 326 samples of Solanaceous plants in total were collected in Malaysia. In the present paper, the result of the screenings for three kinds of wilt conducted with a part of the samples collected is described. Even though in the small parts of the samples, a few samples are found to be resistant to the

three diseases, bacterial wilt, Verticillium wilt and Fusarium wilt. The authors intend to continue the screening of the rest collections for the resistance to some of serious diseases. Recently a large amount of herbicides have come to be used in rubber and oil palm plantations occupying more than half of the land in Malaysia. It may result in the reduction of varieties of plants. Local varieties rich in wide variations (genetic resources) seem to be oppressed by new exotic cultivars. Collection and preservation of germplasm of Solanaceous plants, before the valuable species or lines come to disappear, are most indispensable for the future breeding works.

Solanaceous plants are also important from the viewpoint of pharmacy. Resistant plants to diseases or pests are expected with hope to contain some kinds of components which may be utilized as agricultural chemicals. In addition, most Solanaceous plants have some kinds of alkaroids or terpenoids which can be utilized as medicines.

References

1) Ozaki, K.: Pathogenicity divergence of *Pseudomonas solanacearum*. *In* 13th Plant Microbiology Workshop, 1–8 (1985) [In Japanese].
2) Takeuchi, S. & Hagiwara, H.: Parasitic habit of various *Verticillium dahliae*. *Abst. Ann. Phytopathol. Soc. Jpn.*, 49, 394 (1983) [In Japanese].
3) Yamakawa, K.: Use of rootstocks in Solanaceous fruit-vegetable production in Japan. *JARQ*, 15, 175–179 (1982).

(Received for publication, January 22, 1988)