

Breeding of New Cultivars of Cucumber and Strawberry with Multiple Disease Resistance under Japan and China Collaborative Program

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Abstract

By using Japanese and Chinese genetic resources, the authors have bred two disease resistant cucumber cultivars 'Hu No.116' and 'Hu No.119' resistant to disease and two strawberry cultivars 'Shenxu No.1' and 'Shenxu No.2' resistant to disease within the framework of the collaborative project on "Breeding of disease-resistant vegetable cultivars in sub-tropical China, 1992-1997" between JIRCAS and Shanghai Academy of Agricultural Sciences. One cucumber cultivar, 'Hu No.116', shows a high productivity with many female flowers and it also has good fruit quality including good shape, deep green skin color, few nodules and few spines. Another cucumber cultivar, 'Hu No.119' has also good fruit quality and can lead to more stable production, although the female

flower bearing ability is lower than that of 'Hu No.116'. In addition, 'Hu No.116' and 'Hu No.119' show a higher resistance to *Fusarium oxysporum* Sch. : Fries f. sp. *cucumerinum* Owen and *Pseudoperonospora cubensis* Rostowzew. 'Hu No.116' and 'Hu No.119' are adapted to semi-forcing culture throughout the Shanghai area as well as in the provinces of Jhejiang, Jiangsu, Shandong, Sichuan, etc.

One strawberry cultivar, 'Shenxu No.1' displays a high productivity and good fruit quality, with large-size fruits showing a conical shape and shiny scarlet skin color. Furthermore, it can be easily transported, because the flesh is firm and the skin is hard.

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Another strawberry cultivar, 'Shenxu No.2' is one of the earliest maturing cultivars and it displays excellent fruit characters, including large fruit with a conical shape, very shiny scarlet skin color, with sweet and good taste. In addition, 'Shenxu No.1' and 'Shenxu No.2' exhibit a high resistance to *Colletotrichum acutatum* Simmonds and *C. gloeosporioides* Penz & Sacc. 'Shenxu No.1' and 'Shenxu No.2' are adapted to forcing culture throughout the Shanghai area. As the flower bud initiation of 'Shenxu No.2' is slightly late, the cultivar is not adapted to forcing culture in the warmer southern area of China.

Additional key words: *Cucumis sativus* L, *Fragaria* × *ananassa* Duch, breeding

Introduction

Shanghai is located at latitude 31° N in the northern part of the sub-tropical zone. The mean temperature in a year is 15.7°C. JIRCAS had been carrying out research in collaboration with the Shanghai Academy of Agricultural Sciences (SAAS) from 1986 to 1997. From 1986 until 1991 studies on the development of heat-tolerant vegetable cultivars and cultivation methods to achieve high and stable production of vegetable crops during the hot season were carried out in the first phase of the research collaboration. From 1992 to 1997, the research program for the development of disease-resistant vegetable cultivars or breeding materials was carried out in the second phase.

Japan-China collaboration research team was composed of three groups engaged in research on cucumber, sweet pepper and strawberry. The main diseases studied in this project were fusarium wilt

(*Fusarium oxysporum*) and downy mildew (*Pseudoperonospora cubensis*) of cucumber, virus diseases of sweet pepper and crown rot (*Colletotrichum acutatum*, *C. gloeosporioides*) as well as virus diseases of strawberry.

During the collaborative project, we developed two new F₁ cultivars of cucumber and two new strawberry cultivars with disease resistance, high yielding ability and high quality by using the genetic resources of Japan and China.

1. New cucumber cultivars 'Hu No.116' and 'Hu No.119'

Breeding process

1) Parents

'Hu No.116' and 'Hu No.119' were selected as cultivars for forcing culture. 'Hu No.116' is the F₁ cultivar derived from a cross between '0202-1-1' and 'SK-11', while 'Hu No.119' is the F₁ cultivar derived from a cross between '0202-1-1' and '019-2' (Fig.1).

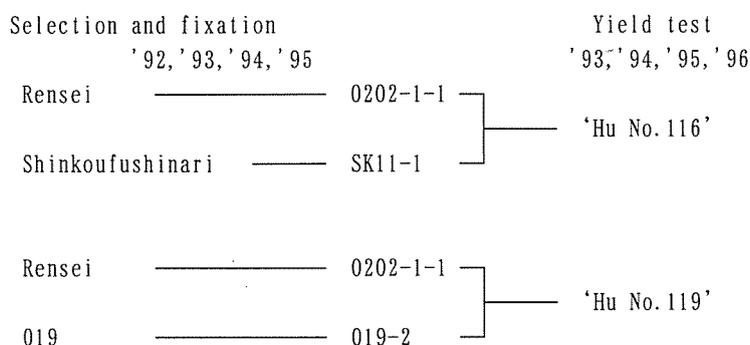


Fig.1. Breeding process of new cucumber cultivars 'Hu 116' and 'Hu 119'

'0202-1-1' is the fixed line selected from a progeny of 'Rensei' which is one of the Japanese cucumber cultivars. '0202-1-1' is characterized by early maturity, high female flower bearing ability, resistance to downy mildew and fusarium wilt.

'SK-11' is the fixed line selected from a progeny of 'Shinkoufushinari 11' which was introduced from Japan to improve low temperature tolerance, female flower bearing ability and fruit quality.

'019-2' is the fixed line with good fruit quality which was selected from a progeny of a cultivar from the southern part of China.

2) F_1 new cultivars

F_1 combining ability test was performed under semi-forcing culture in 1992. '0202-1-1' \times 'SK-11' and '019-2' \times '0202-1-1' were the best F_1 lines among the breeding lines. They were called 'Hu No.116' and 'Hu No.119' later, respectively. A series of experiments was conducted on 'Hu No.116' and 'Hu No.119' to evaluate their

maturity, disease resistance, yield, fruit quality, etc, in Shanghai during the period 1993-1996.

3) Evaluation of fusarium wilt and downy mildew resistance

(1) Field test

Field test was performed by natural infection in the field of Shanghai Academy of Agricultural Sciences in 1993 and 1994. Degrees of disease resistance to fusarium wilt and downy mildew were evaluated based on the disease severity index or mortality by natural infection.

(2) Inoculation test

Fusarium wilt: *Fusarium oxysporum* was cultured in flasks containing a potato-sucrose broth on a reciprocal shaker (120 r.p.m.) at 25°C under illumination with fluorescent light (12 hr). Roots were dipped into a suspension of 10^6 conidia per milliliter. Disease exponential or mortality rate was investigated at 19 days after inoculation. For each cultivar there were 3 replications of 10 plants.

Downy mildew: Source of downy mildew

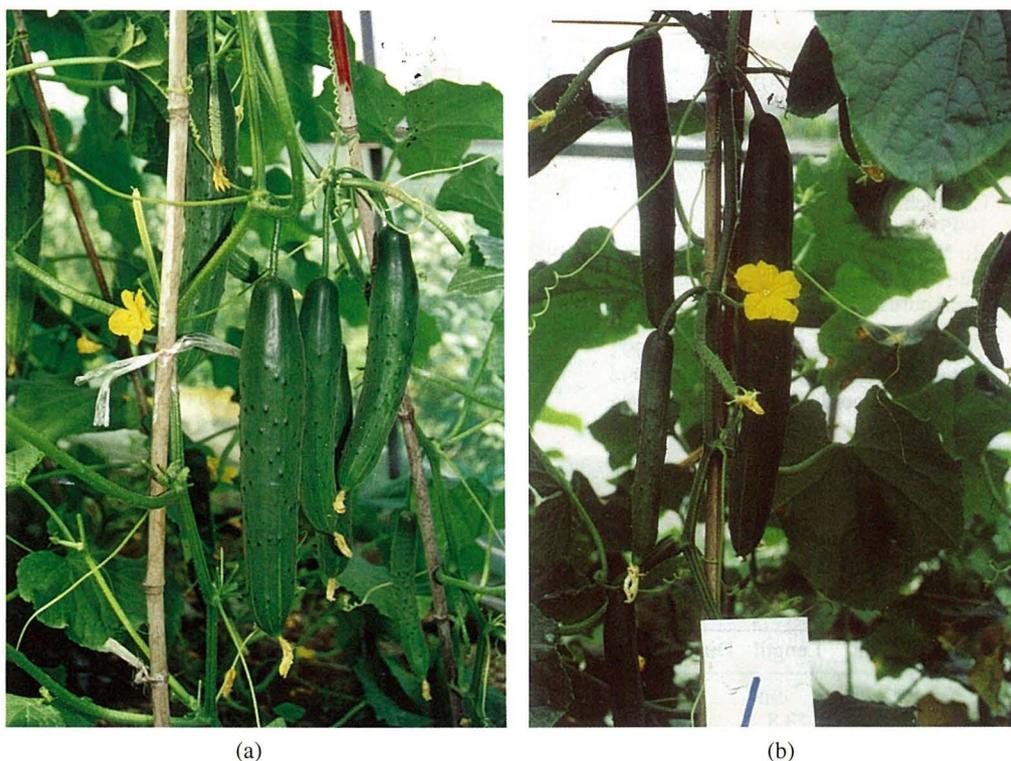


Fig.2. New cucumber cultivars
(a) 'Hu 116', (b) 'Hu 119'

(*Pseudoperonospora cubensis*) was obtained from infected cucumber leaves. They were cultured in a humid chamber at 28°C for 2 days. The conidium concentration was adjusted to 2×10^3 conidia per milliliter. After the leaves were removed, they were inoculated by dropping about 2 milliliter of inoculum at the two points. Inoculated leaves were incubated in a humid petri dish at 28°C under illumination with fluorescent light (12 hr). Disease index was determined at 5 days after inoculation. Four leaves per cultivar were used in this test.

Varietal characteristics

1) Plant growth characteristics

Growth of 'Hu No.116' (Fig.2a) in the early stage was slightly slower than that of the other cultivars (Table 1). Leaf size and node length of 'Hu No.116' were intermediate. Early growth and

plant vigor of 'Hu No.119' (Fig.2b) was intermediate. Leaf size of 'Hu No.119' was slightly smaller.

Bearing node order of the first female flower of 'Hu No.116' and 'Hu No.119' ranged from 3 to 4, a value lower than that of 'Shinkoufushinari 11' but higher than that of 'Changchunmici'. 'Hu No.116' bears a larger number of female flowers than 'Shinkoufushinari 11' and 'Changchunmici'. Although 'Hu No.119' exhibited a lower female flower bearing ability than 'Hu No.116', harvest could be constantly performed during the growing period.

2) Fruit characteristics

The fruit length of 'Hu No.116' and 'Hu No.119' is in the range of about 20 to 24cm (Table 2). The skin color is deep green and there on few

Table 1. Plant characteristics of new cucumber cultivars

Cultivar	1st female flower bearing node ^z	Femaleflower bearing rate ^y	Plant height ^x	Leaf number ^w	Leaf length ^v	Leaf width ^u
		%	cm		cm	cm
1993						
Hu No.116	4.3	50.6	12.2	4.4	8.3	10.1
Hu No.119	3.4	38.0	9.8	4.3	8.1	10.1
Changchunmici	3.4	39.3	13.4	4.7	9.4	11.5
1994						
Hu No.116	3.1	74.0	29.9	7.3	11.8	13.9
Hu No.119	3.9	47.0	36.2	7.8	13.0	15.3
Shinkoufushinari	4.2	40.0	30.3	7.4	11.8	14.2
Changchunmici	2.5	61.0	30.5	7.8	13.2	15.8
1995						
Hu No.116	4.0	59.2	34.8	7.6	12.4	15.0
Hu No.119	3.8	36.1	35.5	7.9	12.0	14.2
Shinkoufushinari	4.9	52.1	37.1	8.8	12.6	15.4

^{z,y}Data were recorded on 7 May, 1993, ^{x,w,v,u} data were recorded on 17 April, 1993.

^{z,y}Data were recorded on 28 March, 1994, ^{x,w,v,u} data were recorded on 14 April, 1994.

^{z,y}Data were recorded on 9 May, 1995, ^{x,w,v,u} data were recorded on 17 April, 1993.

Table 2. Fruit characteristics of new cucumber cultivars

Cultivar	Fruit								Sugar content ^z	Ascorbic acid content
	Weight	Length	Diameter	Shape	Peduncle	Color	Warts	Prickles		
	g	cm	cm						%	mg/100g
Hu No. 116	165.0	23.8	3.2	Stick	no neck	deep green	few	few	2.8	6.5
Hu No. 119	150.6	24.2	3.5	Stick	no neck	deep green	few	few	2.9	8.1
Shinkoufushinari	163.6	26.1	3.4	Stick	no neck	deep green	few	few	2.9	5.9
Changchunmici	130.0	23.4	3.0	Stick	neck	deep green	many	many	-	-

^z Soluble solid content (Brix). Data were recorded in 1994.

warts and spines. 'Changchunmici' has a neck in the fruit shoulder, unlike the fruits of 'Hu No.116' and 'Hu No.119' which are shaped like sticks. Flesh of 'Hu No.116' and 'Hu No.119' is thick and friable. The fruit quality of the new cultivars is considered to be good.

3) Yield characteristics

Early yield of 'Hu No.116' was about 20 to 30% higher than that of 'Shinkoufushinari 11', and almost the same as that of 'Changchunmici' in the field of SAAS (Table 3). Total yield of 'Hu No.116' was about 20% higher than that of 'Shinkoufushinari 11'. On the other hand, early

yield of 'Hu No.119' was higher than that of 'Shinkoufushinari 11' for an average of two years. Total yield of 'Hu No.119' was about 15 to 20% higher than that of 'Shinkoufushinari 11'.

'Hu No.116' and 'Hu No.119' are adapted to semi-forcing culture at throughout the Shanghai area and Zhejiang, Jiangsu, Shandong, Sichuan areas, etc.

4) Resistance to fusarium wilt and downy mildew

'Hu No.116' displays the highest degree of resistance to *Fusarium oxysporum* among the cultivars used in the seedling test (Table 4). 'Hu No.119' has a higher degree of resistance than

Table 3. Yield characteristics of new cucumber cultivars

Cultivar	1994 ^z		1995 ^w	
	Early yield ^y	Total yield ^x	Early yield ^v	Total yield ^u
	kg/a	kg/a	kg/a	kg/a
Hu No. 116	262.2	544.4	220.0	637.3
Hu No. 119	255.6	533.0	159.2	605.3
Shinkoufushinari	200.0	446.7	186.4	518.7
Changchunmici	268.9	533.0	—	—

^zSowing date : February 19, 1994. ^y4 May~17 May. ^x4 May~ 7 June.
^wSowing date : February 21, 1995. ^v3 May~16 May. ^u3 May~19 June.

Table 4. Evaluation of resistance to fusarium wilt of new cucumber cultivars

Cultivar	Seedling test		Field test ^y	
	1993	1996	1993	1994
Hu No. 116	11.1 ^z	35.0 ^z	79.6 ^z	24.7 ^z
Hu No. 119	—	45.0	66.8	34.7
Shinkoufushinari	—	55.0	—	19.1
Changchunmici	55.6	—	89.6	38.6
Yanghang	—	55.0	—	—

^zDisease severity index. ^yNatural infection.

Table 5. Evaluation of resistance to downy mildew of new cucumber cultivars

Cultivar	Seedling test		Field test
	1996	1996	1994
			%
Hu No. 116	39.3 ^z	28.0 ^z	1.4 ^y
Hu No. 119	32.0	31.3	3.8
Shinkoufushinari	34.0	41.3	4.0
Changchunmici	—	—	9.2
Yanghang	62.0	56.0	—

^zDisease severity index. ^yMortality rate

'Shinkoufushinari' and 'Yanghang'. There was severe outbreak of fusarium wilt in the field test in 1993. However, the susceptibility of 'Hu No.116' and 'Hu No.119' was lower than that of 'Changchunmici'.

'Hu No.116' showed a high degree of resistance to *Pseudoperonospora cubensis* in the seedling test and in the field test (Table 5). 'Hu No.119' displayed a degree of resistance similar to or higher than that of *P. cubensis* in the same way as 'Shinkoufushinari'.

2. New strawberry cultivars 'Shenxu No.1' and 'Shenxu No.2'

Breeding process

1) Parents

'Shenxu No.1' and 'Shenxu No.2' were selected as cultivars for forcing culture originally from a cross of 'Belle Rouge' X 'Reiko' and 'Kurume No.49' X '9418-23', respectively (Fig.3).

'Belle Rouge' is a Japanese cultivar for semi-forcing culture used in Northern Japan. The fruit of 'Belle Rouge' is conical, bright red in color, very glossy, very attractive in appearance, and has a very hard skin.

'Reiko' is a Japanese cultivar for forcing culture. The fruit of 'Reiko' is very large, conical, red in color, very glossy, very attractive in appearance.

'Kurume No.49' is the selected line for forcing culture from a cross between the Japanese leading

cultivars, 'Toyonoka' and 'Nyoho'. The fruit of 'Kurume No.49' is very large, conical, red in color, but the skin and flesh are soft.

'9418-23' is the selected line for forcing culture originally derived from a cross of 'Nyoho' x ('Harunoka' x 'Terunoka'). The fruit of '9418-23' is large, conical, hard, bright red in color and very glossy.

2) Evaluation of resistance to anthracnose

(1) Spray inoculation method

At first, the resistance of the new cultivars was evaluated by spraying spores on plant according to the method of Delp et al.¹⁾ *Colletotrichum gloeosporioides*, which is the dominant species in Japan, and *Colletotrichum acutatum*, which is the dominant species in Shanghai, were cultured in flasks containing potato-sucrose broth on a reciprocal shaker (120 r.p.m.) at 25°C under illumination with fluorescent light (12 hr). Strawberry plants growing in plastic pots were inoculated by spraying with a suspension of 10⁶ conidia per milliliter. They were kept under high temperature and humidity conditions. After one month, the mortality rate of each cultivar was investigated. For each cultivar there were 2 replications with 10 plants.

(2) Petiole dip inoculation method

Secondary evaluation of resistance was performed by the petiole dip inoculation method according to the method of Noguchi et al.²⁾. The third youngest, fully expanded leaves (third leaves)

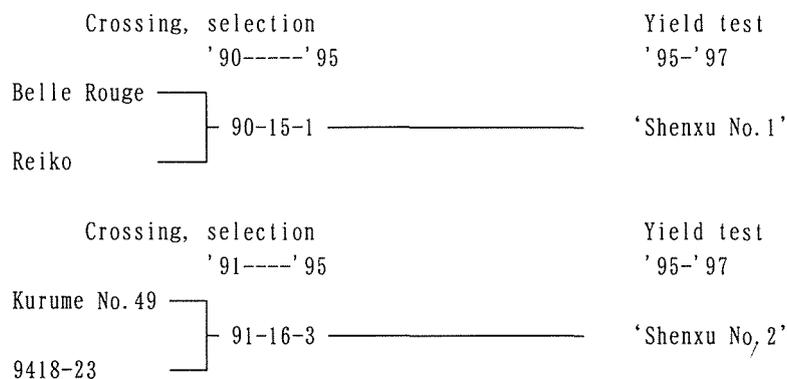


Fig.3. Breeding process of strawberry cultivars 'Shenxu No.1' and 'Shenxu No.2'

were collected from strawberry plants. After the leaflets were removed, the bottom cross-section of the petiole was covered with paraffin. The top cross sections were inoculated by dipping into a suspension of 10^5 conidia per milliliter (*C. gloeosporioides*). Inoculated petioles were incubated in a humid chamber at 25°C under illumination with fluorescent light (12 hr), and the length of the blackish lesions on the petiole was measured at 3, 5 and 7 days after inoculation.

Varietal characteristics

1) Plant growth characteristics

Leaf emergence interval of 'Shenxu No.1' is comparatively short. The size of the leaf is average and the plant shape belongs to the erect type. The peduncle is long. The productivity of the plant is

not satisfactory (Table 6). Dormancy of 'Shenxu No.1' is deep. Blooming occurs later than in 'Toyonoka' and harvesting starts from January (Table 7). The flower number of the first flower cluster is the same as that of 'Toyonoka'.

'Shenxu No.2' is vigorous and the leaf emergence interval is short. The size of the leaf is average and the plant shape belongs to the erect type. The peduncle is long. 'Shenxu No.2' produces many runners and many daughter plants easily. The flowering and harvesting of 'Shenxu No.2' occur over 10 days earlier than in 'Toyonoka'. The flower number of the first flower cluster is the same as that of 'Toyonoka'.

2) Fruit characteristics

The fruit of 'Shenxu No.1' is large in size,

Table 6. Morphological characteristics of new strawberry cultivars

Cultivar	3/5/1996					7/11/1996			
	Petiole length	Leaf length	Leaf width	Leaf area	Plant height	Petiole length	Leaf length	Leaf width	Leaf area
	cm	cm	cm	cm ²	cm	cm	cm	cm	cm ²
Shenxu No.1	25.9	11.1	7.7	220.1	36.4	7.7	7.4	7.1	104.5
Shenxu No.2	22.7	8.8	6.9	121.8	30.0	6.9	6.8	5.8	80.5
Toyonoka	22.3	10.3	10.7	219.0	30.6	7.8	7.1	7.0	100.5
Hokowase	14.9	7.4	7.4	94.0	21.9	5.6	5.9	5.1	60.1

Table 7. Differences among strawberry cultivars in the onset of flowering, harvesting and flower number of the first flower cluster

Cultivar	Flowering	Harvesting	No. of flowers
Shenxu No.1	Nov. 21	Jan. 13	22.5
Shenxu No.2	Nov. 2	Dec. 13	14.1
Toyonoka	Nov. 11	Dec. 28	17.9
Hokowase	Nov. 16	Jan. 3	27.7

Table 8. Fruit characteristics of new strawberry cultivars

Cultivar	Fruit weight	Brix	Acidity	Content of vitamin C	Fruit shape	Fruit skin color	Hardness	Aroma	Taste
	g	%	%	mg/100g					
Shenxu No.1	11.8	8.7	0.54	0.95	L. C	D. R	V. H	N	S. G
Shenxu No.2	10.6	9.3	0.74	0.98	C	V. R	H	V. R	E
Toyonoka	10.7	9.3	0.67	1.09	C	P. R	S. S	V. R	E
Hokowase	7.6	9.3	0.57	0.94	C	V. R	S. H	R	G

Fruit shape : L. C = Long conical, C = Conical. Fruit skin color : D. R = Deep red, V. R = Vivid red, P. R = Pale red
 Hardness : V. H = Very hard, H = Hard, S. H = Slightly hard, S. S = Slightly soft
 Aroma : N = No aroma, VR = Very rich, R = Rich. Taste : E = Excellent, G = Good, S. G = Slightly good

about 11-14 g, conical in shape and has a shiny red skin color (Table 8, Fig.4a). The content of soluble solids in the fruits is slightly lower than that of 'Toyonoka'. Since the flesh is firm and the skin is hard, this new cultivar is suitable for transportation.

The fruit of 'Shenxu No.2' is large in size, about 11g, conical in shape and has a shiny scarlet skin color (Fig.4b). Since the fruit is very sweet, moderately sour and very juicy, the taste is good. The fruit has a high vitamin C content. The flesh is firm but the skin is not hard.

3) Yield characteristics

The yield of 'Shenxu No.1' until December was not high, but the total yield until May was higher than that of 'Toyonoka' or 'Hokowase' (Table 9).

Beginning of harvest of 'Shenxu No.2' took

place about 10 days earlier than in the case of 'Toyonoka'. The yield of 'Shenxu No.2' until December was very high, twice of that of 'Toyonoka'. The early yield until February and total yield were about 20% higher than that of 'Toyonoka'.

4) Resistance to anthracnose

Based on the evaluation by the spray inoculation method, 'Shenxu No.1' and 'Shenxu No.2' are resistant to anthracnose caused by *C. acutatum* and *C. gloeosporioides* in the same way as the resistant cultivar 'Hokowase' (Fig.5). The length of the blackish lesions on the petiole determined by the petiole dip inoculation shows that 'Shenxu No.1' displays a higher resistance than 'Hokowase', while the resistance of 'Shenxu No.2' is the same as that of 'Hokowase' (Fig.6).



(a)



(b)

Fig.4. New Strawberry cultivars
(a) 'Shenxu No. 1', (b) 'Shenxu No. 2'

Table 9. Yield of new strawberry cultivars

Cultivar	Yield			Rate of			
	~Dec.	~Feb.	~May	Commercial fruits	Malformed fruits	Diseased fruits	Small fruits(<6g)
	g/10plants	g/10plants	g/10plants	%	%	%	%
Shenxu No. 1	9.8	1357.4	3220.2	92.2	3.1	0.6	4.3
Shenxu No. 2	489.4	1742.7	3570.2	94.0	1.4	1.3	3.4
Toyonoka	189.6	1363.0	2595.3	87.7	6.4	1.5	4.4
Hokowase	92.3	911.1	1664.9	79.7	7.2	1.2	1.2

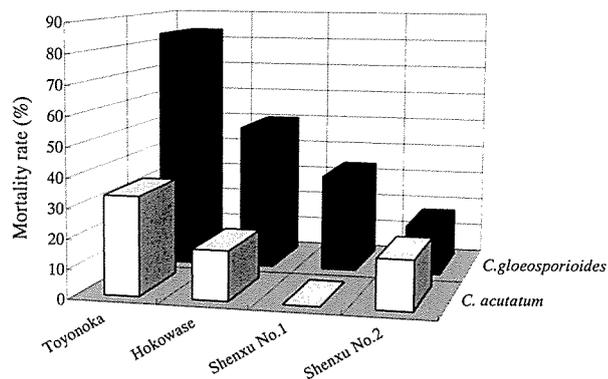


Fig.5. Mortality rate of new strawberry cultivars one month after spraying of *Colletotrichum conidia*

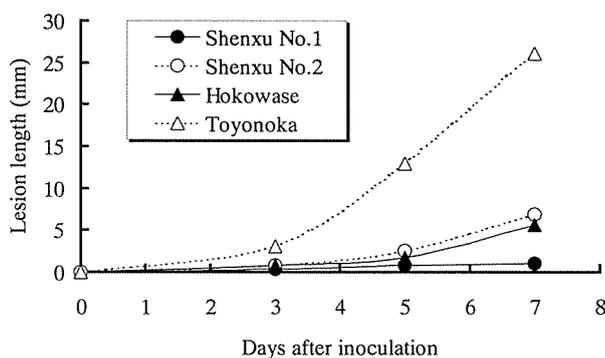


Fig.6. Length of lesions of new strawberry cultivars infected with *Colletotrichum gloeosporioides* after petiole dip inoculation

Discussion

In Shanghai, popular cucumber cultivars 'Changchunmici' and 'Jinyan' display a high resistance to fusarium wilt⁶⁾ and downy mildew⁷⁾, respectively. However, the taste of cultivars is not appreciated by the consumers, unlike that of 'Yanghang', though the latter cultivar is susceptible to fusarium wilt and downy mildew^{6, 7)}. Therefore, we attempted to develop new cultivars with resistance to these diseases and high fruit quality, 'Hu No.116' and 'Hu No.119' were thus bred. It is considered that the fruit quality of 'Hu No.116' and 'Hu No.119' bred in this project will be acceptable in the Shanghai area and throughout the provinces of Chang river. Also, these cultivars showed a high early yielding ability and high disease resistance in many cucumber-growing districts^{3, 4)}. Therefore,

these cultivars are being rapidly spread throughout the Shanghai area as well as in the provinces of Zhejiang, Jiangsu, Shandong, Sichuan, etc.^{3, 4)}. Although it is considered that 'Hu No.116' and 'Hu No.119' are adapted to semi-forcing culture, their adaptability to cropping types in the summer season must be investigated. 'Hu No.116' and 'Hu No.119' are resistant to fusarium wilt. However, in areas with a serious incidence of soil-borne diseases or injury by continuous cropping, we recommend soil improvement, soil sterilization or grafting.

In China, strawberry production is gradually increasing. The main cropping type is open culture and some forcing culture under house covered with vinyl or polyethylene films in suburban areas of large cities. The major problems in forcing culture are low yield, especially early season yield and occurrence of malformed fruits. Within the framework of the collaborative project, a large number of studies were carried out to solve these problems, including planting to nursery bed before the rainy season⁹⁾, shading and root pruning in nursery bed⁵⁾, lighting and heating in a vinyl house¹¹⁾ and pollination by honey bees in the vinyl house^{8, 10)}.

Most of the cultivars planted in China were introduced from foreign countries. 'Hokowase', 'Reiko', 'Meiho' and 'Toyonoka' were introduced from Japan. 'Hokowase' used to be the most popular cultivar in Shanghai, but at present the cultivation of 'Toyonoka' is gradually increasing because 'Toyonoka' is superior to 'Hokowase' in fruit quality. Most of the Chinese cultivars were developed for open culture and are not suited to forcing culture. Therefore, it is important to breed new cultivars for forcing culture which are well adapted to the Chinese cultivation methods and climatic conditions.

New strawberry cultivar 'Shenxu No.1' shows a high productivity and good fruit characteristics such as large fruits with conical shape, shiny scarlet skin color and firm flesh. The firmness of flesh is a very important characteristic for the transportation of the fruits in China, which extends

over a large land area.

It is important to develop in China a cultivar for early harvesting that initiates flower buds easily without short-day or low-temperature treatments. The new strawberry cultivar 'Shenxu No.2' is one of the earliest cultivars for harvesting with excellent fruit characteristics such as large fruits with a conical shape, very shiny scarlet skin color, with sweet and good taste.

In addition, 'Shenxu No.1' and 'Shenxu No.2' display a high degree of resistance to *Colletotrichum acutatum* and *C. gloeosporioides*. 'Shenxu No.1' and 'Shenxu No.2' can be adapted to forcing culture in the southeastern part of China including Shanghai^{3,4}. However 'Shenxu No.2' may be not adapted to the warmer southern area because flower bud initiation is slightly delayed^{3,4}.

References

- 1) Delp, B. R. & Milholland, R. D. (1980). Evaluating strawberry plant for resistance to *Colletotrichum fragariae*. *Plant Dis* **70** : 1071-1073.
- 2) Noguchi, Y. *et al.* (1994). Petiole dip inoculation is a convenient method for screening strawberry for resistance to anthracnose caused by *Colletotrichum fragariae*. *Bull. Natl. Res. Inst. Veg., Orn. Plants & Tea* **9** : 13-26.
- 3) Sugiyama, K. *et al.* (1997). Studies on breeding of cucumber, sweet pepper and strawberry. JIRCAS, Tsukuba, 1-78. [In Japanese].
- 4) Sugiyama, K. *et al.* (1997). Japan and China Collaborative Research highlights. JIRCAS and SAAS, Tsukuba, 1-58. [In Japanese and Chinese].
- 5) Sugiyama, K. *et al.* (1997). Papers of Japan and China Collaborative Research. Effect of shading, root pruning on nursery bed and pot raising before planting on flower bud initiation and plant growth of strawberry in forcing culture. Ye, Z. *et al.*, JIRCAS and SAAS Press, Tsukuba, 105-112 [In Japanese and Chinese].
- 6) Xu, Q. *et al.* (1994). Variation rhythm of peroxidase activity in cucumber during seedling stage and its relation to fusarium wilt resistance. *Acta Agriculturae Shanghai* **10**(3) : 58-62. [In Chinese with English summary].
- 7) Xu, Q. *et al.* (1994). Comparison between seedling test and field test on resistance to downy mildew of cucumber. *Shanghai Agricultural Science and Technology* **1** : 25. [In Chinese].
- 8) Ye, Z. *et al.* (1992). Factor and prevention of malformed fruit of strawberry in forcing culture. *Shanghai Shucai* **2** : 32-33. [In Chinese].
- 9) Ye, Z. *et al.* (1995). Effect of temporary planting on growth of strawberry in forcing culture. *Shanghai Agricultural Science and Technology* **1** : 7-8 [In Chinese].
- 10) Zheng, H. *et al.* (1993). Effect of use of honey bee on yield and prevention of malformed fruit of strawberry in forcing culture. *Shanghai Agricultural Science and Technology* **4** : 8 [In Chinese].
- 11) Zheng, H. *et al.* (1993). Effect of lighting and heating on plant growth and yield of strawberry in forcing culture. *Shanghai Agricultural Science and Technology* **6** : 8-10 [In Chinese].

日中共同研究によるキュウリ・イチゴの耐病性新品種の育成

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摘 要

近年、中国においては人口の都市集中や食生活の向上にともなって野菜の需要が増大しており、野菜の安定生産が強く望まれている。特に主要な野菜であるキュウリについては収量が低く、べと病、つる割病に弱いなどの点が問題となっている。また、イチゴは需要が著しく伸びている作目のひとつであり、促成作型に適した高品質・耐病性品種の作出が期待されている。そこで、1992～1997年の日中共同プロジェクト研究「中国における果菜類等の耐病性優良系統の育成に関する共同研究」において上海地域に適した早生性、多収性、耐病性に優れた高品質キュウリ、イチゴの育成を目的に共同研究を実施した。この結果、所期の目的に合致したキュウリ新品種‘滬116号’及び‘滬119号’とイチゴ新品種‘申旭1号’及び‘申旭2号’を育成したので報告する。

キュウリ新品種‘滬116号’は半促成栽培に適した早生性のF₁品種で、雌花着生数が多く、収量が高い。果実は棒形で、果色が濃く、溝、疣、刺が少なく、果実品質は良好である。また、つる割病及びべと病に対して抵抗性を有する。キュウリ新品種‘滬119号’は中国のキュウリ系統と日本のキュウリ品種を交雑して育成された半促成栽培適応型の多収性のF₁品種である。雌花着生率は

高くないが、生育後半まで安定した着果性を示す。果実は棒形で、果色は濃緑で、疣、刺が少なく、果実品質に優れる。つる割病 (*F. oxysporum*) 及びべと病 (*P. cubensis*) に対して抵抗性を示す。

イチゴ‘申旭1号’はやや晩生であるが、促成作型に適応した品種で、収量は高く、平均果重は11g以上と大果である。糖度は中程度である。灰色かび病などの病果がほとんどみられず、また、上海の炭疽病優占菌株である *C. acutatum* および日本の主病原菌である *C. gloeosporioides* に対しても抵抗性を示す。本品種は果皮が硬く日持ち性、輸送性に優れる。イチゴ‘申旭2号’は促成作型に適応する極早生品種で、年内収量は‘とよのか’の2倍以上であり、早期出荷に有利である。平均果重は10g以上と大果であり、ビタミンC含量および糖度が高く、品質が優れている。‘申旭1号’と同様に、*C. acutatum* 及び *C. gloeosporioides* に対し、抵抗性を有する。

キュウリ‘滬116号’および‘滬119号’は、華南型キュウリ産地の半促成栽培に適応する。イチゴ‘申旭1号’、‘申旭2号’はともに上海市および上海近郊を中心とする促成栽培に適応するが、‘申旭1号’は花芽分化がやや遅いため中国南部地方には適さないと思われる。

キーワード：キュウリ、イチゴ、育種

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