SCREENING FOR TOMATO GENOTYPES ADAPTED TO LOWLAND CONDITIONS

Etti Purwati
Lembang Horticultural Research Institute
PO Box 1586, Indonesia

Budi Jaya
Lembang Hort. Research Institute
PO Box 1586, Indonesia

G. A. M. van Marrewijk
Lembang Horticultural Research Institute
P.O. Box 1586, Bandung, Indonesia

Abstract

Between 1989 and 1992 a series of screening experiments were performed at several locations (West Jaya: Subang and Sukamandi; Central Java: Kramat) in both the dry and the rainy season aiming at the selection of lowland adapted genotypes. Materials consisted of local varieties, land races and selections from the LEHRI gene bank, lines developed by AVRDC and varieties from ASEAN countries participating in the AVNET programmes which is coordinated by AVRDC. Main criteria for field selection were yield, resistance to Bacterial Wilt (*Pseudomonas solanacearum*), some main fungal diseases, fruit quality and plant performance. Several entries were selected for continued testing and for use as genitor in the breeding programme.

1. Introduction

Tomatoes in Indonesia are mainly grown in the highlands. As the available highland area is limited and vegetable growing at higher altitudes constitutes a permanent danger of soil erosions, efforts should be directed towards development of tomato varieties which can be successfully grown in the lowlands. The low yields usually realized un-der lowland conditions in Indonesia are due to unproductive varieties, inadequate cultivation and poor protection methods. The most important diseases in the lowland tropics are: Bacterial Wilt (BW), Leaf Mold and Viruses. Successful growing of tomatoes in the lowland tropics requires the creation of resistant varieties.

Evaluation and screening of a wide range of locally collected or imported germplasm lowland adapted, which give high yields and possess acceptable levels of resistance and tolerance to major pathogens. Previous evaluations resulted in the selection of four cultivars (Intan, Ratna, Berlian and Mutiara) which are reasonably well adapted to lowland conditions, give fair yield and have some tolerance to Bacterial Wilt. Main shortcoming is the lack of fruit firmness.

A number of experiments were conducted between 1989 and 1992 to evaluate and screen tomato genotypes from various sources for general performance, yielding ability, fruit quality, resistance to Bacterial Wilt and other pathogens in order to select promising genotypes which could be recommended for release, and to identify potential parents for a breeding programme. This set of studies was executed in the framework of the Agricultural Technical Assistance Project (ATA-395) sponsored by the government of the Netherlands.

Acta Horticulturae 369, 1994
Small Scale Vegetable Production & Economics

2. Materials and Methods

Experiments I to V consisted of the following materials:

- Released lowland cultivars.
- Promising accessions preselected from locally collected germplasm.
- Lowland selections obtained from AVRDC.
- Other materials.

The accessions used in the individual experiments are mentioned in Annex 1. A description of the material is given in Annex 2. Experiment VI included entries of all countries participating in the ASEAN Vegetable Network (AVNET) programme (Annex 3). The experiments were conducted in different season, at different lowland locations and on different soil types, viz:

2.1. Experimental Station Sukamandi (West-Java), 15 m above sea level, white gray alluvial soil.

- Experiment I : January to April 1989, rainy season, RCBD, 2 replications and 16 plants/entry.

- Experiment II : May to September 1989, dry season, RCBD, 2 replications and 12 plants/entry.

2.2. Experimental Station Subang (West-Java), 110 m above sea level, latosol soil type.

- Experiment III: July to October 1989, dry season, RCBD, 2 replications, 20 plants/entry.

- Experiment V : October 1991 to January 1992, rainy season, RCBD, 2 replications. Plots consisted of three rows of 10 plants. The first and the third row contain material to be tested, the second row consisted of susceptible and resistant plants in alternating order.

- Experiment VIa: May to August, dry season, RCBD, 2 replications, 20 plants/entry. Experiment VI is conducted at two locations (Subang and Kramat) with the same materials.

2.3. Experimental Station Karmat (Central-Java), 1 m above sea level and alluvial soil type.

- Experiment IV : June to September 1990, dry season, RCBD, 2 replications and 20 plants/entry.

- Experiment VIb: May to August 1991, dry season, RCBD, 2 replications and 20 plants/entry.

All experiments got recommended amounts of manure, fertilizer and chemical pesticides were applied to control pest and disease. In experiment V executed on soil artificially infected with Bacterial Wilt, BW resistance/tolerance was the main selection criterion. Evaluation of entries in the other experiments occurred on the basis of the following criteria:

- Yield.
- Percentage of plants attacked by Bacterial Wilt.

With respect to Bacterial Wilt attack, according to Acosta *et al.* (1964), plants infected > 7 weeks after planting are considered resistant, because at that age the plants already have a lot of harvestable fruits.

Apart from these major selection criteria, observation were made on other plant characters, which might be of value for future use of particular genotypes in a combination breeding programs, such as:

- Plant characters/total plant performance.
- Days to flowering.
- Days to harvesting and harvesting period.
- Weight and number of marketable fruits per plant and per plot.
- Weight and number unmarketable fruits per plants and per plot.
- Fruit characteristics (shape, color, size).

The best performing accessions from previous experiments were included in further experiments in addition to new materials. Therefore the materials sometimes overlap each other.

3. Results and Discussion

3.1 Experiment I

Out of 40 evaluated entries, 5 genotypes were selected (Table 1), the main selection criterion being resistant to BW. Only entries with > 50% surviving plants were taken into account. The overall yield level was very low, because of the unfavorable growing conditions (rainy sea-son): therefore the selection threshold for yield was set at 0.4 kg/plant. All selected genotypes met the requirements for standard tomato processing quality employed by AVRDC, viz.: pH 4.4, soluble solid content, 4.5 Brix, crack resistance, uniform color and easy peeling.

3.2. Experiment II

In this experiment selection was mainly based on the level of BW (< 50%) and yield (> 50 kg/plant). Selection was done visually, 6 genotypes out of 38 were

selected (Table 2), among them accessions 25, 27, 99 and 100 which were also selected in experiment I. The level of Bacterial Wilt infection of accessions 25, 27, 99 and 100 in this experiment was lower than in experiment I, because in experiment I the soil was humid (rainy season) stimulating the development of this disease (Kelman, 1953). The level of Bacterial Wilt infection the supposedly resistant control variety Intan (42%) was higher than all selected material.

3.3. Experiment III

The set of material in experiment III with a few exception was similar to the material in experiment II. Main selection criteria were yield (> 0.5 kg/plant) and low BW infection (< 35%). In total 10 of 38 were selected; 3 en-tries were selected in both experiment II and III. Even though accessions 25 and 27 were selected again, the level of Bacterial Wilt infection was much higher than in accessions 59 (3%). Though executed in the dry season, the yield of the accessions used in this experiment was low, the highest yield being 0.7 kg/plant.

3.4. Experiment IV

In general the level of Bacterial Wilt infection in Kramat was very low. A number of genotypes also included in previous experiments had lower BW scares, i.a. entries 19 (3%). Also the low BWQ incidence could be attributed to the rice based crop rotation in this area. The yield levels were much higher than in all previous experiments. The selection threshold was set at 1.5 kg/plant and BW infection level 3%. In total 6 entries out of 22 were selected.

3.5. Experiment V

All the best materials from previous experiments supplemented with some new accessions were used in experiment V. Genotype number 105 (Yellow plum) was added as an indicator for Bacterial Wilt susceptibility. Among all the advanced material only 6 genotypes showed to be more resistant to BW with infection level < 50% (Table 5). The lowest infection reached by level infection of Bacterial Wilt of genotype number 3. The yield ranging from 2.6 to 3.9 kg/plant. The selected material from previous experiment in this method were > 50% level infection of Bacterial Wilt viz number 53.54, 67 and 83 but the yield of these genotypes were high (> 2.0 kg/plant) according to experiment in Kramat.

3.6. Experiment VI

In these experiments, the yield between two locations (Kramat and Subang) for the same genotypes were much different. In general the yield in Kramat was higher than in Subang. Observations were also made on Bacterial Wilt, Early Blight incidence, and total plant performance. Early Blight was chosen because it seems the second most important disease in the lowland. Both in Subang and Kramat on the basis of performance close to (Table 6) 6 entries were chosen for a continued breeding programme.

Making crossings between selected genotypes is the appropriate breeding method to combine major selection criteria, i.e. resistance to Bacterial Wilt, high yielding capacity and good quality of fruits.

References

Acosta, J. C., J. C. Gilbert and V. L. quinon. 1964. Proceeding American Society for Horticultural Science. Vol. 84: 455-462.

Atherton, J. G. and J. Rudich. 1986. The Tomato Crop. University Press. Cambrige-Great Britain.

Etti Purwati. 1990. Seleksi genotip tomat tahan terhadap bakteri layu dan berkualitas baik di dataran rendah. Bull. Penel. Hort. Vol. xviii Edisi Khusus No. 2. Lembang.

Etti Purwati. 1991. Evaluasi genotip tomat di dataran rendah. Jurnal Hort. Vol. I No. 2.

Kelman, A. 1953. The bacterial wilt caused by *P. solanacearum*. A Literature Review and Bibliography. North Carolina. Agr. Exp. Sta. Tech. Bull. 99.

Villareal, R. L. 1981. Tomatoes in the Tropies. West view Press. Colorado-USA.

Table 1 - Evaluation for lowland adaptation of tomato. Experiment I. Characteristics of genotypes selected at Sukamandi. Rainy season, 1989

Entry	BW (%)	Y/P (kg)	NOF	Fruit quality			
				Firm-ness	pH	PT (mm)	SS (Brix)
CLN 475BC1F2-	31	0.6	32	11.0	4.6	3.6	5.3
CLN 657BC1F2-	50	0.6	30	11.0	4.8	3.4	5.8
LV 762	50	0.4	28	10.5	4.5	2.0	6.5
I 64-7-5-0(F4)	40	0.8	27	13.7	4.5	3.2	6.6
CL 1131-0-0-7-	44	0.5	31	10.5	4.5	2.0	6.5
Berlian (check)	50	0.5	28	9.3	4.5	2.7	6.0

Legend: BW = Bacterial Wilt
Y/P = Yield/plant
NOF = Number of fruits per plant
PT = Pericarp thickness
SS = Soluble solid content

Table 2 - Evaluation for lowland adaptation of tomato. Experiment II. Characteristics of genotypes selected at Sukamandi. Dry season, 1989

Entry	Disease infection (%)		Yield/ plant (kg)	NOF
	BW	non BW		
CLN 657BC1F2-285-	13	13	1.1	48
IG 4-7-5-0-0(F5)	35	17	0.9	42
LV 1508	36	4	0.8	33
CL 1131-0-0-7	34	9	0.6	32
LV 762	42	4	0.6	25
CLN 475BC1F2-265-	13	13	0.6	25
Intan (check)	42	34	0.6	20

Legend : BW = Bacterial Wilt
non BW = other disease
NOF = Number of fruits per plant

Table 3 - Evaluation for lowland adaptation of tomato. Experiment III. Characteristics of genotypes selected at Subang. Dry season, 1989. Legend : see Table 2

Entry	Disease infection (%)		Yield/ plant (kg)	NOF
	BW	non BW		
LV 1450	4	10	0.7	34
LV 1646	23	5	0.7	30
CLN 657BC1F2-285-	10	3	0.7	28
LV 2100	8	23	0.7	26
LV 2470	20	0	0.7	24
CLN 475BC1F2-265-9-0	10	10	0.5	23
LV 1508	33	13	0.5	17
CL 1131-0-0-7	3	13	0.5	22
LV 1498	23	0	0.6	20
LV 2099	20	8	0.6	18
Ratna (check)	20	5	0.6	22

Table 4 - Evaluation for lowland adaptation of tomato. Experiment IV. Characteristics of genotypes selected at Kramat. Dry season, 1990. Legend: see Table 2

Entry	Disease infection (%)		Yield/ plant (kg)	NOF
	BW	non BW		
CLN 475BC1F2-265-9-0	0	0	2.0	49
LV 2099	3	3	1.5	62
LV 2100	0	0	1.6	46
BL 702	0	0	2.3	77
FMTT 138 (hybrid)	0	0	2.6	79
PT 4225	0	0	3.2	86
Ratna (check)	3	0	1.8	58

Table 5 - Evaluation for lowland adaptation of tomato. Experiment V. Characteristics of genotypes selected at Subang. Rainy season, 1991-1992. Legend: see Table 2

Entry	Disease infection (%)		Yield/ plant (kg)	NOF
	BW	non BW		
CLN 657BC1F2-274-0-	40	10	1.3	40
LV 2099	45	10	1.3	37
BL 703	40	5	1.5	55
LV 2100	43	2	1.4	45
BL 694	25	10	1.9	76
Berlian (check)	10	15	2.0	90

Table 6 - Evaluation for lowland adaptation of tomato. Experiment VI. Characteristics of genotypes selected at Subang and Kramat. Dry season, 1992

Entry	Yield/plant (kg)				TP
	BW	non BW	Subang	Kramat	
CL 5915-206D4-2-2-0	0	0	1.3	3.3	++
CLN 657BC1F2-274-0-15-	0	0	1.3	4.9	++
FMTT 138 hybrid	0	0	1.9	4.3	++
BL 694	0	0	1.7	2.9	++
BL 703	0	0	1.2	2.6	++
CLN 657BC1F2-267-0-3-	0	0	0.9	4.0	++
Intan (check)	0	0	1.4	2.2	+-

Legend: BW = Bacterial Wilt (scoring: 0 = (nearly) no wilting; 1 = 20-80% surviving platns; 2 = 20% surviving plants)
non BW = Early Blight; - = (nearly) no infection; +- = light infection; + = heavy infection
TP = Total performance (++ = very good)

Annex 1 - Tomato accessions used in experiments I - VI. Legend: x = present

Code number	Entry	number of experiment					
		I	II	III	IV	V	VI
A. Released lowland cultivars							
1.	Intan		x	x	x	x	
2.	Ratna		x	x	x		
3.	Berlian	x	x	x	x		
4.	Mutiara					x	
B. Promising accessions							
5.	LV-1051		x	x		x	
6.	LV-1450		x	x		x	
7.	LV-1498		x	x			
8.	LV-1508		x	x		x	
9.	LV-1513		x	x			
10.	LV-1578		x	x			
11.	LV-1620		x	x			
12.	LV-1646		x	x		x	
13.	LV-1789			x			
14.	LV-1823		x	x			
15.	LV-1843		x	x			
16.	LV-1927		x	x			
17.	LV-1941		x	x			
18.	LV-1962		x	x			
19.	LV-2099		x	x	x	x	
20.	LV-2100		x	x	x	x	
21.	LV-2101	x	x	x			
22.	LV-2105		x	x			
23.	LV-2384			x			
C. AVRDC lowland lines							
24.	CLN-466BC1F2-45-34-9-9	x					
25.	CLN 475BC1F2-265-9-0	x	x	x	x	x	
26.	CLN-656BC1F2-36D-11-0	x					
27.	CLN-657BC1F2-285-0-21-0	x	x	x			
28.	CLN-698BC1F2-585-0-17-1	x					
29.	PT-4026	x					

Annex 1. Continued . . .

Code number	Entry	number of experiment					
		I	II	III	IV	V	VI
30.	PT-4056	x					
31.	PT-4071	x					
32.	PT-4098	x					
33.	PT-4110	x					
34.	PT-4121	x				x	
35.	PT-4165	x					
36.	PT-4172	x					
37.	CL-143-0-10-3-1-10						x
38.	CL-1131-0-0-43-0-6			x			
39.	CL-1131-0-0-43-4-12			x			
40.	CL-5915-93D4-1-0-C-1		x				
41.	CL-5915-93D4-1-0-C-2		x				
42.	CLN-65-349D5-2-0		x				
43.	CLN-698BC1F2-358-1-13					x	
44.	CLN-475BC1F2-265-4-19					x	
45.	CL-657BC1F2-267-0-3-20-8		x				
46.	CL-5915-206D4-2-4-0		x				
47.	CLN-657BC1F2-214-0-15-0		x				
48.	PT-3027				x		
49.	FMTT-3				x		
50.	FMTP-22				x		
51.	FMTP-33				x		
52.	FMTP-95				x		
53.	FMTP-138				x	x	
54.	PT-4225				x	x	
55.	TN.sel.#2	x			x	x	
56.	CL-1131-0-0-7-20-11	x	x	x	x		
57.	CL-93D4-01-09	x					
58.	CR-4210	x					
59.	CL-1131-0-0-7	x					
60.	PETO-86				x	x	
61.	BL-651					x	x
62.	BL-700						x
63.	CL-5915-206D4-2-2-0					x	x
64.	CL-5915-206D4-2-5-0					x	x

Annex 1. Continued . .

Code number	Entry	number of experiment					
		I	II	III	IV	V	VI
65.	CL-5915D4-2-2-0-4					x	x
66.	CLN-657BC1F2-274-0-15-0					x	x
67.	CLN-657BC1F2-274-0-15-4					x	x
68.	CLN-657BC1F2-274-0-15-7	x				x	x
69.	CLN-657BC1F2-285-0-20-0-24						x
70.	CLN-657BC1F2-285-0-20-0					x	x
71.	CL-6046BC3F2-51-0-20-5-15-14-1					x	x
72.	CL-6046BC3F2-51-1-1-20-5-10-13					x	x
73.	L-4783						x
74.	BL-652						x
75.	BL-653						x
76.	BL-654						x
77.	BL-655						x
78.	BL-694					x	x
79.	BL-695					x	x
80.	BL-697					x	x
81.	BL-699					x	x
82.	BL-701		x	x		x	x
83.	BL-702		x	x	x	x	x
84.	BL-703		x	x		x	x
85.	BL-704						x
86.	BL-705						x
87.	BL-706						x
88.	BL-707						x
89.	BL-708					x	x
90.	CLN-657BC1F2-267-0-3-12-7						x
91.	CLN-475BC1F2-265-12-9-1					x	x
92.	CL-5915-93D4-1-0-3						x
93.	TK-70						x
D.	Other accessions						
94.	LV-463			x	x		
95.	LV-547			x	x		
96.	LV-1763			x	x		
97.	LV-2330			x	x		

Annex 1. Continued . . .

Code number	Entry	number of experiment					
		I	II	III	IV	V	VI
98.	LV-2463	x	x	x		x	
99.	LV-2894	x	x	x	x	x	
100.	LV-762		x	x	x		
101.	LV-2470		x	x			
102.	LV-1283				x	x	
103.	LV-3651					x	
104.	LV-3652					x	
105.	LV-3641					x	

Annex 2 - List of tomato genotypes and their characters

Code number	Source	Growth habit	Fruit shape	Fruit colour
1.	AVRD-Taiwan	sp	deep oblate	u-red
2.	Philippines	sp	————	———
3.	AVRDC-Taiwan	sp+	plum	———
4.	Indonesia	sp+	deep ablate	———
5.	Pandegalng (West-Java)	sp+	cherry	gs-red
6.	Jepara (Central-Java)	sp+	ablate	———
7.	Tegal (Central-Java)	sp+	plum	u-red
8.	Tegal (Central-Java)	sp+	oblate	gs-red
9.	Tegal (Central-Java)	sp+	round	———
10.	Brebes (Central-Java)	sp+	oblate	———
11.	Pamekasan (East-Java)	sp+	cylindrical	u-red
12.	Rembang (East-Java)	sp+	oblate	———
13.	Sidoarjo (East-Java)	sp+	deep oblate	———
14.	Gresik (East-Java)	sp+	oblate	gs-red
15.	Surabaya (East-Java)	sp+	———	———
16.	Bojonegoro (East-Java)	sp+	———	———
17.	Bojonegoro (East-Java)	——	———	———
18.	Probolinggo (East-Java)	sp	plum	u-red
19.	Malang (East-Java)	—	———	———
20.	Malang (East-Java)	sp+	globe	———
21.	Jombang (East-Java)	——	round	gs-red
22.	Nganjuk (East-Java)	——	———	u-red
23.	Lombok (NTB)	——	oblate	gs-red
24.	AVRDC-Taiwan	sp	globe	u-red
25.	AVRDC-Taiwan	—	———	———
26.	AVRDC-Taiwan	sp+	———	———
27.	————	——	plum	———
28.	————	sp	round	———
29.	————	—	globe	———
30.	————	—	———	———
31.	————	—	plum	———
32.	————	—	globe	———
33.	————	—	———	———
34.	————	—	plum	———
35.	————	—	———	———
36.	————	—	———	———

Annex 2. Continued . . .

Code number	Source	Growth habit	Fruit shape	Fruit colour
37.	———	—	———	———
38.	———	—	globe	———
39.	———	—	plum	———
40.	———	—	———	———
41.	———	—	———	———
42.	———	—	oblate	———
43.	———	—	———	———
44.	———	sp+	plum	———
45.	———	—	———	———
46.	———	—	globe	———
47.	———	sp	plum	———
48.	———	sp+	oblate	———
49.	———	sp+	globe	———
50.	———	sp+	globe	———
51.	———	—	plum	———
52.	———	—	———	———
53.	———	—	deep globe	gs-red
54.	———	—	plum	u-red
55.	———	—	———	———
56.	———	sp	oblate	———
57.	———	—	globe	———
58.	———	—	———	———
59.	———	sp+	plum	———
60.	———	sp	———	———
61.	AVRDC/Thailand cream	sp+	———	gs-
62.	AVRDC/Philippines	sp+	pear	u-red
63.	AVRDC/Taiwan	—	square	———
64.	———	—	———	———
65.	———	—	plum	———
66.	———	—	deep oblate	———
67.	———	—	———	———
68.	———	—	———	———
69.	———	—	pear	———
70.	———	—	square	———
71.	———	—	cylindrica	———

Annex 2. Continued . . .

Code number	Source	Growth habit	Fruit shape	Fruit colour
72.	————	—	————	———
73.	Taiwan	—	square	gs-red
74.	AVRDC/Thailand	—	plum	u-red
75.	————	sp	pear	u-crea
76.	AVRDC/Peto-USA	sp+	square	gs-red
77.	————	sp	———	———
78.	AVRDC/Malaysia	sp+	oblate	u-red
79.	AVRDC/Malaysia	—	———	———
80.	AVRDC/Indonesia	sp	deep oblate	u-red
81.	————	sp+	square	———
82.	AVRDC/Philippines	—	oblate	———
83.	————	—	cylindrical	———
84.	————	—	plum	———
85.	————	—	cylindical	———
86.	————	sp	el.square	———
87.	AVRDC/USA	sp+	deep oblate	gs-red
88.	———	—	plum	u-red
89.	AVRDC/Philippines	—	el.square	———
90.	AVRDC	—	square	———
91.	———	—	oblate	———
92.	———	—	plum	———
93.	———	sp	oblate	———
94.	Hawaii-USA	—	plum	———
95.	Thailand	sp+	cherry	gs-red
96.	Known-You-Taiwan	sp+	el.square	gs-red
97.	Dahomey-Africa	—	globe	u-red
98.	Bekasi-West Java	—	plum	———
99.	LEHRI-Indonesia	—	——	———

Annex 2. Continued . . .

Code number	Source	Growth habit	Fruit shape	Fruit colour
100.	TS Seed-Netherlands	—	——	——
101.	Philippines	sp	round	gs-red
102.	Magelang-Central Java	sp+	——	u-red
103.	Lousiana-USA	sp+	oblate	gs-red
104.	——————	sp	square	——
105.	West Java	sp+	plum	u-yellow

Legend: sp = self-pruning or determinate type; no need of staking or pruning but would do well with short stakes.
sp+ = indeterminate growth habit; ordinarily needs staking/pruning for better size and fruit quality.
u = uniform; gs = green shoulder; el = elongated.

Annex 3 - Evaluation for lowland adaptation of tomato. Summary of the data per experiment

No. of expt.	Genotypes evaluated	Time	Location	Yield	BW
I	40	January-April 1989	Sukamandi	3	6
II	38	May-September 1989	Sukamandi	7	10
III	38	July-October 1989	Subang	11	26
IV	22	June-September 1990	Kramat	22	22
V	45	Oct.1991-Jan 1992	Subang	6	6
VI a	37	May-August 1991	Subang	34	29
VI b	37	May August 1991	Kramat	37	37

Note: Yield = number of entries yielding ¢ 0.5 kg/plant
BW = number of entries, with Bacterial Wilt infection _ 50%