

**EVALUATION AND PURIFICATION OF THE *GORAKA* TYPE TOMATO
(*LYCOPERSICON ESCULENTUM* MILL)**

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ABSTRACT

The goraka type tomato is a cultivar (land race) which has long been cultivated in Sri Lanka. It is popular among the consumers because of the sour (acidic) taste of fruits, which is much desired in the preparation of Sri Lankan dishes. The goraka cultivars are well adapted to local climatic conditions. There is a wide variability within the locally available goraka germplasm. The objectives of this study were to evaluate the available accessions and to identify a pure line goraka tomato possessing bacterial wilt resistance and typical goraka fruit quality characteristics (grooved fruit surface, red skin and sour/acidic taste). Five accessions (Acc#00270, Acc#00523, Acc#00537, Acc#00538 and Acc#01127) were evaluated with check varieties KWR, T146 and T245. Field trials and laboratory results indicated that there was considerable variation among the goraka accessions. In addition to the above five, twelve new entries were collected and pure line selection was adopted. The mean-coefficient variation method was used to identify the better accessions. Nine pure lines were identified and tested for three consecutive seasons from 1996 to 1998. G9 (from the original populations of Acc#00523) performed better on yield (42 t/ha), resistance to bacterial wilt, fruit size (122 g) and acidity (1.3) and also had an attractive orange red skin color. G9 was officially released as the variety Lanka Sour by the Department of agriculture in 2005.

KEY WORDS: Mean-coefficient , Pure line, Purification, Tomato

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is a very popular vegetable in Sri Lanka. Fruits contain as much as 93% - 94% of water and have a high nutritive value. It is a good source of vitamin A, B and C (Peiris and Ekanayake, 1999). The

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crop can be easily grown in all agro ecological zones in Sri Lanka with an annual rainfall of less than 2000 mm (Anon., 1998). It is a crop capable of giving high income to growers. The Department of Agriculture (DOA) has recommended seven determinate (bush) type varieties namely, Katugastota Wilt Resistant (KWR), Roma, T146, T245, Ravi, Rashmi, Rajitha and three indeterminate (vine) type namely, Marglobe, Bianz and Thilina which are high yielding. However, farmers have failed to exploit the potential of these varieties due to various reasons (Anon., 1998). The Goraka type tomato is a cultivar (land race) which has long been cultivated in Sri Lanka. It is popular among the consumers because of the sour (acidic) taste of its fruits, a quality which is preferred for the preparation of Sri Lankan dishes. The Goraka type cultivars show indeterminate growth habit and well adapted for the local conditions. Opena et al., (1989) suggested that indeterminate tropical lines have consistently better fruit quality than their determinate counterparts. Emery and Munger (1970) also stated that, there have been studies in temperate countries which showed that certain components of fruit qualities such as soluble solids do attain better levels in the indeterminate than in the bush type tomatoes. Therefore Goraka type tomato could be a promising donor source for creating required genetic variability in hybridization programmes. There is a possibility for variability within the existing Goraka type accessions which may be due to genetic mishaps such as out-crossing, genetic drift, mutation and mechanical contamination with seeds of other varieties.

The objectives of this study were to evaluate the available accessions, adopt pure line selection and identify best pure line Goraka type tomato possessing bacterial wilt resistance and typical Goraka type fruit quality characteristics (grooved fruit surface, orange red skin color and sour/acidic taste) to be released for cultivation.

MATERIALS AND METHODS

(1) Preliminary evaluation of goraka type varieties

Five accessions of Goraka types (Acc#00270, Acc#00523, Acc#00537, Acc#00538 and Acc#01127) obtained from Plant Genetic Resources Centre

(PGRC), Gannoruwa, were tested with varieties KWR, T146 and T245 as checks during 1993/1994 Maha and 1994 Yala seasons at Horticulture Crop Research and Development Institute (HORDI), Gannoruwa. Randomized complete block design (RCBD) with 3 replications was used as the experimental design. Each genotype was planted in three row-beds of 3.5 m x 2.4 m. The planting distance was 80 cm between rows and 50 cm within rows resulting in 21 plants per plot per accession. Recommended cultural practices of the DOA for tomato were followed during the field establishment. Data on the incidence of bacterial wilt disease, (Laboratory & Field) plant height, days to 50% flowering, fruit yield, single fruit weight, and fruit quality were recorded and analyzed statistically.

(2) Purification of Goraka type germplasm using pure line method

Seventeen Goraka type accessions collected from twelve farmer's fields and five (Acc#00270, Acc#00523, Acc#00537, Acc#00538 and Acc#01127) from PGRC were purified by the pure line selection procedure from 1994 to 1996. Seventeen genotypes/accessions were planted separately (10 plants/row) in isolation and seeds were produced by selfing. Advancement of generation was carried out until 100% homozygosity observed in the population. During this study in the 5th generation homozygosity appeared to reach almost 100%. Generally homozygosity is achieved during fifth generation (Ivers and Fehr, 1978). The performance of an individual accession was assessed by yield, single fruit weight, resistance to bacterial wilt disease and fruit quality. An individual homozygous plant (pure line) was harvested from each family and the yield potential and resistance to bacterial wilt (laboratory and field) were evaluated. The mean-coefficient of variation method was used to identify the better pure lines. Nine pure line accessions were identified for further evaluation.

(3) Preliminary yield trials with limited replications

The pure lines (pure genotype) were tested during Maha 1996/1997, Yala 1997 and Maha 1997/1998 seasons at HORDI Gannoruwa. Randomized complete block Design with three replications, each with 21 plants was employed in all three seasons. DOA recommendations of field management practices for tomato were followed. Data on yield, single fruit weight, resistance to bacterial wilt disease and fruit quality were recorded and evaluated statistically.

Multi –locational yield trials

Selected pure line G9 was tested with the reference variety T245 for consecutive 4 seasons. Final evaluation of the selected pure lines was done by conducting National Coordinated Varietal adaptability trial (NCVT), Varietal adaptability trial (VAT) in different agro-ecological zones of Sri Lanka) and Distinctness, Uniformity and Stability (DUS) trials.

RESULTS AND DISCUSSION

Performance of the preliminary evaluation

The crop stand of the Goraka type accessions was poor at harvesting; being half of the initial stand in some accessions mainly due to incidence of the bacterial wilt disease (Table 1). Crop stand ranged from 44-86% during Maha 1993/1994 and 58-92% during the Yala 1994. In disease screening tests carried out in the lab, variations in bacterial wilt resistance among the accessions were also observed (Table 2). The field results also indicated variations among the Goraka types (Table 1). Number of days taken for 50% flowering ranged from 26 to 31 and 40 to 44 respectively for both seasons (Table 1). There was a significant variation in plant height among the Goraka type accessions during both seasons (Table 1).

There was a high yield variation ranging from 4.87 t/ha to 9.9 t/ha and 5.2 t/ha to 17.9 t/ha among the Goraka entries (Table3) Acc#00C523 had the highest yield during both seasons.

Table1. Plant height, days to 50% flowering and crop stand of Goraka types and check varieties of tomato during Maha 1993/1994 and Yala 1994 at HORDI Gannoruwa.

Tomato Varieties	Plant height at Flowering (cm)		Days to 50% flowering		Crop stand at harvest (%)	
	1993/94	1994	1993/94	1994	1993/94	1994
	maha	yala	maha	yala	maha	yala
KWR	37c	56.67d	25d	39b	97a	92a
T146	42bc	58.38cd	27b	40.33ab	100a	86ab
T245	44bc	62cd	25d	41.6ab	97a	89ab
AC#00270	43bc	63.70bcd	31a	42.66ab	72ab	67cd
AC#00523	50ab	77.66a	26cd	42ab	86a	83ab
AC#00537	50ab	74.67a	27bc	44a	44c	80abc
AC#00538	43bc	62.33bcd	28b	40.33ab	45c	58d
ACC#O1127	53a	73.67ab	28b	42.33ab	50c	92a
CV%	10.6	9.10	3.27	5.16	17.88	10.09

Mean followed by the same letter is not significantly different from each other according to L.S.D test at $p = 0.05\%$

The fruit quality characters such as orange red color, flattened, grooves and ridges fruits, low or similar pH, and high or similar percentage acidity as citric were recorded when compared with standard check varieties. Acc#00523 had most of the desirable quality characters such as Low pH, high percentage acidity as citric acid (sour taste) and orange red color. Preliminary evaluation indicated that there was considerable variation among the tested Goraka entries. The need for

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further purification of Goraka type was indicated. Therefore accessions and others obtained subsequently were selfed to develop pure lines and evaluated again.

Table 2. Bacterial wilt incidence in Goraka type tomato accessions Under Laboratory conditions.

Tomato varieties	Stem inoculation	Root inoculation
	% disease	% disease
Marglobe	100	100
ACC#00270	20	60
ACC# 00523	10	0
ACC#00537	10	10
ACC#00538	80	60
ACC#01127	30	0
KWR	0	0

Pre evaluation of bacterial screening by pathologist at HORDI Gannoruwa

The mean-coefficient of variation method indicated by Sharma (1989) was used to identify the better varieties. It is a simple descriptive method for grouping a large number of genotypes from yield data collected over several seasons. Figure 1 consisted of plotting the mean yield of a family across the coefficient of variation (CV) for the mean yield. By this method families were divided into four group as, group I high yield, small variation, group II, high yield, large variation group III low yield, small variation and group IV, low yield, large variation. Group 1 families are the most desirable since they meet the requirement of a stable genotype having high and consistent performance. Figure 2 shows the mean percentage of wilt resistant plants plotted against coefficient of variation for the 17 families. The families which fitted to group 1 in Figure 1 and Figure 2 were identified as better families, such as TG 2 , TG 3, TG 4, TG 5, TG 7, TG 9, TG 10, (farmer's field) Acc# 00523 and Acc#01127 (PGRC). A pure line was defined by Johansen (1903), as the progeny of single self fertilized homozygous individual. An individual homozygous accession (pure line) from each family was identified. Nine pure lines G1, G2, G3, G4, G5, G6, G7, G8, and G9 were obtained and they were used for further studies.

Table 3. Yield and quality characters of Goraka types and check varieties of tomato during maha 1993/1994 and yala 1994 at HORDI Gannoruwa.

Tomato Varieties	Yield t/ha		Mean fruit Weight (g)	Fruit shape /fruit surface	% Acidity as citric acid	pH
	1993/94 maha	1994 yala				
KWR	15.77ab	11.73b	57.5	Round/ Smooth	0.9	3.8
T146	21.67a	15.17a	84.1	Round/ Smooth	0.7	4.0
T245	16.31ab	12.6ab	97.8	Slightly flattened/ Smooth	0.9	3.8
ACC#00270	9.42b	5.25d	82.9	Flattened/ Ridges and groves	0.8	3.8
ACC#00523	9.9b	17.92a	91.5	Flattened Ridges and groves	1.1	3.6
ACC#00537	9.42b	13.25bc	81.2	Flattened/ Ridges and groves	0.8	3.8
ACC#00538	6.78c	9.52c	61.3	Flattened/ Ridges and groves	0.9	3.8
ACC#01127	4.87c	13.67b	58.7	Flattened/ Ridges and groves	0.7	4.0
CV %	35.22	17.88				

Means followed by the same letter are not significantly different from each other according to L.S.D test at $p = 0.05\%$

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Mean and Coefficient of Variations

Figure 11 shows the mean percentage of wilt resistant plants plotted against coefficient of variation for the 17 families.

Final evaluation of the Accessions

Nine Goraka pure lines were tested for consecutive three seasons from 1996/1997 to 1997/1998. No bacterial wilt incidence/disease was noticed in the field. However, the laboratory results showed that G4, G7, G8, and G9 had zero percentage of bacterial wilt (Table 4). G4 and G9 had significantly similar plant height in all seasons (Table 5). Days to 50% flowering were not significantly varied among the tested entries during both Maha seasons. Flowering was delayed 4-12 days in Yala season than Maha season (Table 5).

Fruit yields (Table 6) did not differ significantly among the tested pure lines during Maha 1996/1997 and Yala 1997 seasons. However, during Maha 1997/1998 there was a significant yield difference among the pure lines ranging from 18 to 22 t/ha. G9 had highest fruit yield during the season (Maha 1997/1998). Fruit quality analysis data of these fruits indicated that G9 was prominent for quality characters such as moderate pH (3.8) and acidity as citric acid (1.3) (Table 7).

The fruit color was orange red in all tested lines. Therefore, the selection G9 was tested with reference variety T245 in research (NCVT) and farmer's fields (VAT) in different agro-ecological zones of Sri Lanka. The selection G9 showed promise in NCVT and VAT (Tables 8 and 9) had resistance to bacterial wilt disease in the laboratory and field screening tests and possessed desirable fruit quality characters of pH (3) and acidity (1.3) as citric acid (Table 10).

Table 4. Bacterial wilt screening for Tomato - (Under Laboratory conditions).

Family	Pure line	Stem inoculation	Root inoculation
TG7	G1	20	0
TG9	G2	60	10
TG2	G3	10	10
ACC#01127	G4	0	0
TG4	G5	10	0
TG10	G6	10	0
TG5	G7	0	0
TG3	G8	0	0
ACC#00523	G9	0	0
Marglobe		100	100
KWR		0	0

Source: Post evaluation of bacterial wilt screening carried out by pathologist at HORDI Gannoruwa.

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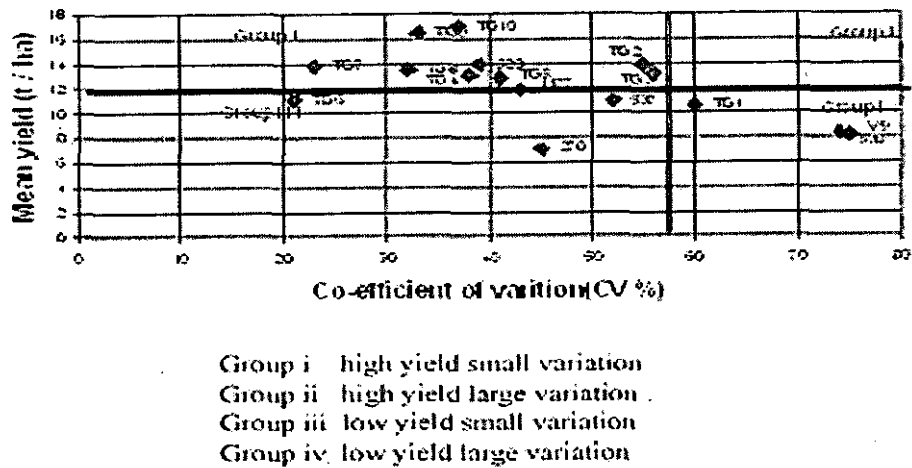


Figure 1. Mean yield plotted against coefficient of variation from data collected on 17 families in six seasons.

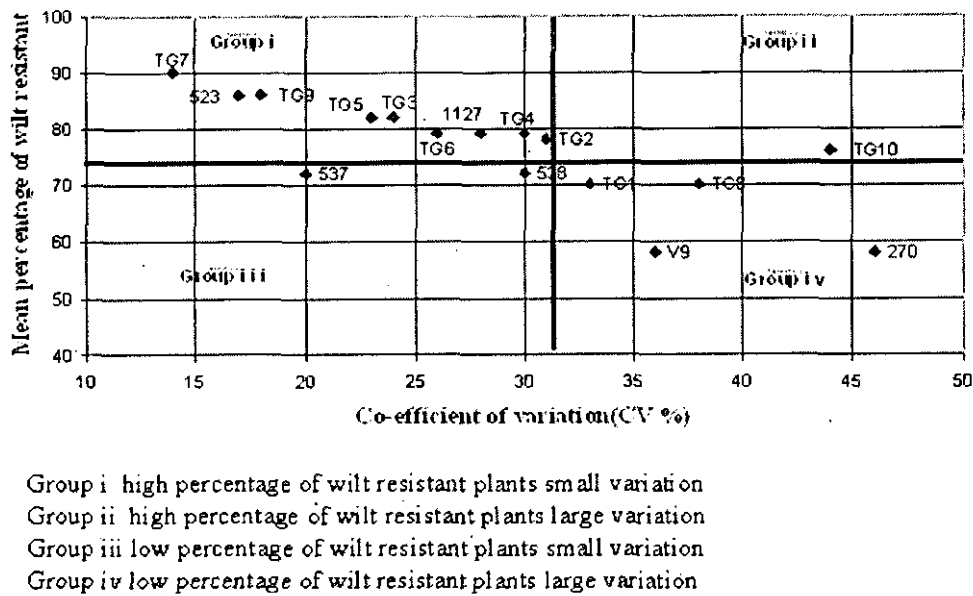


Figure 2. Mean percentage of wilt resistant plants plotted against coefficient of variation from data collected in 17 families in six seasons.

Table 5. Plant height and Days to 50% flowering from transplanting on the tested entries during Maha 1996/97, Yala 1997 & Maha 1997/1998.

Family	Pure line	Plant height at first harvest (cm)			Days to 50% flowering		
		1996/ 97 maha	1997 yala	1997/98 maha	1996/97 maha	1997 yala	1997/98 mah
TG7	G1	96a	103bc	77abc	28a	34bc	33a
TG9	G2	87a	108abc	81a	30a	33c	29a
TG2	G3	104a	116abc	81a	28a	33c	31a
ACC#01127	G4	94a	101bc	69c	29a	38ab	30a
TG4	G5	96a	108abc	72bc	28a	32c	31a
TG10	G6	94a	123a	78abc	28a	35bc	30a
TG5	G7	98a	103bc	80ab	29a	40a	29a
TG3	G8	91a	125a	78abc	29a	37abc	29a
ACC#00523	G9	89a	91c	70bc	29a	32c	29a
CV%		8.05	9.42	8.2	5.31	8.62	6.01

Mean followed by the same letter is not significantly different from each other according to L.S.D test at $p = 0.05\%$.

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Table 6. Fruit yield on the selected entries during 1996/1997 Maha, 1997 Yala and 1997/1998 Maha at HORDI Gannoruwa

Family	Pure line	Yield t/ha		
		1996/1997 Maha	1997 Yala	1997/1998 Maha
TG7	G1	33a	44a	22a
TG9	G2	38a	43a	20ab
TG2	G3	35a	43a	18b
AC#01127	G4	31a	35a	19ab
TG10	G6	33a	43a	18b
TG5	G7	34a	38a	20ab
TG3	G8	32a	44a	20ab
AC#00523	G9	29a	42a	22a
CV%		8.72	12.36	8.92

Mean followed by the same letters are not significantly different from each other according to L.S.D test at $p = 0.05\%$.

Table 7. Fruit quality characters on the selected entries during 1997/1998 Maha at HORDI Gannoruwa

Family	Pure line	Mean fruit Weight (g)	% Acidity as citric acid	pH
TG7	G1	118	1.4	3.6
TG9	G2	108	1.6	3.6
TG2	G3	93	1.4	3.6
ACC#01127	G4	92	1.4	3.6
TG4	G5	102	1.3	3.6
TG10	G6	111	1.0	3.5
TG5	G7	114	1.3	3.6
TG3	G8	116	1.5	3.6
ACC#523	G9	122	1.3	3.8

Table 8. Mean yield (t/ha) of selected tomato line G9 and T245 in National Co-ordinated Variety Trials.

Variety	Agro-ecological zone		
	Mid country Wet zone	Up country	Low country Dry zone
G9	26.70	33.97	13.03
T245	29.52	33.25	24.06

Table 9. Yield performance of G9 in Variety adaptability trials t/ha.

Seasons	Agro-ecological zone	T245	G9
Yala 2003	Mid country Intermediate zone	3.38	1.68
	Mid country Wet zone	21.63	26.50
	Mid country Wet zone	9.31	7.43
	Low country Wet zone	1.82	2.90
	Variety Mean	9.03	9.63
	Variety Deviation Mean	1.78	1.19
	Variety Deviation Variance	2.13	1.49
Maha 2003/04	Mid country Wet zone	1.75	0.5
	Low country Dry zone	5.5	4.0
	Mid country Wet zone	17.25	10.0
	Low country Dry zone	5.87	16.01
	Variety Mean	7.59	7.62
	Variety Deviation Mean	8.31	8.77
	Variety Deviation Variance	8.97	6.26
Yala 2004	Mid country Intermediate zone	21.8	25.2
	Mid country Intermediate zone	20.01	15.2
	Mid country Intermediate zone	18.0	6.5
	Mid country Intermediate zone	15.0	15.8
	Variety Mean	18.7	15.6
	Variety Deviation Mean	4.21	3.84
	Variety Deviation Variance Mean	3.41	2.98

Table 10. Performance of pure line G9 and reference variety T245 to Bacterial wilt disease and fruit quality characters(pH and acidity% as citric acid).

Variety	Bacterial wilt disease		Acidity	pH
	Resistance			
	Laboratory	Field		
G9	Resistant	Resistant	1.3	3.0
T245	Moderate	Resistant	0.84	4.1
Marglobe	Susceptible	Susceptible	-	-
KWR	High	High	-	-

DUS reports indicated that the selection G9 was distinct with all the acceptable qualities compared to the reference variety T245 and is sufficiently uniform and stable in morphological characteristics.

CONCLUSIONS

The selection G9 had resistance to bacterial wilt in the field and also in laboratory tests, potential fruit yield of 22-42 t/ha, and prominent fruit characteristics, moderate pH (3.8), acidity as citric acid (1.3) and orange red skin colour. Therefore, the selection G9 was nominated for National Coordinated Varietals Trials (NCVT) and Varietals Adaptability Trials (VAT) in research and farmer's field. The selection G9 was showed promise in NCVT and VAT. It also satisfied Distinguish Uniformity and Stability (DUS) test. Therefore, the selection G9 was nominated for the Varietals Release Committee and it was released officially as variety Lanka Sour in 2005.

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