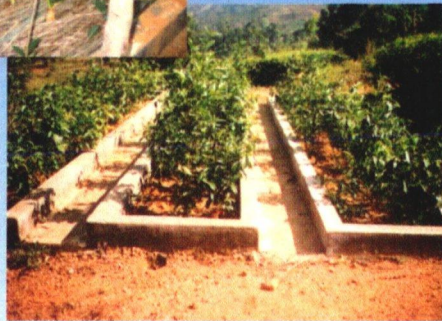


THE TEA RESEARCH INSTITUTE OF SRI LANKA



Tea Clones & Tea Nematodes

Sushila I. Vitarana
D.D. Liyanage, G.P. Udamulla, U.B. Herath & N. Navaratne

Editorial Assistance :

Shyamantha Bandara

Design and Layout :

S.A. Naleen Nishantha Ratnapala

Secretarial Assistance :

Chapa Munasinghe

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**The Tea Research Institute of Sri Lanka
Talawakelle
Sri Lanka**

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Project Team

Dr. Wester W.D. Modder - Project Coordinator / Local Manager

Mrs. Sushila I. Vitarana - Project Leader

Mr. D.D. Liyanage - Experimental Officer

Mr. U.P. Jayaratne - Research Assistant (Contractual)

Mr. N. Navaratne - Experimental Officer

Mr. U.B. Herath - Experimental Officer

Mr. P. Udamura - Experimental Officer

Mr. A.K. Prematunge - Experimental Officer

Mr. P.K. Jayawickrama - Experimental Officer

Mr. U.S. Mudalige - Technical Assistant (Contractual)

Mr. S.A.N.N. Ratnapala - Technical Assistant (Contractual)

Mrs. M.W.C. Munasinghe - Project Clerk (Contractual)

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Mr. Hicham Nahro / Portfolio Manager

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Ms. Christine Sporel / Resident Representative, UNDP, Colombo

Mrs. Manel Jayamanne / Programme Officer, UNDP, Colombo

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Mr. M. Pathiraja,

Mr. Chula Weerakoon,

Mr. A.S. Ratwatte,

Mr. Chaminda Gunaratne,

Mr. M.S.A. Akbar,

Mr. Lucas Bogtstra,

Mr. Manzur Mustaq,

Mr. Ronnie Gunaratne,

Mr. Sudath Ekanayake

Mr. Ranjan Gunasekera,

Mr. Wasantha Wijesinghe,

Mr. A. Tissera,

Mr. H.A.P. Jayathilake,

Mr. Anil Bowange,

Mr. A.D Samarasekera,

Mr. M.I. Goudian,

Mr. C.S. Ekanayake,

Mr. Mohan Rajendran,

Mr. L. Fonseka,

Mr. Manil Perera.

What are the objectives of this Monograph?

- ⊗ **To elucidate the procedures adopted at screening tea clones against nematode pests**
- ⊗ **To apprise the end-user of the clones that have been evaluated todate.**

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Sushila I. Vitarana, G.P. Udamulla, D.D. Liyanage, U.B. Herath and N. Navaratne
The Tea Research Institute of Sri Lanka, Talawakelle, Sri Lanka

1.0 Introduction

It was in 1939, simultaneously with the detection of the Meadow Nematode, *Anguillulina pratensis* (= *Pratylenchus pratensis*, = *Pratylenchus loosi* Loof) that clonal selection for nematode resistance originated. Dr. Gadd had noticed dark-leaved normal looking bushes among the Witches-Broom bushes (Hutchinson, 1960). (Symptoms of witches Broom condition are yellowing of leaves, spurs with tufts of leaves at the terminals, and small shoots with short internodes and dwarfed leaves). It is reported that clonal selection immediately started in January 1940 on Drayton Estate, under the guidance of the Tea Research Institute (TRI), but for the use of that estate.

By this time, the TRI had developed vegetative propagation of tea. The Institute started large scale selection for nematode resistance in 1950 (Visser, 1959). Those selections had been planted in a nematode infested area in St. Coombs in 1955 and some of them together with some other clones selected for yield and quality, in cement pots. By 1959, those had yielded 8 clones resistant to the Meadow Nematode and having above average quality and yield. They were DK8, DK16, DT 1, DT95, GL48, K150, TRI2142 and TRI2145* (Loos, 1955). The production of nematode resistant clones began, thus.

It was Mr. Lambert Perera who was recruited by the Estate and whom the TRI trained in clonal selection and propagation who discovered the first nematode resistant estate clone (Perera, 1999). That was DT1 and to date it has retained its original characters.

2.0 What is Nematode Resistance?

A resistant plant is unsuitable for the normal development and reproduction of the nematode. However, resistance is a relative term. On the other hand, the terms susceptible and immune mean distinct and undoubtedly recognized phenomena of plant reaction to nematode attack. If a nematode can attack a plant to any extent, the plant is referred to as **susceptible** to the pest. It is immaterial as to whether only a few nematodes enter the roots or whether the damage is significant or not. **Immunity** is the status where the plant is in no way a host to the nematode. **Resistance** is the character of the plant that restricts the entry of nematodes into the root tissue. There are various mechanisms by which nematode resistance is imparted to the plant. Therefore, there is such a variability in the degree of resistance among the different clones.

*DT=Drayton, DK=DiyaniLakele, GL=Glasaugh, K=Kirkoswald

2.1 Mechanism of Resistance

Resistance can be brought about by several ways.

✦ Resistance to Entry of the Nematode into Root Tissue :

A nematode is attracted to a root by virtue of a chemical sense. That is, a chemical exuded by the root attracts the nematode to its surface (Loos, 1941). Before entry, the nematodes explore the root surface for a suitable entry point. On encountering such a point, the nematode proceeds to pierce the root epidermis. This, it does with the help of a skeletal structure called stylet that protrudes out through the mouth, and resembles a hyperdermic needle. Once the root is pierced it sucks up the cell sap that oozes out. With repeated stylet action it makes the puncture large enough to enter into the epidermal cells. The plant can offer resistance to the piercing action and prevent the entry of the nematode. The root tissue can also, offer toxic substances that prevent entry (Hutchinson, 1960). Thus, resistance at root penetration is offered by 3 factors:

- i. absence of attractants / kairomones
- ii. mechanical hardness of the cell wall of the epidermal layer
- iii. presence of repellents / allomones

✦ Resistance to Development Inside Root Cells:

The cell contents may be toxic to the nematode (as it is the case with Marigold, *Tagetes* spp.) or they may inhibit development by way of not allowing the 3 moults required for development, or else they may make the adults sterile.

✦ Resistance to Viable Egg Production:

Egg production may be drastically reduced or the eggs may fail to hatch, as a result of toxic substances acting on them.

2.2 Break-down of Resistance

The physiological health of the plant too can influence the resistance of a plant to nematode attack. A nematode can attack with greater ease, a plant that has already been weakened by other conditions. Also, a plant or a clone that is resistant to a nematode species in one area may not necessarily be so in another area. This is due to the occurrence of different nematode populations or pathotypes, in different areas. This is why the Institute collects infested soils from different estates to prepare the growing medium of testing tanks.

3.0 Immunity

Immunity is the character by which a plant would not allow a pest to attack itself even under very high pest pressure. This is a phenomenon that is very rare in the case of a primary pest in relation to varieties of the same crop plant. It is the same with tea clones and the nematodes. The only clone that was known to be immune to *P. loosi* was TRI 2135.

Webster in the 1956 TRI Annual Report stated thus: "...*Particularly low levels of population, indicating a considerable reduction in the original level (2500 worms per pot) were found in clones D 95, DE 10/2 and T.R.I.2135. This latter, T.R.I. 2135, also exhibited a curious phenomenon in the heavily infested clonal proving area in that repeated sampling has failed to indicate the presence of any meadow eelworm in its root system. Examination of the rhizosphere of this clone for antagonistic organisms or toxic root exudates should merit attention.*" (Webster, 1956).

This indicates that, the clone TRI 2135 planted in the heavily infested clonal proving area in St.Coombs Estate had clearly shown that it was immune to the nematode. However, TRI Circular C8 (Tea Research Institute, 1991) categorized the same clone as susceptible. There is doubt as to whether a new pathotype was responsible for this difference, or not.

4.0 Tolerance

Tolerance is a character that we refer to often when we talk about tea and nematode resistance. A tolerant plant has the ability to grow regardless of nematode infestation. Thus, a tolerant clone is one that is susceptible but, can produce tissue matter (compensatory growth) to offset the damage caused by the nematode.

Tolerance too has different manifestations

- Firstly, even though the nematode may be feeding, the root may not be injured. A clone having such tolerance may not bear the 'lesions' that are characteristic of the Meadow eelworm /Root-lesion nematode. The lesions are caused by the toxic oesophageal gland secretions that are pumped into the cells while the nematode is feeding before the cell contents are sucked out. In the absence of such injury the plant may grow unhindered.
- Secondly, a tolerant plant could repair the mechanical damage arresting the processes that take place as a consequence of nematode injury.

Thirdly, the plant may be so vigorously growing that it produces roots faster than the nematode can attack them. This type of tolerance is not desirable because, with time, root growth attains a limit at which the soil volume is completely filled with roots and the nematodes can get established in all roots. Thus, "break-down" of tolerance may be observed in a clone which was referred to as highly tolerant originally. In such a situation, tolerance is not preferred to resistance. A highly resistant average yielder may be chosen for planting in preference to a tolerant high yielder. The other disadvantage in a tolerant clone is that it, being a good host, will promote build up of populations and become a source of infestation to nearby areas.

5.0 Screening of Tea Clones for Their Resistance and Tolerance to Tea Nematodes

The present methods of processing root and soil for nematode assessment do not ensure 100% extraction of nematodes from soil. Very low levels of infestation can remain in the soil without being detected at assessment. On the other hand plantations may adopt sub-standard methods or carry out sub-standard work at eradication of the pest, resulting in residual populations in the land. Such populations can develop into high levels if a suitable host is planted in the area. Thus, it is necessary to use resistant or tolerant clones for new-planting as well as re-planting. For this purpose tea clones are being screened for their resistance to tea nematodes.



Plate 01- **Clonal Testing: Tolerance Test Tanks (Beds)**

Hantane Estate, Kandy (2000-2002)

Tanks are 1 m deep and 1 m wide; length is variable - can be according to the number of test clones. At use these tanks are filled with infested soil of known level of infestation, and allowed to settle over 2 weeks prior to planting 9-month old plants of test clones which had been previously grown in MeBr treated nematode free soil.

Currently Adopted Methodologies

Clonal screening is carried out by planting 9-month old nematode free plants in cement tanks filled with infested soil (Plate 01 to 03).



Plate 02 - Tolerance Test Beds

Hantane Estate, Kandy - N1B Trial (2000-2002)

Tanks built in August 2000 - 1m deep X 6m long x 1m wide.

Tanks can accommodate 16 clones x 3 plants each; each clone has 3 Replicates (in the 3 tanks)



Plate 03 - Clonal Screening against *Radopholus similis* on-going

Hantane Estate, Kandy - N.1 B trial (2000-2002)

9-month old plants of test clones which had been previously grown in MeBr treated nematode free soil have been transplanted in the infested soil of the tanks.



Plate 04 - Clonal Screening against *Radopholus similis* on-going
Hantane Estate, Kandy - N 1B trial (2000-2002)
Growth assessments are carried out at regular intervals.

Assessments

Destructive sampling is carried out at 18 to 24 months from transplanting of the test clones in the tanks.

- i. Nematode population in feeder roots as well as soil of the rhizosphere is assessed to evaluate the degree of susceptibility.
- ii. Root weight and Shoot weight are recorded in order to evaluate the degree of tolerance of a susceptible clone.

Based on the above assessments, the clones are characterized as susceptible or tolerant or resistant.

6.0 Characterization of Tea Clones in Relation to Nematode Susceptibility

It is possible to classify the reaction of a tea clone towards pathogenic nematodes in a broad sense as follows:

- a.) susceptible but not tolerant (S)
- b.) Susceptible and tolerant (T)
- c.) Resistant (R)
- d.) Immune

6.1 Clonal Screening at the TRI

Since 1955, the Institute has been screening clones for nematode resistance with particular reference to *P. loosi* Loof and *R. similis*. Table 01 shows the categorization of clones in terms of their reaction to nematode attack.

Table 01- Clonal Screening for Nematode Resistance at the TRI of Sri Lanka

Year *	Clone	<i>P. loosi</i>			<i>R. similis</i>		
		R	T	S	R	T	S
1955	DT95	+	+				
	DE 20/10		+				
	TRI 2135	+					
1960/1961	TRI 2022			+			
	K 145	+	+				
1965/1966	N2		+				
	NAY 3		+				
	CY 3		+				
	DN					+	
1959	DK 16		+				
	DK 69		+				
	M 18	+					
	DK 10	+					
	M 111		+				
	M 208		+				

* The year refers to the year the clones were tested for *P. loosi*; screening work for *R. similis* had been undertaken after 1984

Clonal Screening at the TRI

Year *	Clone	<i>P. loosi</i>			<i>R similis</i>		
		R	T	S	R	T	S
1960	TRI 2023			+		+	
	TRI 2026			+			+
	TRI 2120			+			
	DK 48		+				
	TRI 2025		+				+
	M 3	+					
	TRI 2024			+			
1961	K 150		+				
1962	DK 1		+				
	DR 6		+				
	DR 12		+				
1964	TRI 2142		+				
	MO 146		+				
	MO 116		+				
1965	DUN 7		+				
	KEN 16/3		+				
	NL 4/2			+			
	NL 3/1			+			
	TRI 425			+			
1969	TRI 62/9	+					
	DG 7		+			+	
	NEM 3		+				
	NEM 4		+				
	NEM 6		+				
	NEM 9			+			
	NEM 8			+			
	NEM 1			+			
	TRI 2016			+			
	NEM 15			+			
	NEM 5			+			
	NEM 7			+			
	NEM 14			+			
	NEM 13			+			
	H 10A			+			
	TC 9			+			
	TRI 2043			+			
D			+				
DG 39			+				

* The year refers to the year the clones were tested for *P. loosi*; screening work for *R. similis* had been undertaken after 1984

Clonal Screening at the TRI

Year *	Clone	<i>P. loosi</i>			<i>R. similis</i>		
		R	T	S	R	T	S
1971	MT 18		+			+	
	Hybrid X 316		+				
	W 1/1		+				
	Hybrid X 310		+				
	TRI 2016		+				
	Hybrid X 729		+				
	Hybrid X 664		+				
	Hybrid X 687		+				
	G 7/1		+				
	TRI 2020				+		
MT/BG				+			
1980	TRI 3016	+					
	TRI 3019	+					
	TRI 3037	+					
	TRI 3041	+					
	TRI 3018		+				
	TRI 3022		+				
	TRI 3023		+				
	TRI 3031		+				
	TRI 3035		+				
	TRI 3069		+				
	TRI 3015				+		
	TRI 3017		+				
	TRI 3021				+		
1980	TRI 3022			+			
	TRI 3029			+			
	TRI 3030			+	+		
	TRI 3033			+			
	TRI 3036			+			
	TRI 3038			+			
	TRI 3039			+			
	TRI 3042			+			
	TRI 3046			+			
	TRI 3059			+			
	TRI 3066			+			
	TRI 3067			+			
	TRI 3068			+			

* The year refers to the year the clones were tested for *P. loosi*; screening work for *R. similis* had been undertaken after 1984

Clonal Screening at the TRI

Year *	Clone	<i>P. loosi</i>			<i>R. similis</i>		
		R	T	S	R	T	S
1983	TRI 3057 TRI 800 TRI 62/1 TRI 830 TRI 3014 TRI 3055 TRI 3061 TRI 3065 TRI 62/7			+			
			+				
			+				
			+				
			+				
			+				
			+				
1984	CH 13 Cr 9 MPA 1 TRI 777 TRI 1526					+	+
							+
				+			+
1985	PB 908 PB 959 PB 1051 PB 1074 PB 972 PB 1019 PB 3063 PB 843 PB 898 PB 1021 PB 1031 PB 3025 PB 3054 PB 3061	+					
		+					
		+					
		+					
			+				
			+				
				+			
				+			
				+			
				+			
				+			
				+			
				+			
1986	PB 989			+			
1990	TRI 4052 TRI 3063 TRI 3070 TRI 4033 TRI 4053 TRI 4006 TRI 4066 TRI 4079 TRI 3035 TRI 3051 TRI 3071 TRI 4010	+				+	
			+				
			+				
			+				
			+				
			+				
		+					+
			+				
			+				
			+		+		+
					+		
					+		
					+		
					+		+

* The year refers to the year the clones were tested for *P. loosi*; screening work for *R. similis* had been undertaken after 1984

Clonal Screening at the TRI

Year *	Clone	<i>P. loosi</i>			<i>R. similis</i>		
		R	T	S	R	T	S
1990	TRI 4027			+			
	TRI 4034			+			
	TRI 4038			+			
	TRI 4063			+			
	TRI 3025						+
	TRI 3031					+	
1991	TRI 4064						+
	TRI 4067						+
	TRI 4085						+
	TRI 4024					+	
	TRI 4070	+				+	
	TRI 4078					+	
	TRI 4084					+	
	TRI 4051					+	
	TRI 4054					+	
	TRI 4071					+	
	TRI 4077			+		+	
1992	TRI 4055	+				+	
	TRI 4056	+					
	TRI 4060	+					
	TRI 4002		+				
	TRI 4012			+			
	TRI 4059			+			
	TRI 4063			+			
1994/1995	TRI 2025						+
	TRI 3022						+
	TRI 3053						+
	TRI 3016						+
	TRI 3017					+	
	TRI 3014					+	
	TRI 3015					+	
	TRI 3018					+	
	TRI 3013					+	
	TRI 3025					+	
	TRI 3051					+	
	TRI 3052					+	
	TRI 3055					+	
	TRI 3069					+	
	TRI 3019					+	
TRI 3020					+		

* The year refers to the year the clones were tested for *P. loosi*; screening work for *R. similis* had been undertaken after 1984

Year *	Clone	<i>P. loosi</i>			<i>R similis</i>		
		R	T	S	R	T	S
1998	TRI 4042		+				
	TRI 4047		+				
	TRI 4024		+				
	TRI 4014		+				
	TRI 4019		+				
	TRI 4089			+			
	TRI 4004			+			
	TRI 4088		+				
	TRI 4015		+				
	TRI 4052		+				
	TRI 4005			+			
	TRI 4003			+			
	TRI 4002			+			

Source:

Tea Research Institute, Annual Reports (1955, 1959, 1960, 1961, 1962, 1964, 1965/66, 1969, 1971, 1980, 1983, 1984, 1985, 1990, 1991, 1992 & 1998)

Tea Research Institute, Advisory Circulars (1972, 1990, 1991, 1994, 1994a, b & c, 1997, 1999).

* The year refers to the year the clones were tested for *P. loosi*; screening work for *R. similis* had been undertaken after 1984

7.0 Recommendations

All plantations situated in nematode active areas should follow the guidelines given below at new planting, replanting and infilling:

- 1st Choice- Use nematode **resistant clones** from the list of clones recommended for the particular agro-climatic area and adopt all prophylactic nematode control measures at planting and ensure nematode free conditions in the field.

- 2nd choice- Use nematode **tolerant clones** from the list; but, **compulsorily**, adopt all prophylactic nematode control measures at planting and ensure nematode free conditions in the field.

If for some reason, one considers using any of the nematode susceptible clones in a nematode active area, one has to ensure that the land is free of nematodes, that the nursery plants are free of nematodes and that all hygienic conditions are maintained in such a way that re-infestation of the land can be ruled out.

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For more information contact:

The Director

The Tea Research Institute of Sri Lanka
Talawakelle
Sri Lanka.

Tel. : 00-94-5258230, 00-94-5122601

Fax : 00-94-5258229

e.mail : <tri@slstinet.ac.lk>, <postmaster@tri.ac.lk>

<triratn@lanka.ccom.lk>, <vitaranasi@hotmail.com>