Differential Symptomological Expressions of *Pratylenchus loosi* under Climate Change

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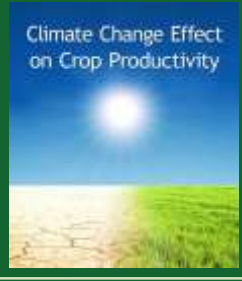
Climate Change

- Impacts of climate change and weather are well documented on crop growth and yield
- References on impacts of climate change on biological organisms are limited
- Very scares on pests and diseases



Caenorhabditis elegans

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Climate, Tea Pests and Parasites

Climate affects our tea pests directly and indirectly.
climatic factors - temperature, moisture and rainfall, light and sunshine and wind.
Each species has very definite optimum conditions.
Above and below the optimum - falling off in survival activity or rate of increase.
Beyond certain points inactivity occurs and beyond that death.
Temperature, as controlled by elevation - occurrence of pests.

The natural balance of pests and parasites on Ceylon tea, especially Tea Tortrix and *Macrocentrus*
J. E Cranham T. Q. Vol .22 (1961)

Climate Change and Agricultural Pests

Title	Author, Year
Climate change effects on insects and pathogens	Curtis and Abby (2008)
Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of northeastern North America	Jeffrey *et al*. (2009)
Adaptation to Climatic Variability and Change	Murdiyarso (2000)
Integrating pests and pathogens into the climate change/food security debate	Peter *et al.* (2009)
Impact of climate change on soil nematodes – Implications for sustainable Agriculture	Somashekar and Ganguly (2010)

Climate Change and Tea

Pest	Comment	Reference
Tea Tortrix 	No more a dry weather pest; additional generations (3-4) per year	Walgama, 2008
Shot Hole Borer 	Widespread; extended elevations and damage	Walgama and Pallemulla, 2005
Mites 	Less incidence due to frequent rains	Nagahaulla and Danthanarayana, 1999
Meloidogyne brevicauda 	suppressed in previously known localities, replaced with *P. loosi*	Mohotti, 2009
White Grubs 	Expansion in distribution; Unusual occurrence	Unpublished data
LC Live Wood Termites 	Expansion in distribution	Unpublished data

Nematode - *Pratylenchus loosi* as most sensitive biological organism

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Pratylenchus loosi (Up Country Species of Nematode)

Nematode damage in tea : First reported in 1926

A perennial pest damaging tea nurseries, new clearings and mature tea fields

Leading to a crop loss of

4 %- 40 %

- Distribution of *P. loosi* - soil temperature and soil moisture (Gnanapragasam and Mohotti, 2005)
- Highest population and pathogenicity - altitudes with soil temperatures of 18-24 ˚C (Sivapalan and Gnanapragasam, 1975)

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Symptoms of Damage

Weak patches of unthrifty tea

Very little new growth
Leaves - smaller and yellow
Flowering and fruiting

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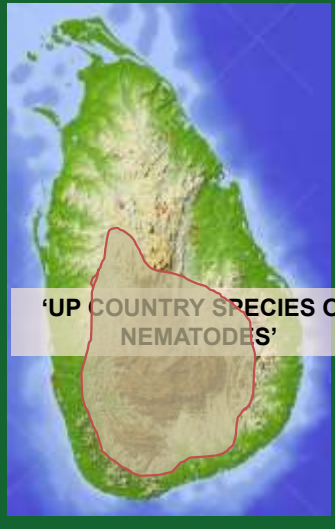
A Marked Shift in Nematode Distribution Pattern



Pratylenchus loosi **: Spreading in the Mid and Low elevations**

Radopholus similis **: Populations seemed to be suppressed in previously known localities and spreading in newer locations**

Concomitant occurrence with *P. loosi* : in Mid and Low elevations

Spreading in Mid and Low Elevations

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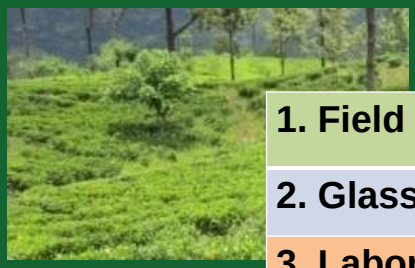
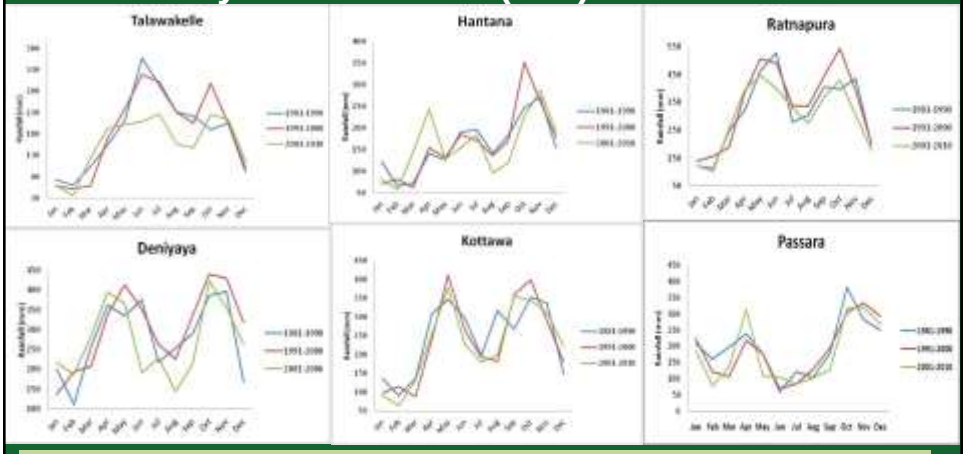


1. Field Experiments
2. Glasshouse Experiments
3. Laboratory Experiments

Weather Data Analysis

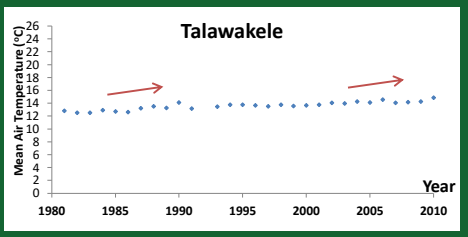
1. Monthly Mean Rainfall (mm)

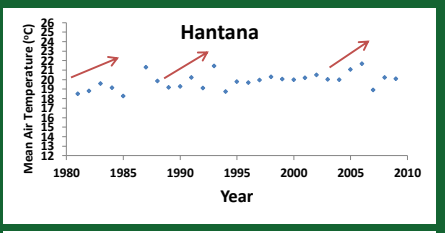


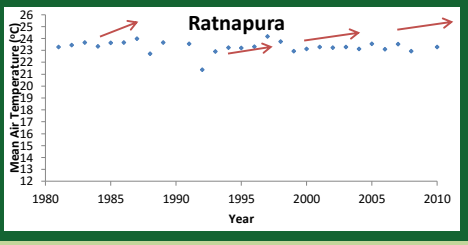
Changed rainfall pattern affects soil temperature; in turn *P. loosi* fluctuations

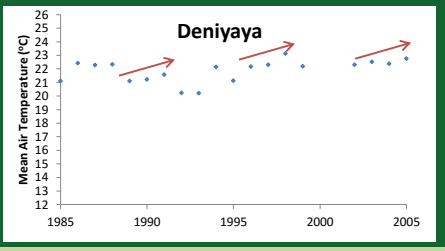
Weather Data Analysis

2. Mean Air Temperature









An increasing trend in air temperature; one or several hikes leading to unexpected stress to tea

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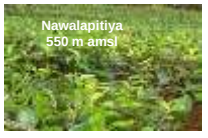
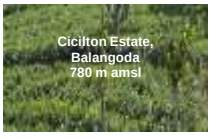
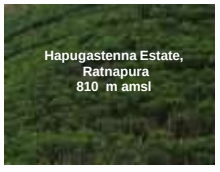
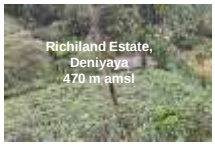
Study Locations Covering *P. loosi* Infestations





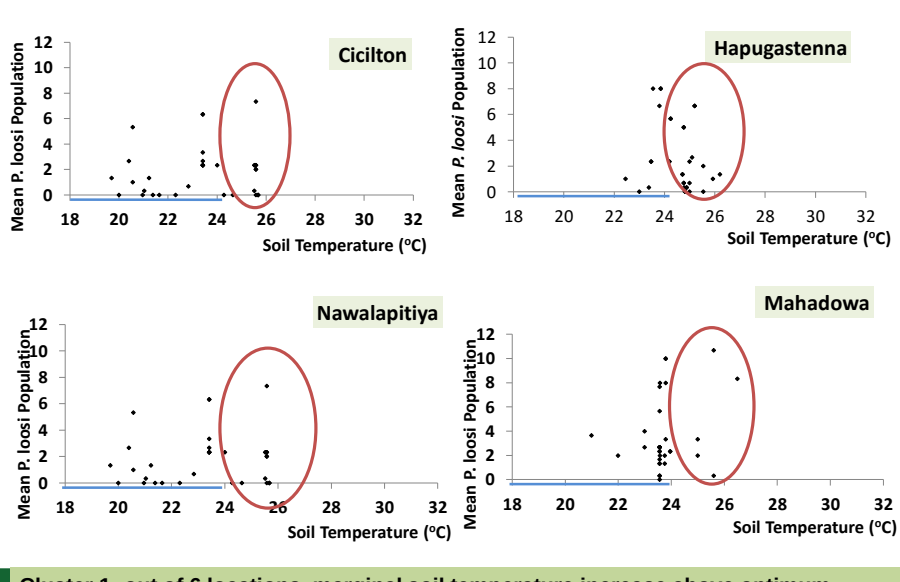




Study Approach

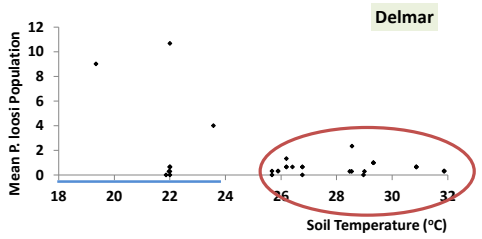
- Periodic assessment of nematode populations
- Extraction and quantification
- Soil temperature, soil moisture and rainfall data
- Data presentation
  Soil temperature, Soil Moisture, Rainfall and *P. loosi* populations

Mean *P. loosi* Population Densities in Soil Vs Soil Temperature

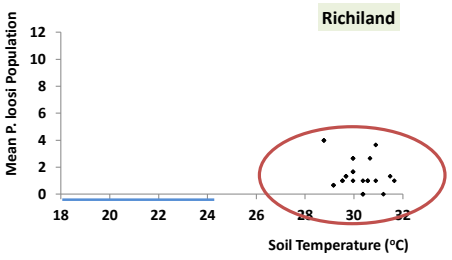


Cluster 1: out of 6 locations, marginal soil temperature increase above optimum in 4 locations

Mean *P. loosi* Population Densities in Soil Vs Soil Temperature



Delmar and Richiland- beyond 24°C – a remarkable change



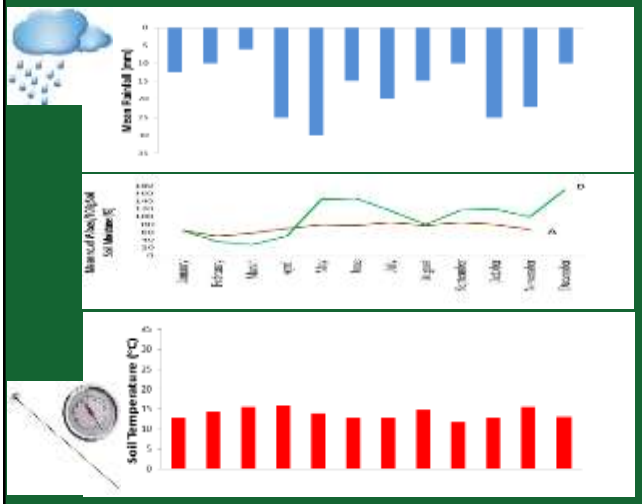
Deviated soil temperatures above optimum (18-24 °C) for *P. loosi* development even up to 32 °C

Cluster 2: out of 6 locations, 4 were critically beyond the optimum range

P. loosi Population in Soil with Vs Soil Temperature

- ***P. loosi* populations irrespective of soil temperature increase behaved as different isolates**
- **Their damage symptoms were different**
- **Results showed potentials of wide spreading of *P. loosi* species in all tea growing regions**
- **Virulence as a dominating nematode species with potential survival mechanisms and adaptations**

Monthly Variations in *P. loosi* Populations in Soil



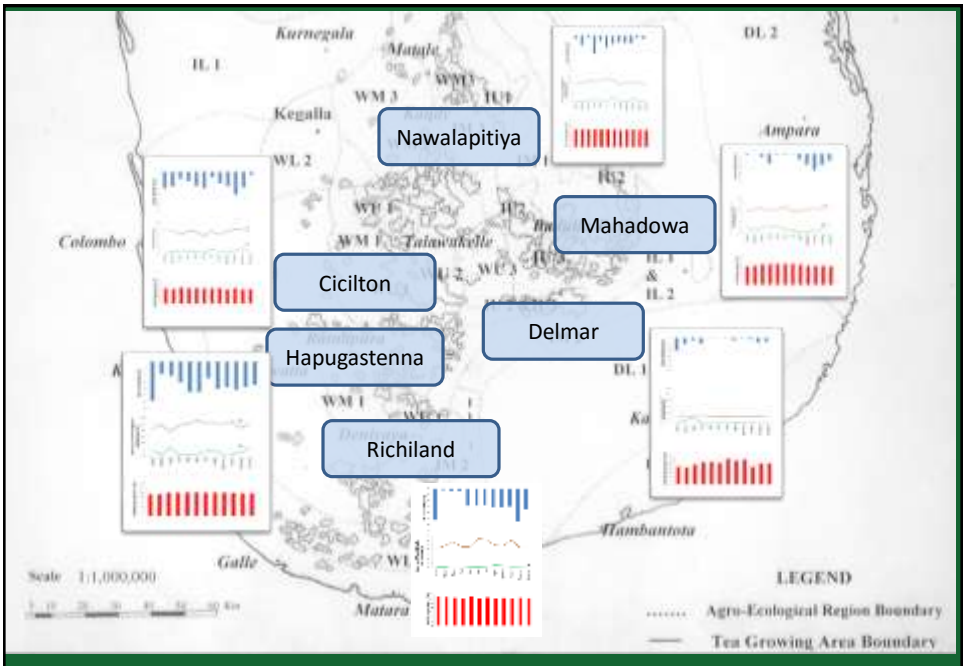
A - Mean Soil Moisture Content (%)

B - Mean Number of *P. loosi* per 100g soil

(Extracts from Sivapalan, 1972)

Relationship Deployed in:

- ✓ Sampling for nematode analysis
- ✓ INM strategies
- ✓ Cultivar screening



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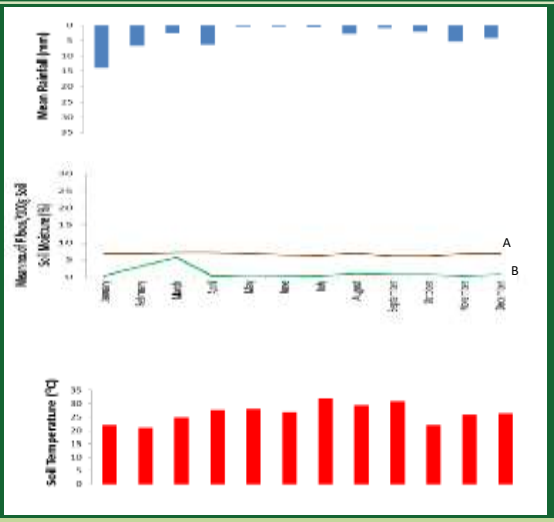
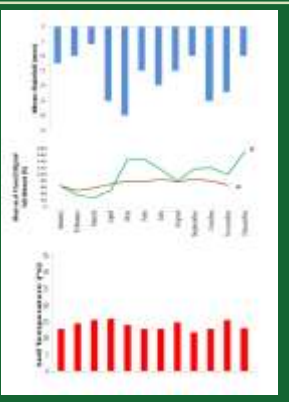
Delmar, Ragala





A - Mean Soil Moisture Content (%)

B - Mean Number of *P. loosi* per 100g soil

Longer dry periods, Less Rainfall, Very high soil temperature
Acclimatized *P. loosi* populations

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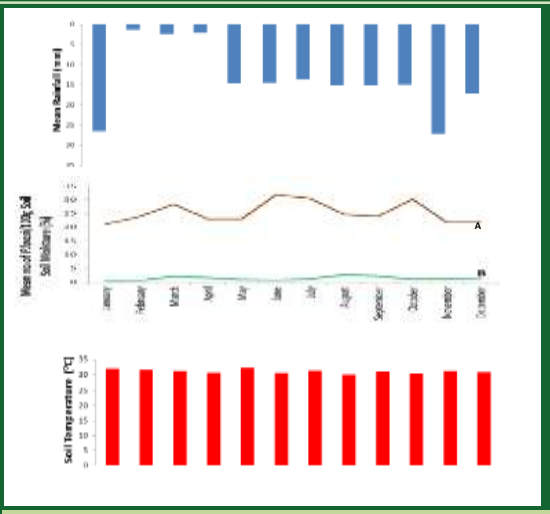
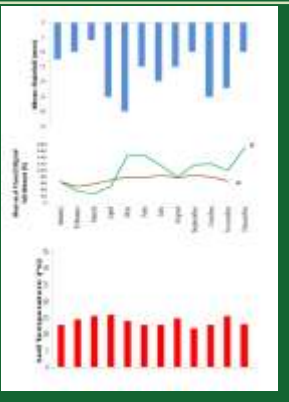
Richiland, Deniyaya





A - Mean Soil Moisture Content (%)

B - Mean Number of *P. loosi* per 100g soil

High Rainfall, Very high soil temperature
Acclimatized *P. loosi* populations

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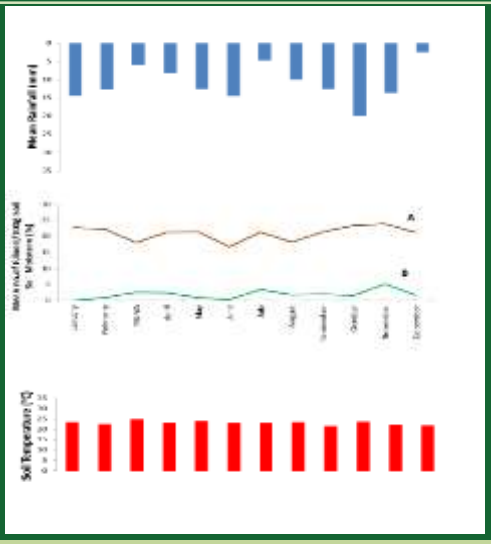
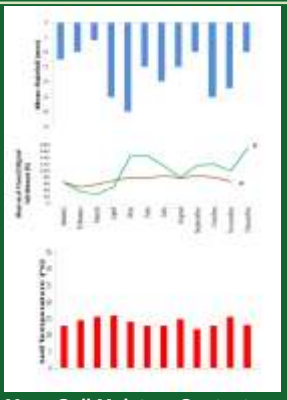
Cicilton, Balangoda





A - Mean Soil Moisture Content (%)

B - Mean Number of *P. loosi* per 100g soil

Marginally high soil temperature

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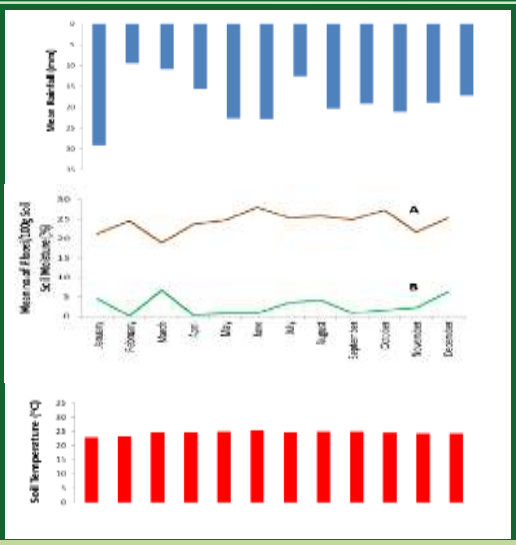
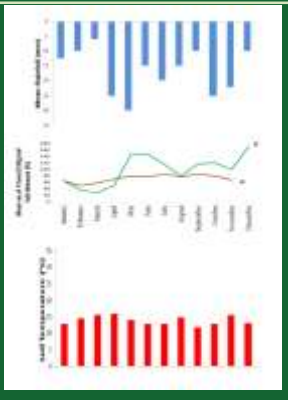
Hapugastenna, Ratnapura





A - Mean Soil Moisture Content (%)

B - Mean Number of *P. loosi* per 100g soil

High Rainfall, Marginally high soil temperature

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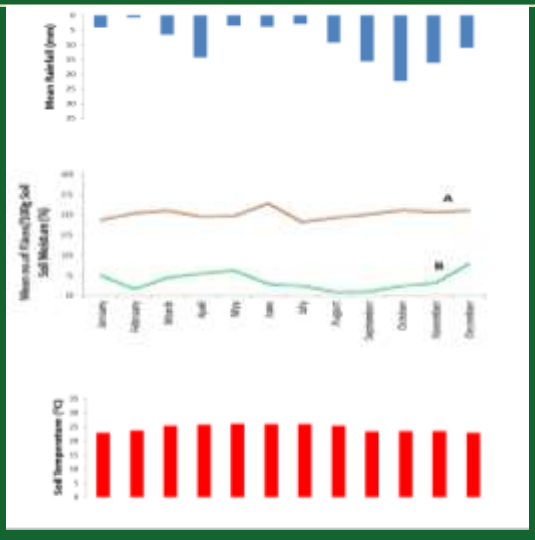
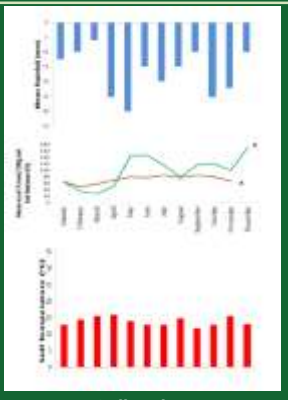
Mahadowa, Passara





A - Mean Soil Moisture Content (%)

B - Mean Number of *P. loosi* per 100g soil

Less Rainfall, Marginally high soil temperature

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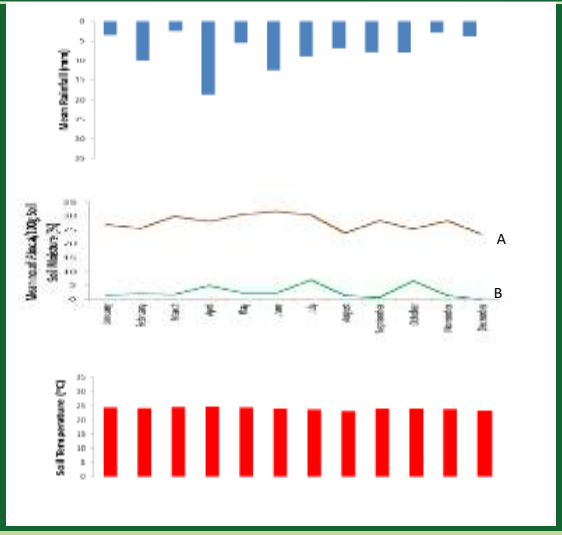
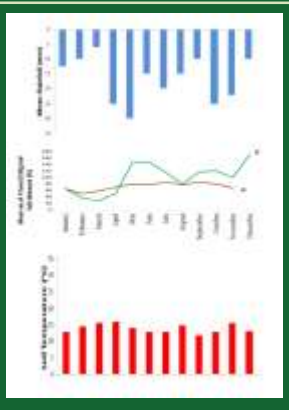
Nawalapitiya





A - Mean Soil Moisture Content (%)

B - Mean Number of *P. loosi* per 100g soil

Deviated Rainfall Pattern, Marginally high soil temperature

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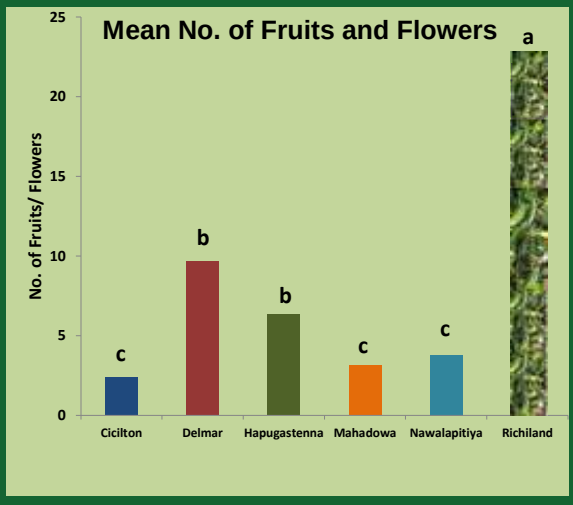
Overall Results

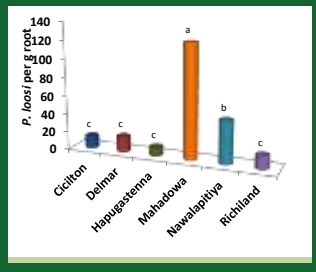
- Pattern of soil temperature, soil moisture content and rainfall - highly erratic
- Different climatology graphs resulted
- Accordingly, sampling plans, INM strategies, cultivar selection to be decided

Symptoms of Damage




Symptomological Expressions in Tea Plants due to *P. loosi* Infestation in Six Locations





Richiland - Symptomological expressions high

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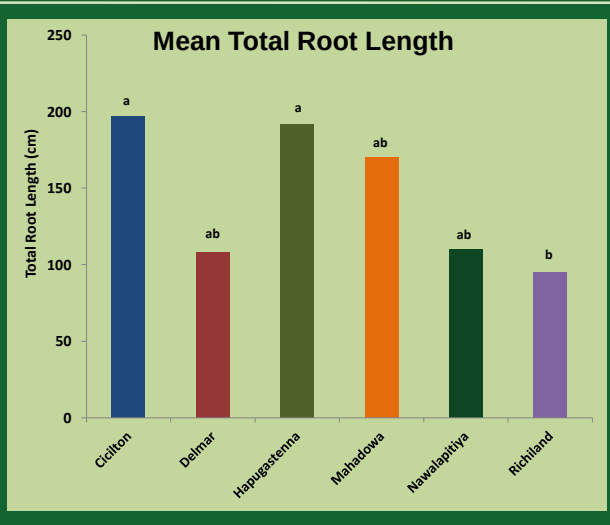
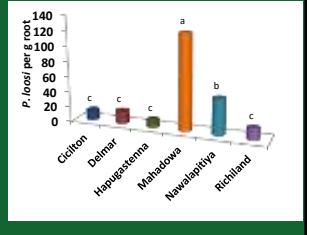
Symptomological Expressions in Tea Plants due to *P. loosi* Infestation in Six Locations





Richiland – Root damage is high

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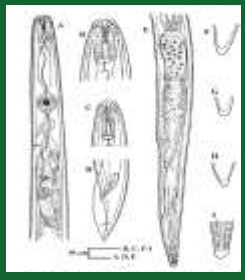
Growth of Tea Plants Inoculated with *P. loosi* Populations (at Soil Temperature 24 ^{o}C)

P. loosi Population	Mean Plant Height		Mean Total Root Length	
	(cm)	% change	(X10^{3}cm)	% change
Cicilton	34.3 c	(-52)	5.2 c	(-66)
Delmar	36.2 c	(-49)	7.7 b	(-50)
Hapugastenna	48.9 bc	(-32)	5.7 c	(-63)
Mahadowa	61.9 b	(-14)	6.6 b	(-57)
Nawalapitiya	60.5 ab	(-16)	10 ab	(-34)
Richiland	60.1 b	(-16)	6.5 b	(-58)
Uninfested Control	72.0 a		15 a	

Growth Parameters of Tea: Mean Total Root Length (cm) as Affected at Different Soil Temperatures

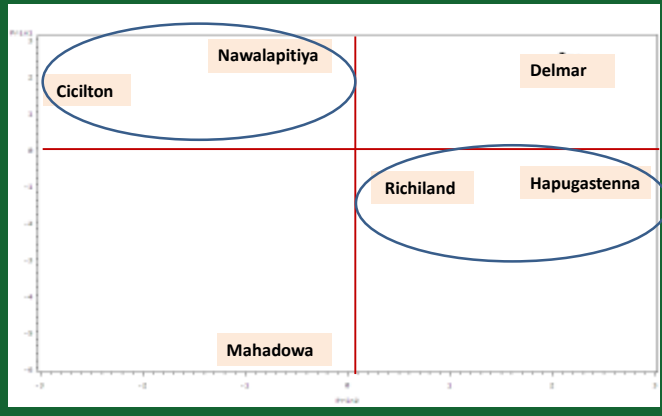
P. loosi Population	at 24 ºC (x 10^3)	at 28 ºC (x 10^3)	at 30 ºC (x 10^3)
Cicilton	5.2 c	10 ab	9.6 a
Delmar	7.7 b	5.2 b	7.5 b
Hapugastenna	5.7 c	4.8 b	7.1 b
Mahadowa	6.6 b	7.4 b	3.8 c
Nawalapitiya	10 b	2.6 c	5.4 bc
Richiland	6.6 b	3.6 c	5.1 bc
Uninfested Control	16 a	15 a	10 a

Morphological Differences



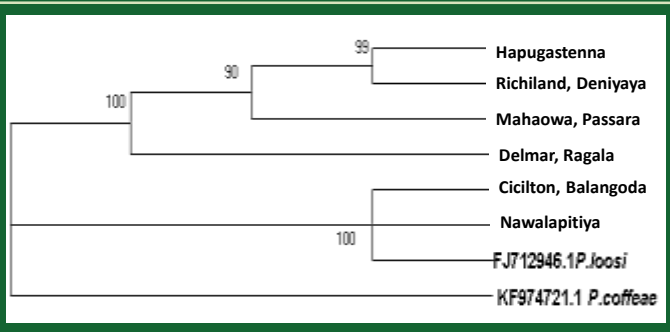
- Body length (µm)
- Max. body width (µm)
- Tail length (µm)

etc.



- Six *P. loosi* populations in 4 groups – showed morphometric differences
- Delmar and Mahadowa populations in separate groups

Molecular Diversity – DNA based Study



Cicilton and Nawalapitiya - closely related
Hapugastenna and Richiland - closely related
Delmar and Mahadowa - distantly related

Avenues to Industry through Specific INM Strategies

- Information added on vulnerability of nematodes to changing soil temperatures
- Location / isolate specific nematode management approaches
- Précised nematode management package through which cost savings via unnecessary usage of prophylactic nematicides
- Rational use of prophylactic treatments

Avenues to Industry through Specific INM Strategies

- Improvement of vegetation
- Climate change mitigation strategies
- Crop and soil health improvement through GAPs

Contribution to Carbon Neutral Tea Cultivation……

Thank you