Responses of Low Grown Tea to Irrigation

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Drought & Climate Change

Drought

1. Soil moisture depletion - PWP
2. Temperature rise - >35^{0}C
3. Vapor pressure deficit - >2KPa

Picture: Mt. Everest Nepal

- **Climate change**

1. Temperature rise
2. C-3 type crop
3. Island nature
4. Mountainous area
5. Tea vegetative crop

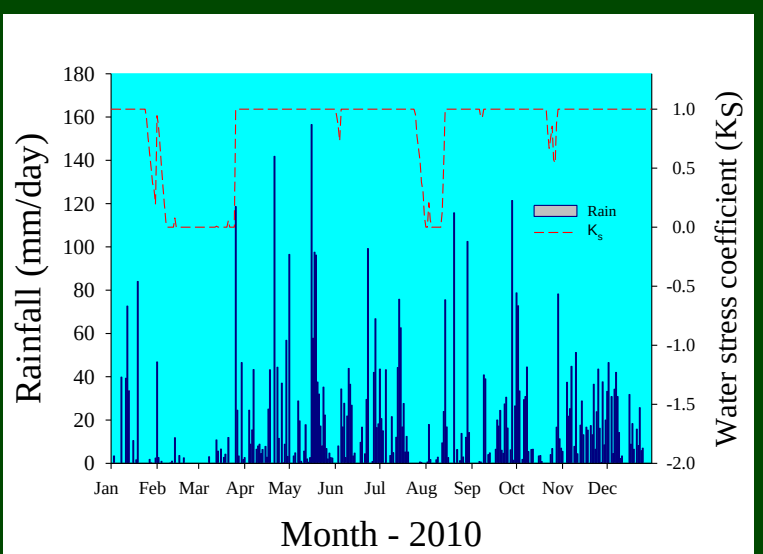
Is there a moisture stress?

Young Tea Water Stress Coefficient

$$K_s = \frac{TAW - D_r}{(1-p)TAW}$$

K_s – Water Stress Coefficient
TAW – Total Available Water
D_r - Depletion rate
P – fraction of TAW plant can use
(for tea, p = 0.4)

Water Stress Coefficient - Ratnapura 2010



2010 very wet year with annual rainfall of 4983mm. Still there are some moisture stress periods.

Different Irrigation Practices

-manual irrigation

-small sprinkler

-high labor cost

-delayed irrigation

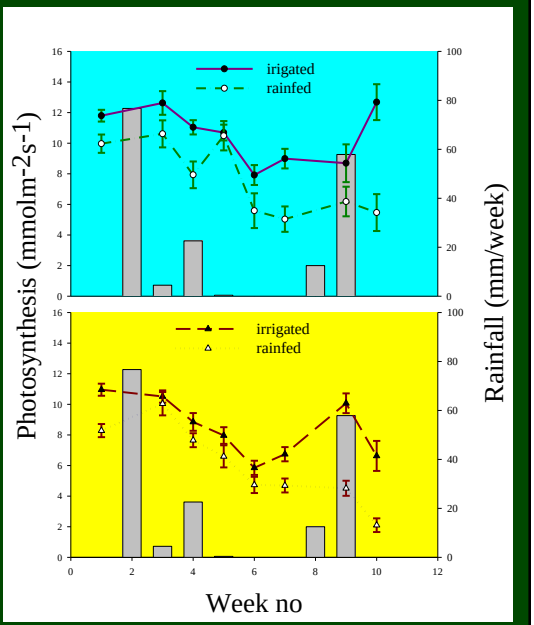
-low monitoring

Methodology

- Netafim Ram 17D inline drip system
- Application rate 1.6L/hr
- TRI 2023 & TRI 3025 cultivars
- 1999 May planting
- Harvesting commenced 2001 Oct
- Irrigation during January-March
- Graze period 5 con. rainless days
- Based on Class A pan evaporation

Physiological response….,

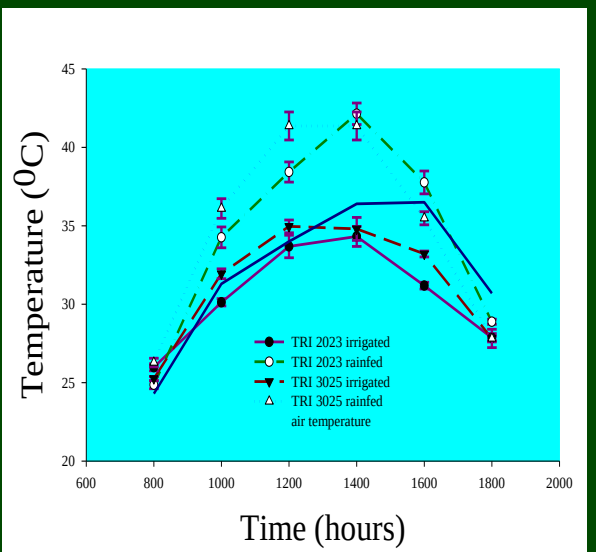
•33 and 38% higher photosynthesis under irrigation for TRI 2023 and TRI 3025



Leaf temperature

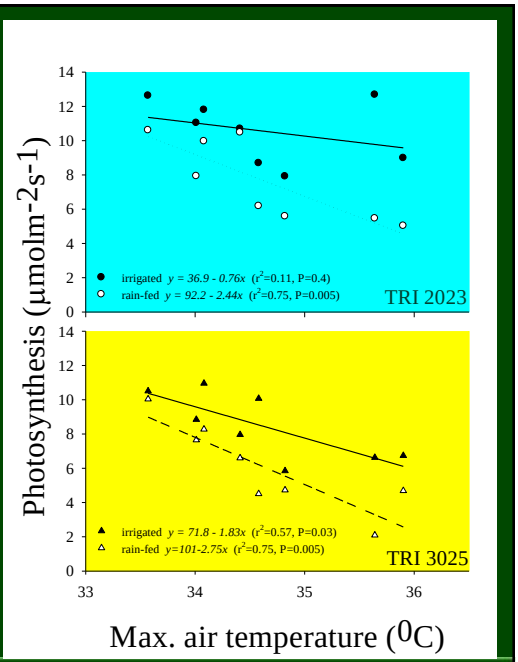
•TRI 3025 leaf temperature rapidly build up than TRI 2023

•At 1400hrs, ~10^{0}C difference between irrigated and rain-fed plants



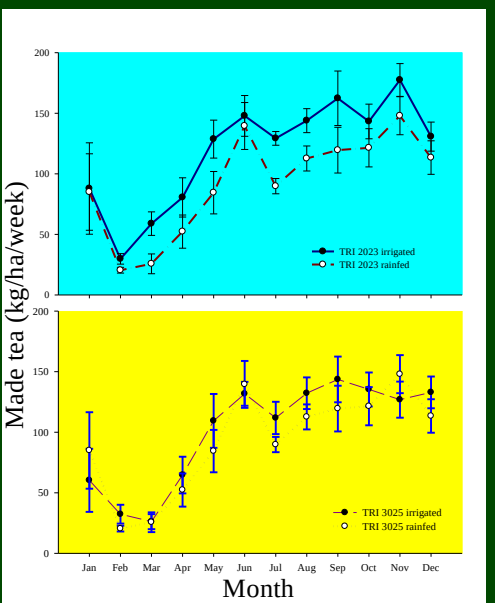
Temperature effect on photosynthesis

- TRI 3025 more sensitive to increasing ambient temperature even under irrigation



Tea yield

- Graph shows weekly tea yield for each month
- There are some months with high yield fluctuation
- Effect of irrigation on tea yield observed even during wet season



Yield analysis

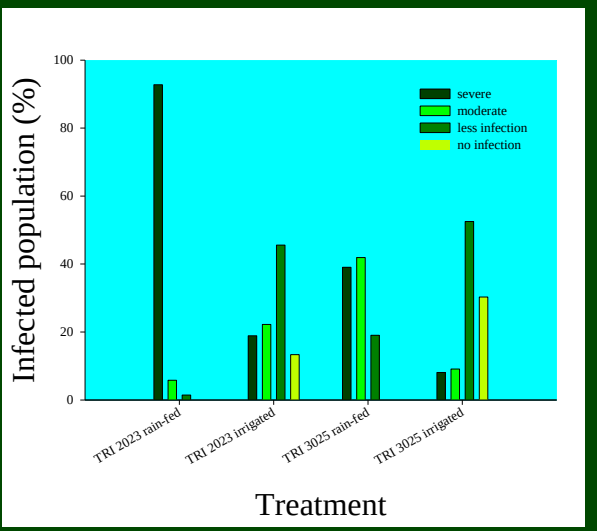
Treatment	Yield (Made tea kg/ha)
TRI 2023 rain-fed	4468(±327)
TRI 2023 irrigated	5650(±220)
TRI 3025 rain-fed	4176(±137)
TRI 3025 irrigated	4859(±160)
Significance	
Cultivar	0.0009
Irrigation	0.0001
Cultivar X Irrigation	0.24

Environmental factors controlling low elevation tea yield

Variable	TRI 2023 rain-fed		TRI 2023 irrigate		TRI 3025 rain-fed		TRI 3025 irrigate	
	slope	P	slope	P	slope	P	slope	P
T_{min}	6.1	0.27	13.0	0.02	4.5	0.32	9.6	0.06
T_{max}	**-28.8**	**<0.001**	**-26.4**	**0.002**	**-27.1**	**<0.001**	**-22.9**	**0.003**
Radiation	1.2	0.58	1.0	0.64	-0.09	0.64	-0.9	0.66
RF	-0.06	0.64	-0.04	0.78	0.03	0.75	0.03	0.83
Evaporation	1.4	0.42	0.9	0.59	0.15	0.91	-0.09	0.95
VPD	30.0	0.60	53.0	0.36	73.7	0.13	66.7	0.2

Stem canker infection

- Irrigation reduced the infection ~80%
- TRI 2023 highly vulnerable



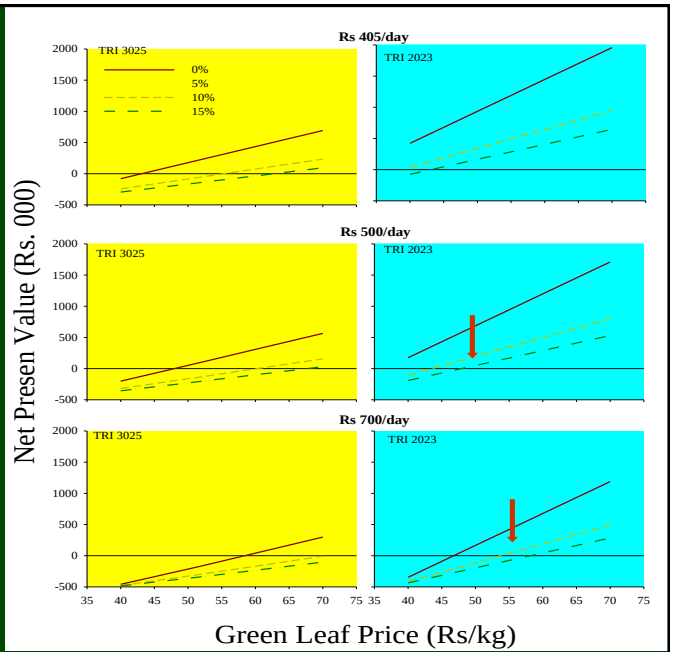
NPV analysis for TRI 2023 and TRI 3025

Year	Increased yield		Income (add.)		Cost (add.)		Net revenue		Discount Factor (10%)	NPV	
	TRI 3025	TRI 2023	TRI 3025	TRI 2023	TRI 3025	TRI 2023	TRI 3025	TRI 2023		TRI 3025	TRI 2023
Investment cost									1	-515,841	-515,841
1999/00					7433	7433	-7433	-7433	**0.91**	-6757	-6757
2000/01					5011	5011	-5011	-5011	**0.83**	-4141	-4141
2001/02	8071	10498	417271	542726	170027	219165	247244	323560	**0.75**	185758	243096
2002/03	5873	12802	303634	661843	125192	265496	178442	396347	**0.68**	121879	270710
2003/04	1908	3902	98644	201754	47381	87767	51263	113987	**0.62**	31830	70777
2004/05	3254	5448	168232	281646	72349	116771	95883	164875	**0.56**	54123	93067
2005/06	203	1148	10495	59349	7284	26419	3211	32930	**0.51**	1648	16898
2006/07	2606	5318	134730	274923	64547	119458	70184	155465	**0.47**	32741	72526
2007/08	1121	9993	57956	516623	28546	208198	29410	308425	**0.42**	12473	130802
2008/09	2691	2052	139125	106088	65490	52550	73635	53539	**0.38**	28390	20641
Net Present Value (Rs)										-57898	**391779**

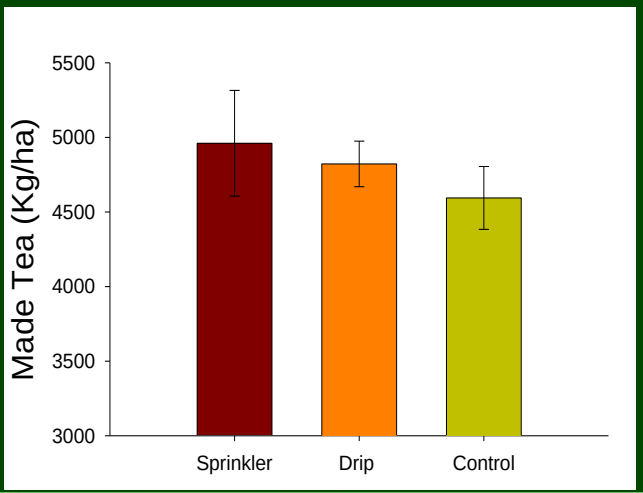
Sensitivity analysis - land

Extent (ha)	Unit cost	TRI 3025				TRI 2023			
		0%	5%	10%	15%	0%	5%	10%	15%
1	515841	25255	-93529	-247476	-369983	638180	360259	13706	-244545
2	452921	88175	-30609	-184555	-307063	701101	423180	76626	-181624
5	413168	127927	9144	-144803	-267310	740853	462932	116379	-141872
10	363168	177927	59144	-94803	-217310	790853	512932	166379	-91872
20	343168	197927	79144	-74803	-197310	810853	532932	186379	-71872

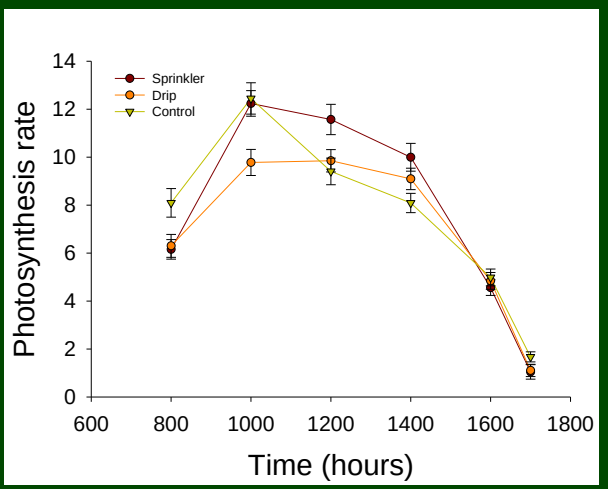
Sensitivity analysis for wage rate at different green leaf prices



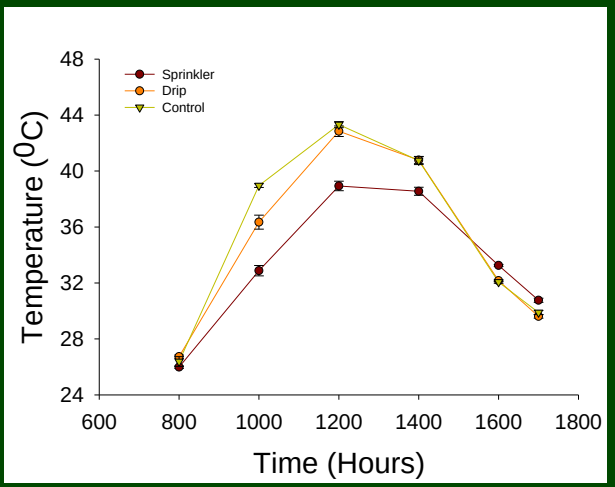
Results of Drip/Sprinkler Trial Yield 2008



Diurnal photosynthetic rate

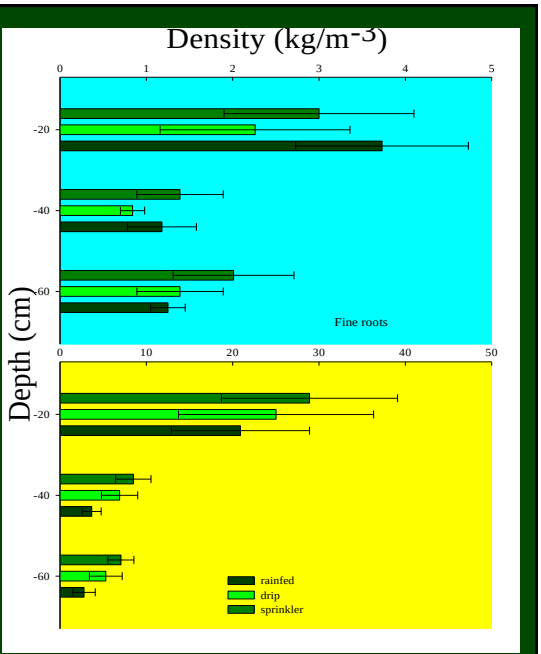


Diurnal temperature



Root Development

Root development was studied on a parallel drip sprinkler experiment.



Conclusions

- Response depends on cultivar
- High yield observed during wet season
- High temperature limits photosynthesis as well as yield
- No reduction in root development
- Drip irrigation economical only with high productive cultivars

Implications to industry

- Alternative solution to mitigate drought effect and threat posed by climate change
- Main factor availability of water sources
- Cost effective irrigation solutions are available
- Based on severity of water stress, young plant deaths and productivity, irrigation can be considered as alternative for improved performance
- New technology, like GIS can be used to identify potential areas for irrigation

Mobile irrigator

- Low cost mobile irrigation system with gun sprinkler
- Irrigation head cost approximately Rs 15000.00
- Can be operated with common 2" kerosene pump
- Application area ~ 1000m^2

Weather Forecasting

- To sense future weather patterns
- Important in deciding applications like fertilizing, planting, irrigation etc.,
- Department of Meteorology, Sri Lanka www.meteo.gov.lk
- Weather forecasting websites
  www.noaa.gov
  www.accuweather.com
  www.intellicast.com

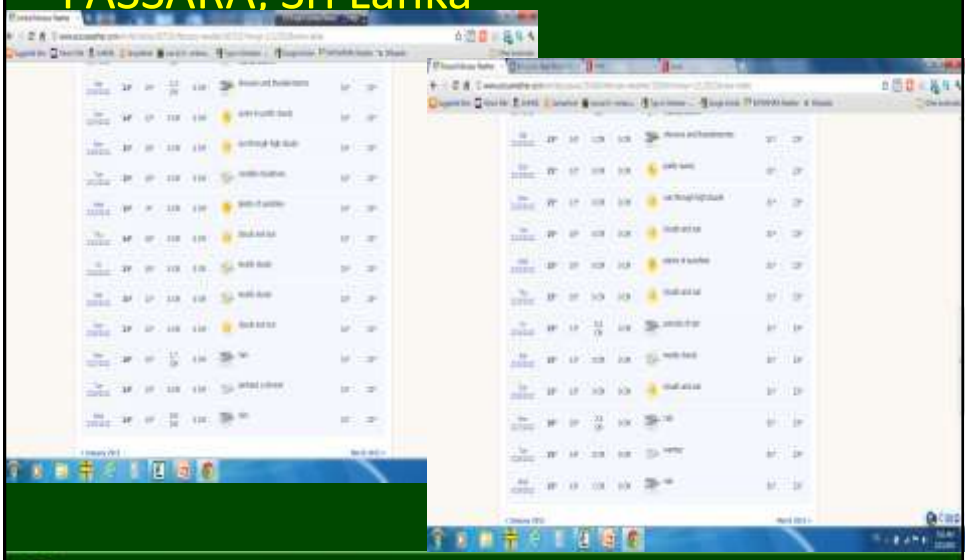
Department of Meteorology, Sri Lanka

www.meteo.gov.lk

Weather forecasting websites

www.accuweather.com

Weather forecast for LINDULA and PASSARA, Sri Lanka



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