

TECHNOLOGICALLY IMPROVED COMPOUND FERTILIZER FOR MATURE TEA FERTILIZATION.

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Brewing Innovations
1925 | TRI | 2025

Introduction



Tea fertilization has become challenging in the present scenario due to various reasons, such as high cost, low efficiency, degraded soil fertility, *etc...*



Since tea is a perennial leafy crop, grown as a monoculture, the application of fertilizer plays a vital role in its economic production



Nitrogen fertilization affects the growth, yield, and quality of made tea



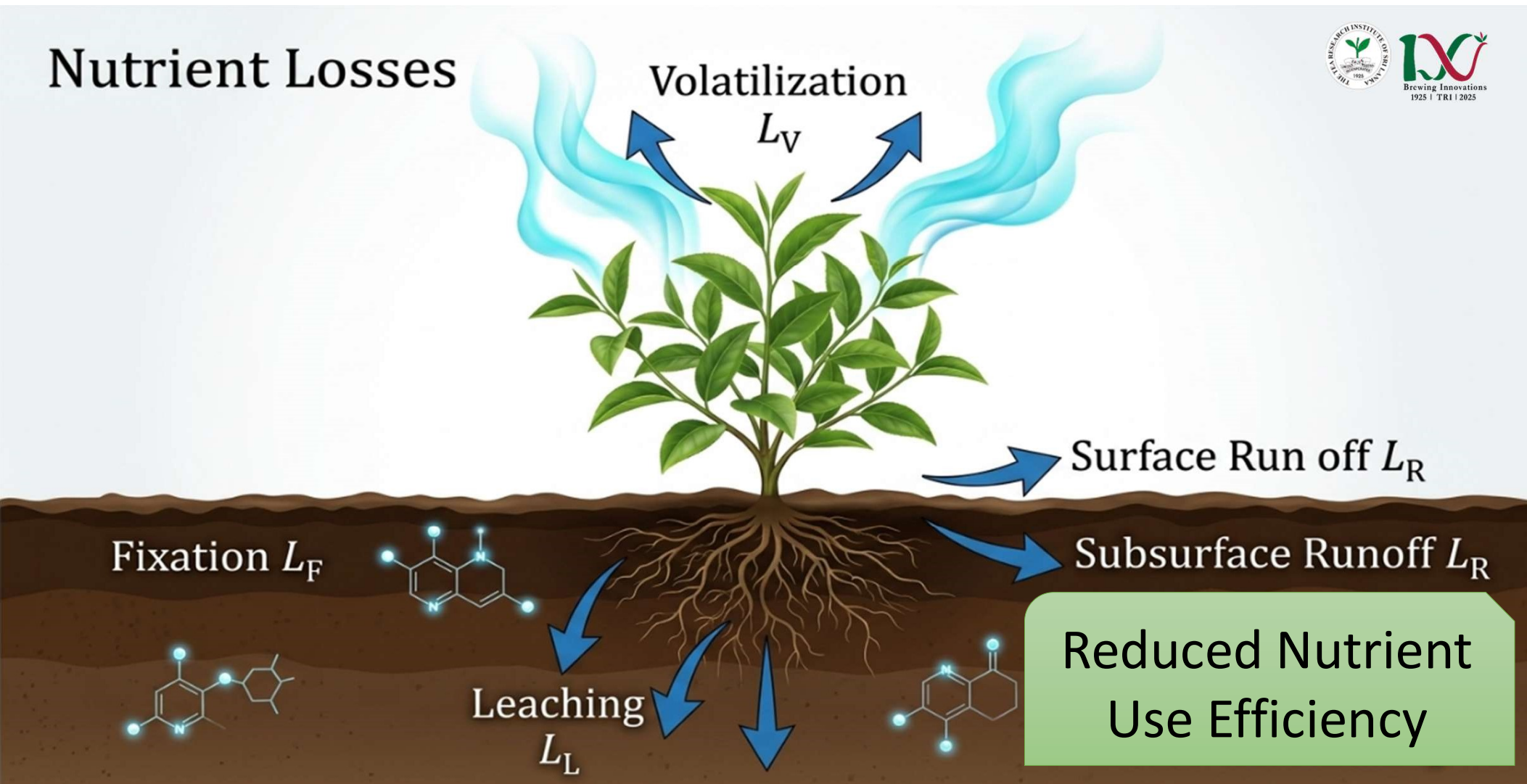
N recommended level Ranges from $90 \text{ kg N ha}^{-1} \text{ year}^{-1}$ to $400 \text{ kg N ha}^{-1} \text{ year}^{-1}$, depending on yield potential

Nutrient Removal

- Nutrient removal by different made tea yield categories and recommended nutrient quantity as fertilizer ($\text{kg ha}^{-1} \text{yr}^{-1}$)

Yield Made tea $\text{kg ha}^{-1} \text{yr}^{-1}$	N ($\text{kg ha}^{-1} \text{yr}^{-1}$)		P ₂ O ₅ ($\text{kg ha}^{-1} \text{yr}^{-1}$)		K ₂ O ($\text{kg ha}^{-1} \text{yr}^{-1}$)	
	Removal	TRI Recommendation	Removal	TRI Recommendation	Removal	TRI Recommendation
1000	64	140	16	35	34	100-140
2000	128	270	32	35	67	100-140
3000	192	360	48	35	101	100-140
4000	256	400	64	35	135	100-140

Nutrient Losses



Introduction: Global Scenario

- Average N utilization has been estimated as very low, with less than half of the applied N recovered (Bueren and Struik, 2017)
- N Use Efficiency is around 30% in China (Han *et al.*, 2008)
- As a result, the negative environmental effects of excessive fertilizer application to tea cultivation are well documented (Hirel *et al.*, 2011).

Soil acidification, acceleration of nutrient leaching, groundwater pollution and greenhouse gas emissions are some of the reported environmental impacts resulting from excessive fertilization (Rebello *et al.*, 2022)



Introduction: Local Scenario

- The Ammonium volatilization Losses (Fernando and Bhavanandan; 1971) found in tea

Urea	24-33%
Ammonium Sulfate	0.2-4.7%
Calcium Ammonium Nitrate	0.2-1.8%

- Loss of applied N in VPLC 880 mixture through leaching and volatilization was 27.6% and 21.5%, respectively (Liyanage, 2016).
- Application of conventional fertilizer in tea resulted in losses of N of 50-70% due to leaching, higher temperature & precipitation (Gunaratne *et al.*, 2016).

Introduction Cont.,

- Compound fertilizers are a type of fertilizer that contains two or more nutrients in a single granule that are chemically/physically combined, maintaining a specific ratio of the included nutrients.
- Advantages
 - Multiple nutrient supply in a single application
 - Uniform nutrient distribution
 - Improved crop yield and quality
 - Easy handling, storage, and transportation
 - Compatibility with mechanical fertilizer application systems



Introduction Cont.,

- Application of 4th Generation Yara compound fertilizer is an alternative fertilizer to increase fertilizer use efficiency while getting a yield increase.
- It contains a balanced nitrogen source, which contains nitrate N and ammoniacal N to ensure fast and sustained nutrient absorption by plants
- Produced by Yara International, Norway, and distributed by CIC Agribusiness (Pvt) Ltd in Sri Lanka



4th Generation Compound Fertilizer :

T Yara 23:7:10

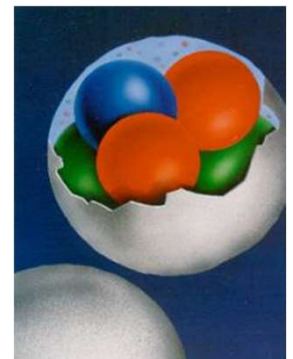
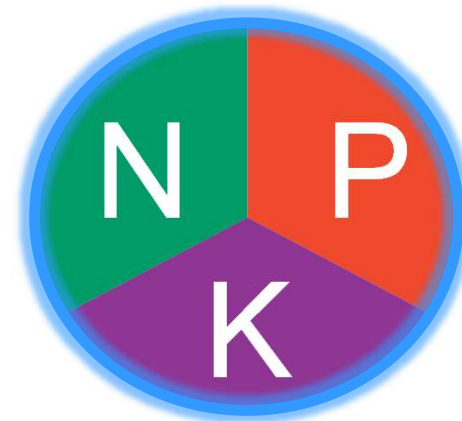


- Reduce nutrient leaching
- Reduce volatilization
- Least effect on soil acidification
- Increase soil nutrient absorption
- Fertilizer efficiency enhancement
- Reduce the fertilizer quantity
- Increase the crop yield
- Minimize the Environmental impact

Tea Yara Composition

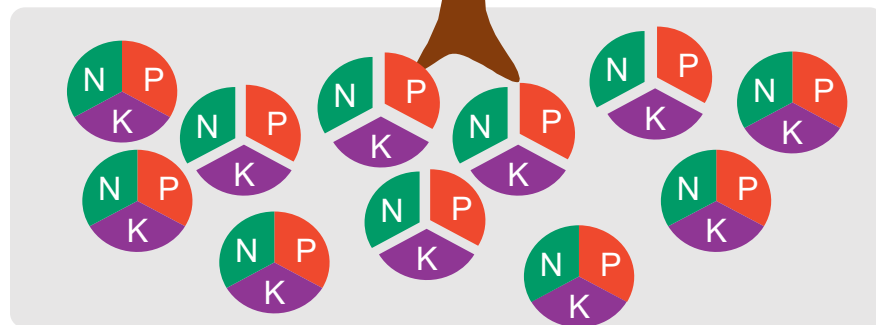
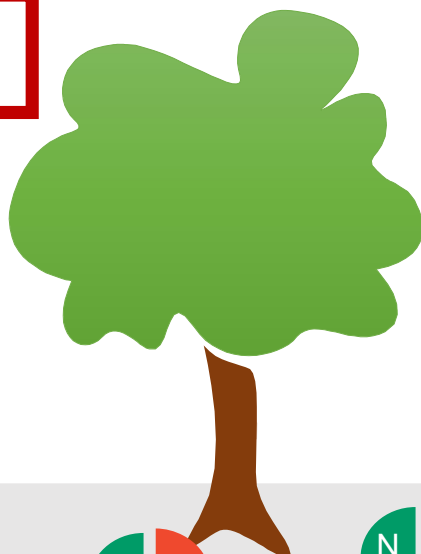
- Compound Fertilizer, which contains all nutrients in one granule at the required nutrient ratios, ensures uniform distribution, balances nutrients, and minimizes losses
- It is composed of Ammonium Nitrate, Polyphosphate, and KCl in one granule

Composition of Tea Yara	%
Nitrogen (as ammonium nitrate)	23
Phosphorus (as poly phosphate)	7
Potassium (as MOP)	10

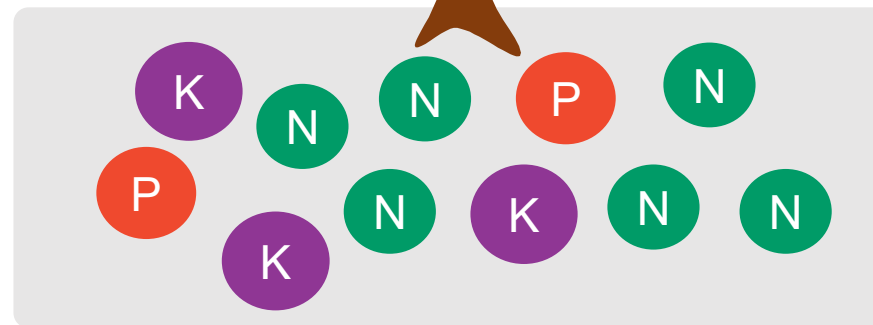


Tea Yara Nutrients Absorption

Compound Fertilizers



NPK Blend



Objectives

- To find out the effect of Tea Yara (23:7:10) Compound Fertilizer on tea yield and the quality of made tea

Specific Objectives

- To compare the effect of application of Tea Yara Compound fertilizer on soil and leaf nutrient concentrations, with the TRI-recommended fertilizer
- To find out the effect of the application of Tea Yara Compound fertilizer on the made yield compared to TRI-recommended fertilizer.
- To find out the effect of Tea Yara on the quality of made tea (total polyphenol analysis, sensory evaluation)



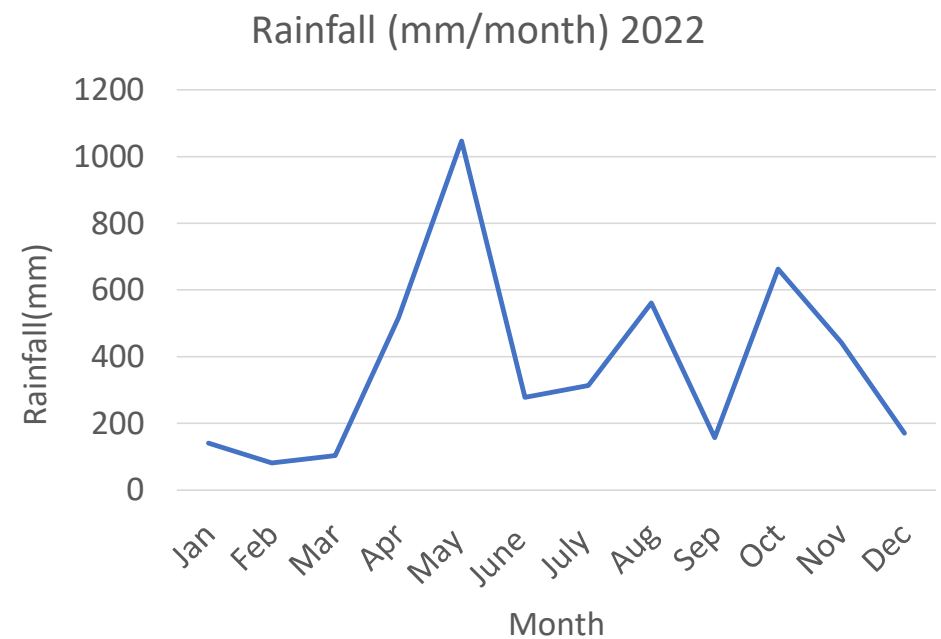
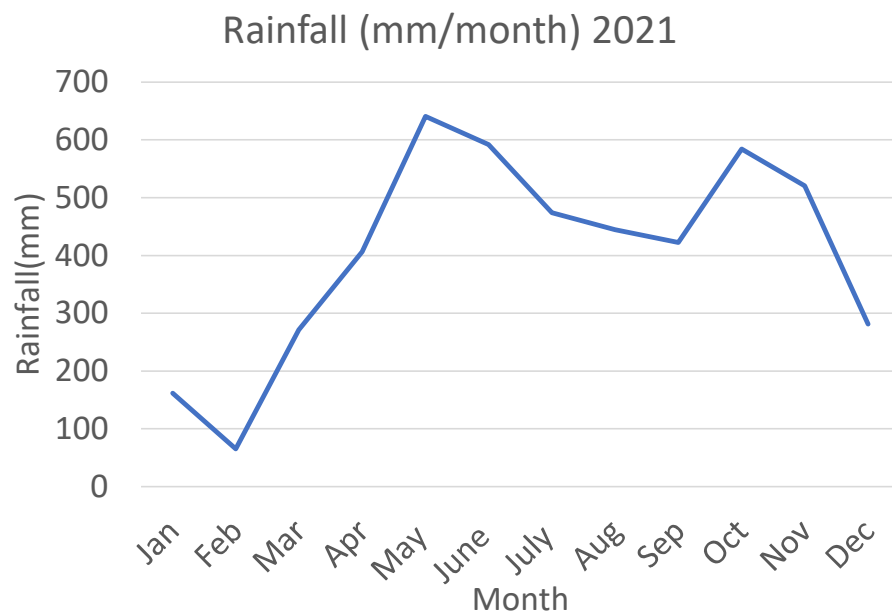
Experimental Approach

Location:
Field No 3, Galkandura
Division, Galaboda
Estate, Ratnapura
Jan-2021-Dec 2024



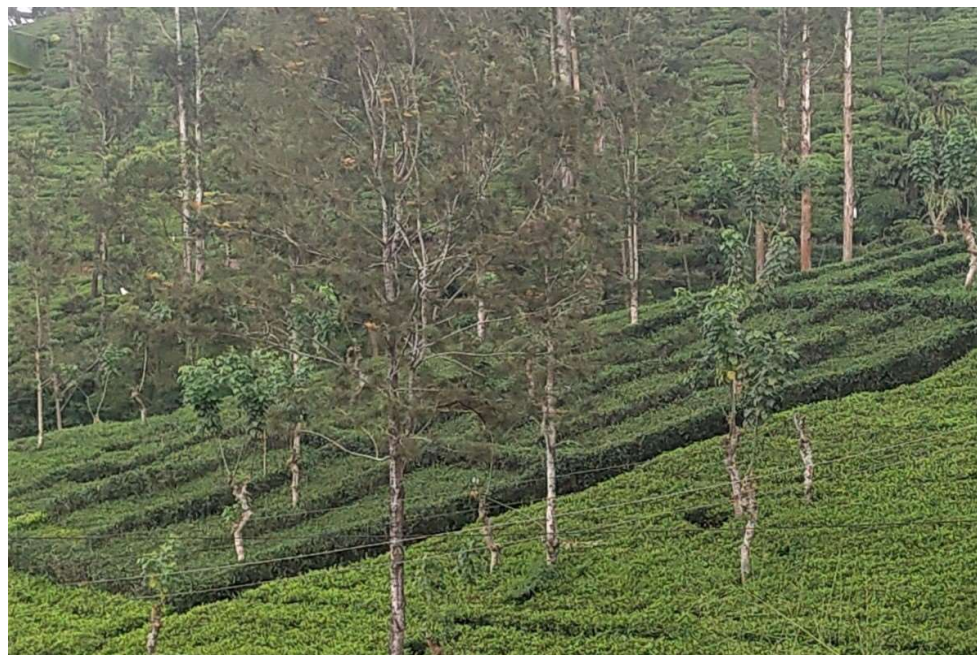
Cultivar	: TRI 2026
Experimental design	: Randomized Complete Block Design
No. of plots	: 12
No. of bushes/Plot	: 60

Monthly Rainfall Variation in the Low-Country Site



Location:

Field No. 2, New Middle
Division, Madecoombura
estate, Wattagoda
March 2021-Feb 2023



Cultivar

: TRI 4052

Experimental design

: Randomized Complete Block Design

No. of plots

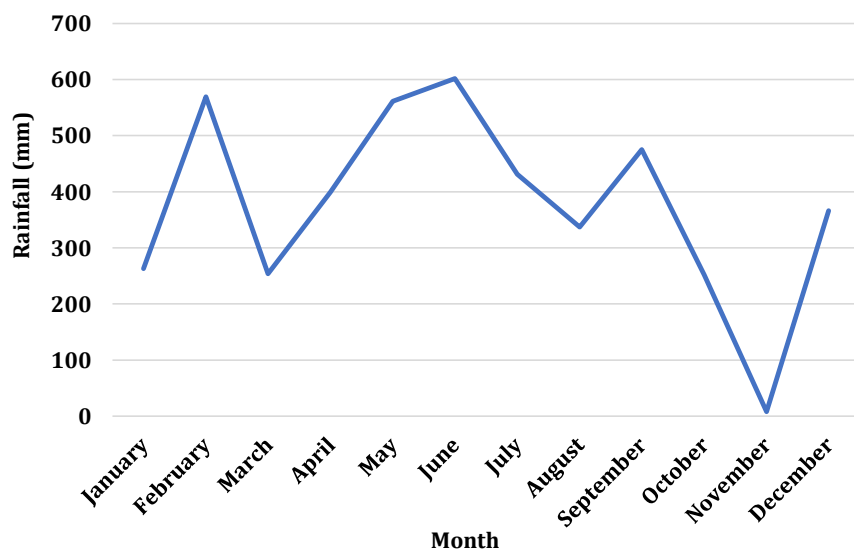
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No. of bushes/Plot

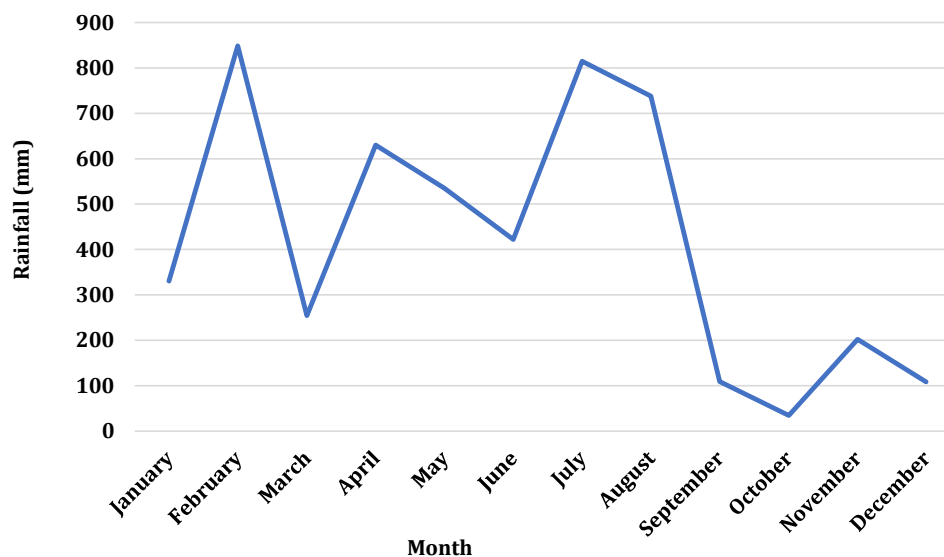
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Monthly Rainfall Variation in the Upcountry Site

Rainfall Data (mm/Month) 2021



Rainfall Data (mm/Month) 2022



Treatments

- 1 Tea Yara at 50% of the TRI-recommended N rate (135 kg of N)
- 2 Tea Yara at 75% of TRI recommended N rate (203 kg of N)
- 3 T Yara (100% Recommended N rate) (270 kg of N)
- 4 Present TRI Recommendation (VPUM 910/ VPLC 880) (270 kg of N)

Tea Yara compound fertilizer: Tea Yara (23-7-10)

TRI recommended fertilizer for up-country: VPUM 910 (29.7-3.9-13.2)

TRI recommended fertilizer for low-country: VPLC 880 (30.7-4.1-11.4)



Methods

- Pre-recording was taken for three months before the treatment application with Soil and Leaf analysis
- Soil & Leaf analysis were repeated after the treatment application annually
- Statistical analysis was done using SAS, and Mean Separation using LSD
- Yield was recorded at each plucking round throughout the experimental period
- **Phase -2**
 - A trial was conducted to assess the quality aspects of made tea from September 2023 to September 2024 for(T1)T Yara -100%, (T2)T Yara 75%, (T3)TRI VPUM 910
 - Sensory evaluation was done by professional tea tasters who are involved in tea exports



Results and Discussion

Soil Chemical Properties of the Experimental Area Before the Trial : Low-Country Trial at Galaboda Estate

Soil parameter	Test value 0-15 cm depth	Critical levels for tea (low country)
pH with water	4.55	4.50-5.50
Organic C (%)	2.72	≥ 1.50
Available P (mg/kg)	31	≥ 20
Available K (mg/kg)	116	≥ 100
Available Mg (mg/kg)	84	≥ 60
Available S (mg/kg)	176	≥ 40

All parameters tested were within the sufficient ranges

Effect of Tea Yara Application on Leaf Nutrient Concentrations in the Low-Country Trial in the **First Year**

Treatment		Leaf Nutrient Concentration (%)					
		N	P	K	Mg	Ca	S
T1	50% N Tea Yara	3.14	0.29	1.88	0.33	0.98	0.25
T2	75% N Tea Yara	3.14	0.30	2.14	0.32	0.94	0.22
T3	100% N Tea Yara	3.04	0.25	1.90	0.31	0.90	0.21
T4	VP/LC 880	3.04	0.25	1.87	0.33	1.15	0.21
Significance (P>0.05)		NS	NS	NS	NS	NS	NS

N, P and K concentrations in mother leaf are also within the sufficiency ranges of 3 - 4%, 0.15 - 0.3 and 1.25 - 2.0%, respectively (Hettiarachchi, 2008)

Effect of Tea Yara Application on Leaf Nutrient Concentrations in the Low-Country Trial in the **Second Year**

Treatment		Leaf Nutrient Concentration (%)					
		N	P	K	Mg	Ca	S
T1	50% N Tea Yara	2.82	0.26	1.55a	0.30a	1.06	0.20
T2	75% N Tea Yara	2.48	0.27	1.61a	0.29b	1.02	0.22
T3	100% N Tea Yara	2.86	0.24	1.32b	0.31a	0.96	0.22
T4	VP/LC 880	2.76	0.22	1.45ab	0.27c	0.97	0.25
Significance (P>0.05)		NS	NS	*	**	NS	NS

Mean values followed by the same letters in each column are not significantly different at 0.05 level.

Effect of Tea Yara Application on Plant Nutrient Concentrations in the Soil at 0 – 15 cm Depth at the Low-Country Trial in the **First Year**

Treatment		pH Water	pH CaCl ₂	OC %	P	K	Mg	Ca	S
		(mg kg ⁻¹)							
T1	50% N Tea Yara	4.32	3.66	2.79	22	101	69	153	403
T2	75% N Tea Yara	4.71	4.04	2.99	23	127	114	260	396
T3	100% N Tea Yara	4.86	3.82	3.08	27	102	125	531	249
T4	VP/LC 880	4.40	3.67	2.72	31	92	111	308	371
Significance (P>0.05)		NS	NS	NS	NS	NS	NS	NS	NS

Most of the plant nutrients tested are sufficiency range required for the growth of the tea plant

Effects of Tea Yara Application on Plant Nutrient Concentrations in the Soil at 0 – 15 cm Depth at the Low-Country Trial in the **Second Year**

Treatment		pH Water	pH CaCl ₂	OC %	P	K	Mg	Ca	S
		(mg kg ⁻¹)							
T1	50% N Tea Yara	4.93a	4.40a	1.70	26	111	61	215b	105
T2	75% N Tea Yara	5.05a	4.16b	2.09	47	101	79	377a	82
T3	100% N Tea Yara	4.63b	4.06b	1.65	32	105	53	202b	149
T4	VP/LC 880	4.77b	4.16b	2.00	42	102	78	350a	130
Significance (P>0.05)		*	*	NS	NS	NS	NS	*	NS

Mean values followed by the same letters in each column are not sign significantly different at 0.05 levels

Effect of Application of Tea Yara for Made Tea Yield in the Low-Country Trial

Treatment		Made tea yield (kg/ha) 2021	Percentage Increase	Made tea yield (kg/ha) 2022	Percentage Increase
T1	50%N Tea Yara	7310b	1.1	6239b	-7.2
T2	75%N Tea Yara	7877ab	8.9	7609a	13.1
T3	100% N Tea Yara	8623a	19.3	7668a	14.0
T4	VP/LC 880	7228b	-	6726b	-
Significance (P>0.05)		*		**	

Mean values followed by the same letters in each column are not significantly different at the 0.05 level

Up-country trial at Maddecoombura Estate :

Initial soil properties of the experimental area before commencement of the trial

Soil parameter	0-15 cm Depth	Critical levels in the soil for tea (Up-country)
pH with water	5.22	4.50-5.50
Organic C (%)	2.79	≥3.00
Available P (mg/kg)	23	≥20
Available K (mg/kg)	152	≥100
Available Mg (mg/kg)	69	≥60
Available S (mg/kg)	176	≥40

All parameters tested were within the sufficient ranges except OM%

Effects of Tea Yara Application on Leaf Nutrient Concentrations in Up- Country Trial in the **First Year**

Treatment		Leaf nutrient concentration (%)					
		N	P	K	Mg	Ca	S
T1	50%N Tea Yara	3.09	0.13	0.69c	0.19	1.18	0.21
T2	75%N Tea Yara	3.22	0.13	0.76bc	0.21	1.27	0.23
T3	100% N Tea Yara	3.25	0.13	0.87a	0.17	1.14	0.28
T4	VP/UM 910	2.97	0.13	0.82ab	0.19	1.12	0.25
Significance (P>0.05)		NS	NS	*	NS	NS	NS

Mean values followed by the same letters in each column are not significantly different at the 0.05 level

Effect of Tea Yara Application on Leaf Nutrient Concentrations at Up- Country Trial in the **Second Year**

Treatment		Leaf nutrient concentration (%)					
		N	P	K	Mg	Ca	S
T1	50%N Tea Yara	3.09	0.14	0.77	0.14	1.10b	0.20ab
T2	75%N Tea Yara	3.14	0.13	0.78	0.16	1.15b	0.16c
T3	100% N Tea Yara	3.24	0.13	0.77	0.15	1.13b	0.18bc
T4	VP/UM 910	3.11	0.13	0.79	0.16	1.33a	0.23a
Significance (P>0.05)		NS	NS	NS	NS	*	*

Mean values followed by the same letters in each column are not significantly different at the 0.05 level

Effect of Tea Yara Application on Plant Nutrient Concentrations in Soil at 0 – 15 cm Depth in the Up-Country Trial in the **First Year**

Treatment		pH Water	pH CaCl ₂	OC %	P	K	Mg	Ca	S
					(mg/kg)				
T1	50% N Tea Yara	4.23	3.81	2.54	131	166	41	349	70
T2	75% N Tea Yara	4.04	3.63	2.53	100	186	8	496	73
T3	100% N Tea Yara	4.25	3.85	2.53	109	211	52	557	68
T4	VP/UM 910	3.87	3.59	2.48	97	211	49	359	82
Significance (P>0.05)		NS	NS	NS	NS	NS	NS	NS	NS

Effect of Tea Yara Application on Plant Nutrient Concentrations in Soil at 0 – 15 cm Depth in the Up-Country Trial in the **Second Year**

Treatment		pH Water	pH CaCl ₂	OC %	P	K	Mg	Ca	S
					(mg/kg)				
T1	50% N Tea Yara	4.41b	3.93	2.29	131a	128	35	310	58ab
T2	75% N Tea Yara	4.79a	4.02	2.22	100b	102	46	308	67ab
T3	100% N Tea Yara	4.70a	3.04	2.59	109ab	134	46	425	42b
T4	VP/UM 910	4.54ab	3.90	2.30	97b	126	27	288	88a
Significance (P>0.05)		*	NS	NS	*	NS	NS	NS	*

Mean values followed by the same letters in each column are not significantly different at the 0.05 level

Effect of Tea Yara on Made-Tea Yield in the Up-Country Trial in the First and Second Years

Treatment		Made tea yield (kg/ha) 2021	% Increase	Made tea yield (kg/ha) 2022	% Increase
T1	50%N Tea Yara	6409	3.8	6673ab	9.8
T2	75%N Tea Yara	6511	5.5	7098a	16.8
T3	100% N Tea Yara	6477	4.9	6172bc	1.5
T4	VP/UM 910	6170	-	6077c	-
Significance (P>0.05)		NS		*	

Mean values followed by the same letters in each column are not significantly different at the 0.05 level

Phase – 2 Study

- **Effect of Tea Yara fertilizer on the quality of tea -*Total Polyphenol (TPP) analysis***
- Effect of Tea Yara application on TPP content (W/W_d %) of made tea

Treatment	Wet season			Dry season		
	Week 1	Week 2	Week 3	Week 1	Week 2	Week 3
T1	18.20	17.10	20.30	21.50	21.20	20.10
T2	17.60	18.00	21.70	17.30	22.20	20.50
T3	18.10	17.00	21.00	18.40	18.10	19.30
Significance	NS	NS	NS	NS	NS	ns

- T1- Tea Yara 100% Recommended N Rate
- T2- Tea Yara 75% Recommended N Rate
- T3- Present TRI Recommendation- VPUM 910

Sensory Evaluation of Made Tea by 3 Experts

- Effect of Tea Yara application on TQS (Total Quality Score) of made tea

Treatment	Wet season			Dry season		
	Week 1	Week 2	Week 3	Week 1	Week 2	Week 3
T1	17	15	17	17	18	20
T2	15	15	17	18	19	20
T3	16	15	16	18	19	18

T-1, 100%, T2 -75% Values were comparable with T3 (VPUM 910)

1. Cost-benefit Analysis of Tea Yara Application in the Low-Country Tea Field

Treatments	Total cost (Rs/ha)	Revenue (Rs/ha) at Rs. 1308.46/kg of made tea	Producer Margin (Rs/ha)	Rank based on Producer Margin
T1 -50%N Tea Yara	2,788,968	4,752,327	1,963,359	4
T2 - 75%N Tea Yara	3,145,308	5,173,651	2,028,343	2
T3 - 100% N Tea Yara	3,440,150	5,462,821	2,022,670	3
T4 - VP/LC 880	2,751,233	4,858,312	2,107,079	1

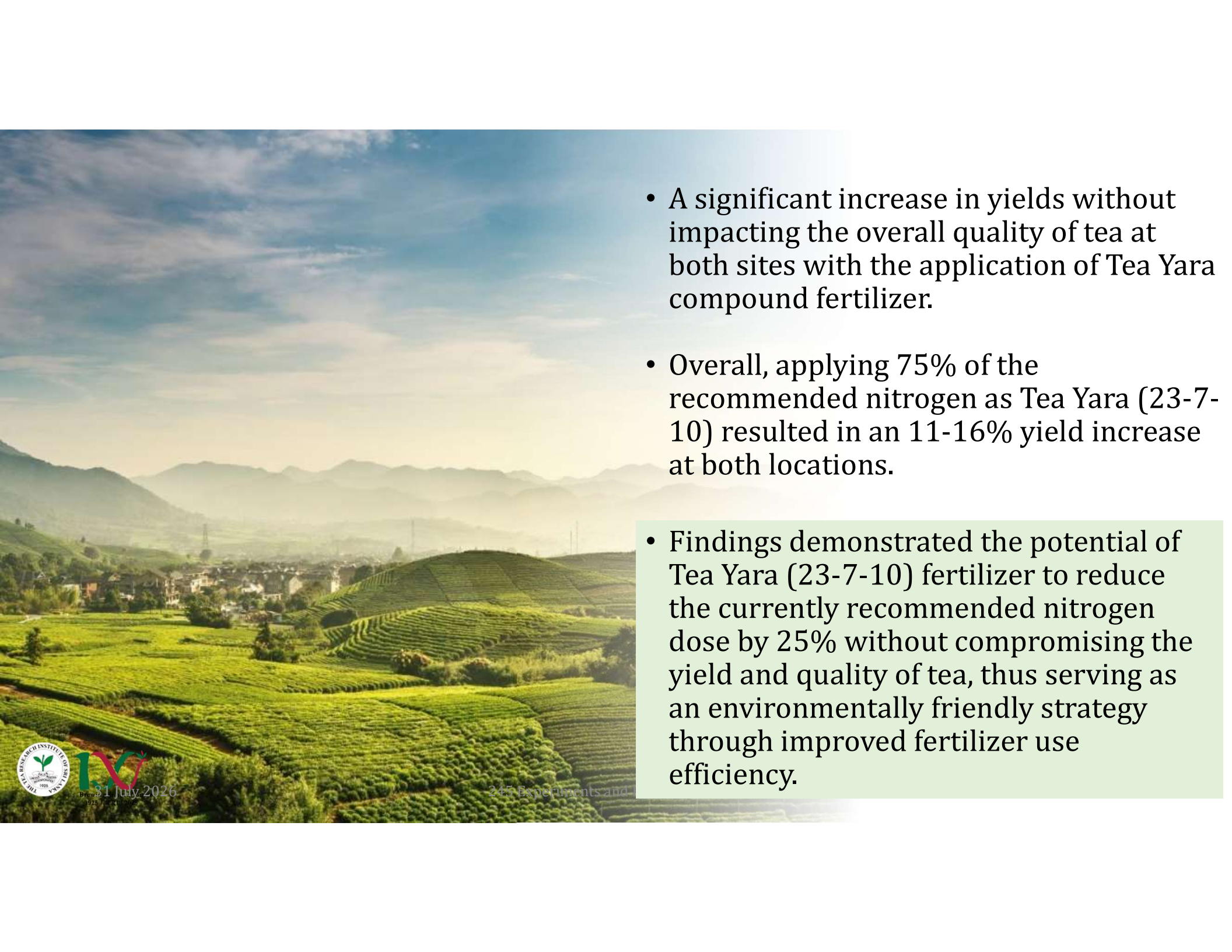
Costing was done only for measurable parameters; parameters such as benefits to the environment were not included in the analysis

Cost information is as of 2024.

2. Cost-benefit Analysis of Tea Yara Application in the Up-Country Tea Field

Treatments	Total cost (Rs/ha)	Revenue (Rs/ha) at Rs. 1142.60/kg of made tea	Producer Margin (Rs/ha)	Rank based on producer Margin
TI -50%N Tea Yara	4,432,324	7,473,747	3,041,422	1
T2 - 75%N Tea Yara	4,903,244	7,774,822	2,871,577	2
T3 - 100% N Tea Yara	4,768,995	7,226,374	2,457,379	4
T4 - VPUM/910	4,244,823	6,996,711	2,751,888	3

Conclusions and Recommendations

- 
- A significant increase in yields without impacting the overall quality of tea at both sites with the application of Tea Yara compound fertilizer.
 - Overall, applying 75% of the recommended nitrogen as Tea Yara (23-7-10) resulted in an 11-16% yield increase at both locations.
 - Findings demonstrated the potential of Tea Yara (23-7-10) fertilizer to reduce the currently recommended nitrogen dose by 25% without compromising the yield and quality of tea, thus serving as an environmentally friendly strategy through improved fertilizer use efficiency.



31 July 2026

245 Experiments and

Guideline 02/2026



Tea Research Institute of Sri Lanka

Technologically Improved Compound Fertilizers for Mature Tea Fertilization

Issued in : March 2026

Guideline No: 02/26

Tea-growing soils in many parts of the country have become severely degraded due to both natural processes and human activities. As a result, the nutrient retention capacity of the soil has been severely depleted, leading to increased nutrient losses from applied fertilizers. As a result, fertilizer use efficiency is affected, thereby reducing tea crop productivity. The application of integrated nutrient management techniques helps increased nutrient retention in the soil. In particular, the addition of organic matter enhances the formation of clay-humus complexes, enabling the soil to retain more positively charged nutrients.



2026
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- Managers and their field staff of Madakombora Estate and Gallabodde Estate for their valuable support extended for the field trials.
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- The services of professional tea tasters involved in sensory quality assessment are much appreciated.

Thank You!