Growth and resource use of young rubber (*Hevea brasiliensis*) on hillsides in northern Thailand

Nuttapon Khongdee[1], Wanwisa Pansak[1] and Thomas Hilger[2]
[1]Department of agricultural science, Faculty of agriculture, natural resources and environment, Naresuan University, Thailand
[2]Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute), Section Agronomy in the Tropics and Subtropics (490e), University of Hohenheim, 70599 Stuttgart, Germany

Introduction

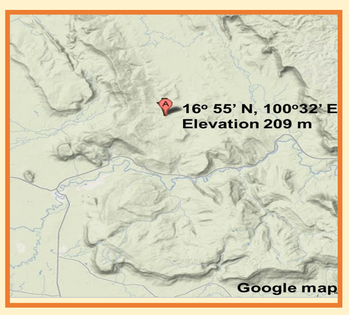
In the past decade, rubber production largely expanded into the uplands of northern Thailand, substituting primary forests. Without proper soil conservation, monocropping of rubber generates soil loss in the magnitude of 14 Mg ha^{-1} in upland areas (Khamkajorn *et al*, 2014). Growing rubber together with either annual crops and/or cover crops is a way to decrease such environmental impacts.

Objectives

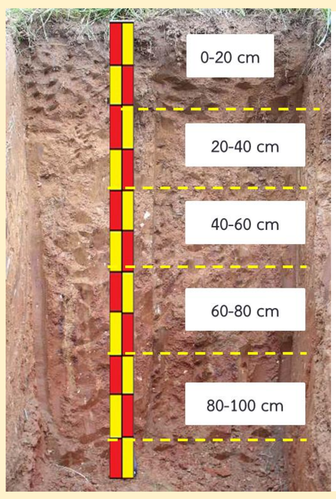
- Evaluate rubber growth and nutrient uptake under soil conservation practices
- Identify cropping options for non-traditional extension areas

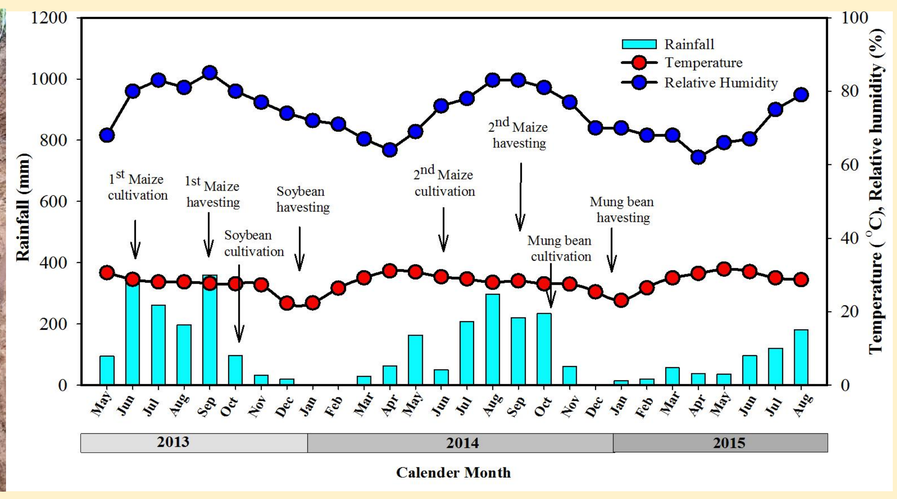
Materials and Methods

Site description



- Wang Thong district (16˚55' N, 100°32' E), Phitsanulok province, Thailand.
- Slope gradients:18 - 20%
- Elevation is 209 m a.s.l.
- Tropical savannah (AW) climate
- Annual rainfall: ~1200 mm
- Temperature range 23- 33°C





- Fine-loamy, mixed, semiactive, isohyperthermic Typic Haplustults
- Parent material: residuum from sandstone
- Texture: clay loam
- Soil depth: 70 cm
- Strongly acid (pH 5.5)

Experimental design & treatments

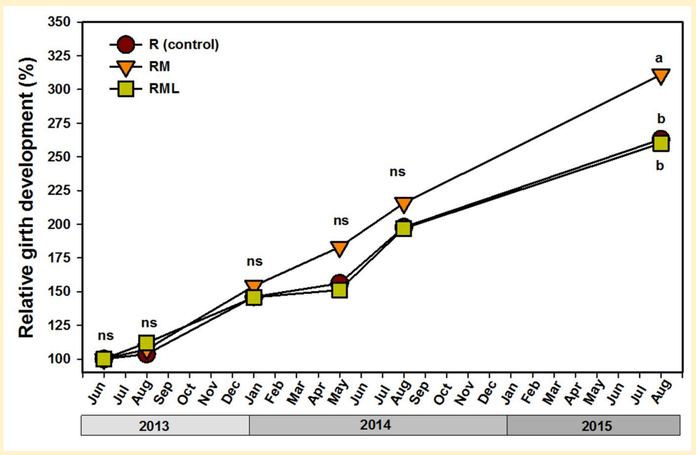
- Plot size: 9 x 10 m
- Trial established in 2013 when rubber (RRIM 600) was 3 years old
- Tree spacing: 3 x 7 m.
- Trial layout: randomized complete block design; 3 treatments, 3 reps.
- Soil and leaf sampling for nutrients analysis.
- Crop growth measurements.

(i) Sole rubber

(ii) Rubber+Maize

(iii) Rubber+Maize+Legumes

Result



Relative rubber girth development during June '13 and August '15

Soil and rubber leaf nutrient concentrations. Data are averages of 2014

Treatments	Soil nutrients									
	C	N	C/N	P_{av}	K_{ex}	Ca_{ex}	Mg_{ex}	K/Mg	K/Ca	Mg/Ca
	------(%)------			----------(mg kg^{-1})----------						
Control	1.26	0.14	8.93	2.85	387	95	245	1.67	4.47	2.63
RM	1.18	0.13	8.89	3.16	466	93	203	2.22	5.22	2.44
RML	1.22	0.13	9.17	2.74	396	76	203	1.93	5.26	2.72
F-test	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Treatments	Plant nutrients in rubber leaf									
	C	N	C/N	P_{av}	K_{ex}	Ca_{ex}	Mg_{ex}	K/Mg	K/Ca	Mg/Ca
	---------(%)---------			----------(%)----------						
Control	47.68	2.87b	16.86a	0.17b	0.21b	0.09	0.45a	0.48b	2.72	5.75
RM	47.71	3.11a	15.55b	0.24a	0.25a	0.09	0.39b	0.81a	3.73	5.24
RML	48.17	3.04ab	16.30ab	0.23a	0.26a	0.09	0.35b	0.87a	3.65	4.95
F-test	ns	*	*	*	*	ns	*	*	ns	ns

ns = Non-significant at $p > 0.05$; * = Significant difference of average value among treatments ($p < 0.05$); Different letters within the column showed the significant difference of average values among the treatments by DMRT ($p < 0.05$).

Comparison of soil and leaf values with the standard recommendations of the Rubber Research Institute (Suchartgul et al., 2012)

Soil properties	Optimum range	Observed values in the rubber plantation					
		Sole rubber			Rubber intercropping		
		Low	Optimum	High	Low	Optimum	High
Carbon (%)	0.05-0.15			●			●
Nitrogen (%)	0.11-0.25		●			●	
Phosphorus (mg kg^{-1})	10-20	●			●		
Potassium (mg kg^{-1})	150-250			●			●
Calcium (mg kg^{-1})	50-70	●			●		
Magnesium (mg kg^{-1})	>117		●			●	
K/Mg	3.0-4.2	●				●	
K/Ca	0.8-1.4			●			●
Mg/Ca	0.3-0.5			●			●

Leaves properties	Optimum range*	Observed values in the rubber plantation					
		Sole rubber			Rubber intercropping		
		Low	Optimum	High	Low	Optimum	High
Nitrogen (%)	3.2-3.8	●			●		
Phosphorus (%)	0.25-0.30	●			●		
Potassium (%)	1.0-1.4	●			●		
Calcium (%)	1.0-1.5	●			●		
Magnesium (%)	>0.35		●			●	
K/Mg	3.4-4.2	●			●		
K/Ca	0.8-1.4			●			●
Mg/Ca	0.3-0.5			●			●

Conclusion

The soil and water conservation systems tested provide a fair resource use and improve economic output, avoiding negative environmental impacts. Rubber intercropping with annual crops is, hence, a viable alternative for farmers in non-tradional cropping areas.

Reference

Khamkajorn, T., Pansak, W., Takrattanararan, N. and Homhual, W. (June 8-13, 2014). Erosion in hillside Para Rubber Plantation of Northern Thailand as Affected by Soil Conservation Measures: A Case Study. In **The 20th World Congress of Soil Science.** Korea: Jeju.

Suchartgul, S., Maneepong, S. & Issarakrisila, M. 2012. Establishment of standard values for nutritional diagnosis in soil and leaves of immature rubber tree. *Rubber Thai Journal*, 1, 19-31.