A qualitative assessment of the N Status of Young Rubber Trees as Affected by Interrank Crops in Northeast Thailand

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Abstract
Chlorophyll-meter readings on leaves and measurements of trunks girth of five years old rubber trees (*Hevea brasiliensis*) were carried out during the rainy season 2009 within an experiment comparing three treatments, at two positions in a landscape of Northeast Thailand: i) a rank of trees without cover crop in both inter-ranks surrounding it, ii) a rank of trees with *Pueraria phaseoloides* and iii) a rank of trees with *Vetiveria zizanioides* in the inter-ranks. These perennial inter-rank cover crops were set up from 2007 and they were cut and their residues spread as mulch at the soil surface every three months. In 2009, rubber trees growing with Pueraria in their interranks had the highest rate of growth and SPAD values. Differences between treatments were smaller upslope than downslope where the soil water reserve was higher. These results suggest that despite the chemical fertilizer application, N nutrition rather than water could be the most limiting factor for the growth of rubber trees in some fields of this area. Managing a legume cover crop in their interranks could be an interesting option.

Key Words
Agroforestry, competition, spectral reflectance, N uptake, litter mineralization, toposequence, sustainable agriculture.

Introduction

Soils of Northeast Thailand are described as low fertility because of their coarse texture, low nutrient availability, strong weathering and erosion risks. Introducing cover crops in the inter-ranks of young rubber tree (RT) plantations would protect the soil against erosion. Moreover, the mulching of their residues would help to conserve the soil moisture, to recycle soil organic matter and supply high amounts of nitrogen to the trees, particularly in the case of legume residue (Rubber Research Institute of Thailand 2005). These changes could result in higher growth and yield for the RT. However, some possible drawbacks of growing cover crops in the inter-ranks of young RT should be managed, as for example, the risk of competition for water, and nutrients by these cover crops at some periods of the year.

The chlorophyll-meter is an efficient tool for evaluating plant N status, and for managing N fertilizer application for various annual crops (Mistele and Schmidhalter 2008), to our knowledge, no study has been carried out on its use for RT. The characterization of the nutrient status of RT is classically based on the analysis of the nutrient content of the leaves (Watson 1989), this method is destructive, time consuming and expensive in comparison to the chlorophyll-meter method. Comparisons of the chlorophyll-meter readings (Soil-Plant Analysis Development (SPAD) readings) between RT with and without cover crops in their interranks, could be an easy way to classify the treatments according to the N nutrition of the trees, and to give an insight into the impact of the associated cover crops. The highest values of SPAD recorded for this RT clone growing in conditions where neither water or nutrients were limiting (Shapiro and Francis 2006) could be considered as the potential value of the SPAD and be used as an indicator of the nutrient status of RT in farmers' fields of this area. A quantitative assessment of the N uptake by the trees could be based on the equation linking the SPAD readings with the N content in the tree leaves.

The objectives of this study are: 1) evaluate the impact of two inter-ranks cover crops on the SPAD readings on leaves of a young RT plantation in northeast Thailand, 2) examine the relationship between SPAD readings and growth of RT as affected by soil water availability at two position of a toposequence.

Methods

The experiment was conducted at Ban Non tun, Nongwaeng subdistrict, Phra Yuen district, Khonkaen province, Thailand, during 2008-2009. Chemical characteristics of the top soil (0-15 cm) were as follows : pH, 5.5 (1:1 soil:water); available P, 3 mg/kg (Bray II method); available K, 21 mg/kg (NH_4OAc method) and organic matter 4.0 g/kg (wet digestion). The proportions of sand, silt and clay in the soil were 87, 11 and 2% respectively. Total rainfall was 1957 mm in 2008 and 994 mm in 2009. Most of this amount fell from July to November. The risk of water stress is particularly high in the upslope, where the soil is very shallow with the presence of sandstone at less than 80 cm, whereas at the bottom, it is at about 200 cm depth. From August to November 2009, the soil water tensions at 10, 25 and 65 cm depths were all above -100 mbar whatever the position in the toposequence, whereas the highest basal leaf water potential of the RT stands reached -3 bars and were recorded only from the month of September to November.

The experimental design was a randomized complete block. The treatments were i) T1= Rubber trees alone (control), ii) T2 = Rubber trees + Pueraria and iii) T3= Rubber trees + Vetiver. Each treatment comprised a row of 20 trees, and was replicated on the top and the bottom of the field of 3% slope. The rubber trees were three years old at the start of the experiment. Rows of trees were on bunds of 2 m width and 0.15 m height. The trees were 3 m apart in the ranks. The cover crops were planted on July 2007 on the inter-rows of 7 m large. The cover crops did not receive any fertilizer application whereas the trees received annually 180 g/tree of chemical fertilizer (formula 20-10-12% N-P_2O_5-K_2O). The perennial cover crops were cut every three months and their residues applied as mulch on the soil surface of the inter-rows. The girth of rubber trees were measured about each 15 days at 1.50 m from the soil. The leaf greenness was measured from March to November 2009 with a chlorophyll- SPAD- 502, at 1 month interval on six fully expanded leaves per plant. Four replications of each leaf were measured. The same leaves were monitored during all the period of the study. These leaves appeared in February 2009 and most of them fell in early January 2010.

Results

Effect of interrank crops on growth of rubber trees

The results showed that rubber trees with Pueraria have higher rate of growth of their trunks than in the control and the vetiver grass treatments. Differences between treatments are higher and start earlier downslope than upslope. Downslope, not only the Pueraria, but also the Vetiver were associated with higher rates of growth of the trees (Figure 1).

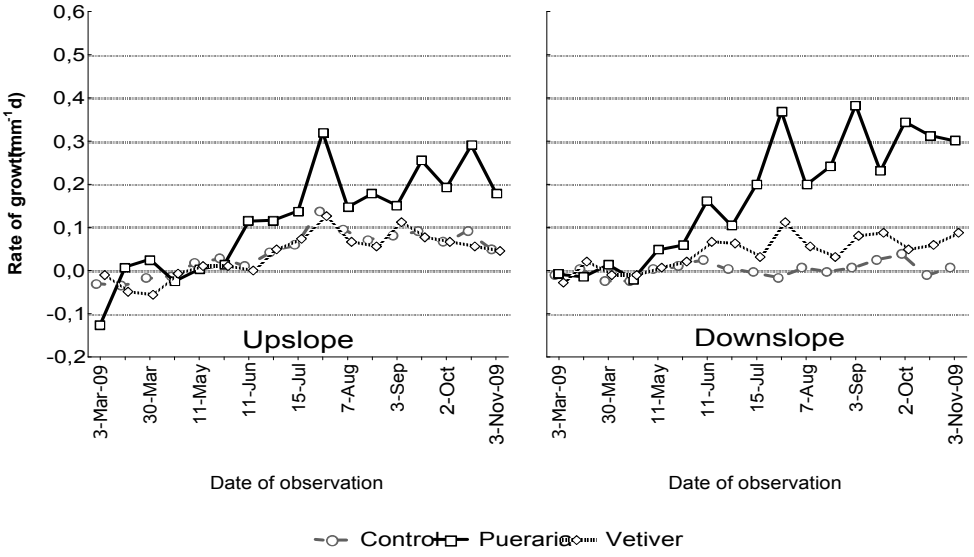

Figure 1. Rate of Growth of Rubber tree trunks at 50 cm from soil surface

Effect of interrows crops on SPAD readings of rubber trees leaves

Figure 2 shows that the rubber trees with Pueraria has higher SPAD units than the Control and Vetiver grass treatments, especially downslope. The bumpy ascending course of the SPAD unit plot for the rubber trees growing with Pueraria could be due to the effect of the nutrients released after cutting the Pueraria. This trend is particularly marked downslope where the highest soil water availability probably allowed highest recovery by the trees of the N released by the legume residues. A high difference in the delay of the residue

effects on the RT SPAD units may exist between treatments, as their C/N ratio are very different. The study of Suvannang *et al*. in this congress indicated that the legume cover had a C/N ratio of 15 while that of the vetiver grass was about 66. The high decrease recorded in September for the SPAD of the rubber trees growing with vetiver upslope is surprising however high competition for nutrients exerted by the grass, which was at the flowering stage at this date, could have occurred. The effect of the chemical N fertilizer application on the rubber trees SPAD is not apparent, probably because the nitrogen has been rapidly leached by the heavy rains of May 2009.

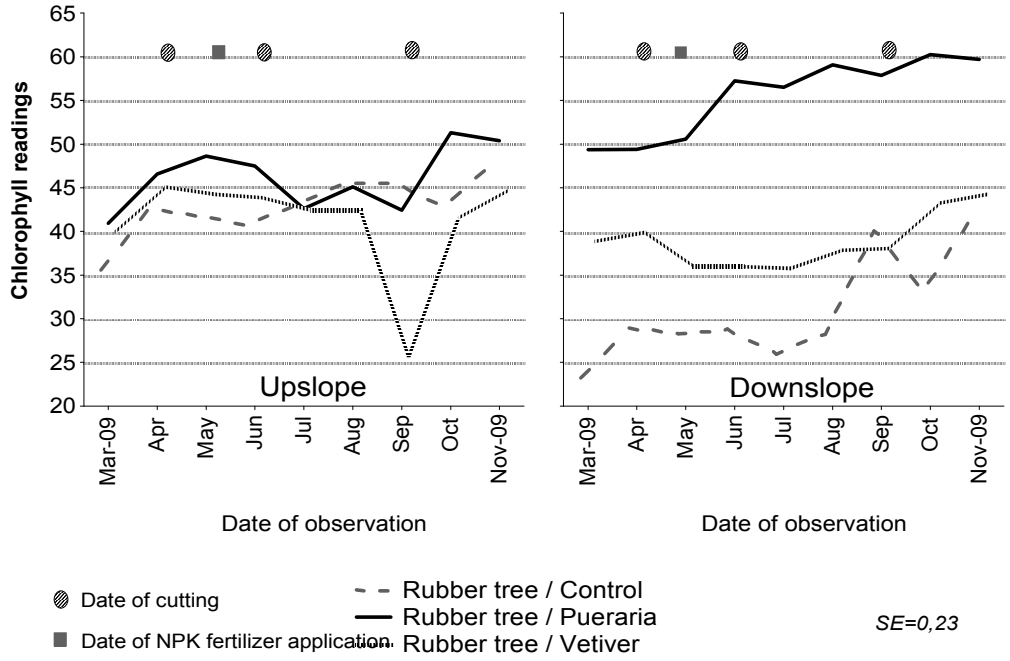

Figure 2. Chlorophyll readings evolution as affected by inter-row management and field position in the toposequence.

Relation between growth rate and SPAD

From the month of September until November, the basal leaf water potential of the RT was above -3 bars. Therefore there is a only low probablity that water had been limiting for the tree growth at this period, whatever their position in the toposequence. Figure 3 showed that during this period however, the higher the SPAD, the higher was the rate of growth of RT.

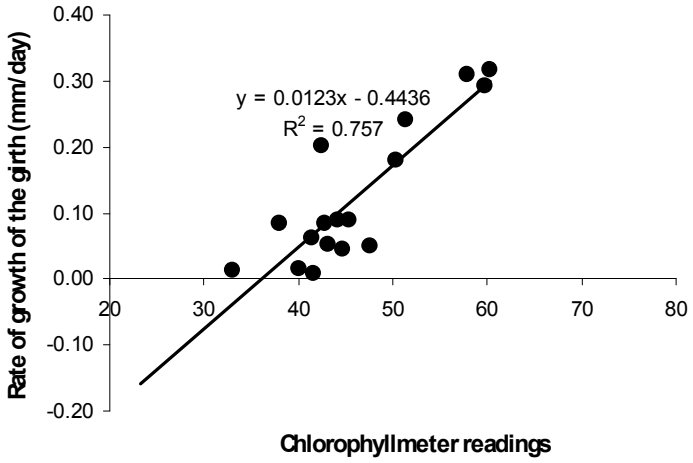

Figure 3. Growth rate of RT trunks as affected by SPAD readings over the period from September to November (Basal leaf water potential of RT was above -3 bars during all this period)

Conclusion

Using the SPAD readings as an indicator of N status of rubber trees, this study showed that the introduction of cover crops in the interranks of rubber trees growing in the bottom of a toposequence was associated to

higher N nutrition and growth of the trees. N nutrition rather than water could be the most limiting factor for the rubber trees growing in some fields in Northeast Thailand.

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