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Role of Upland Rice on Sustainability and Food Security of Sugarcane Production System

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Abstract. This experiment aimed to study the effects on soil chemical properties of some proceeding crops grown in rotation during the gap period between the last ratoon cane harvest and the next sugarcane planting. The experimental design was RCBD with 4 replications. The implemented treatments were: (i) control (ii) upland rice (iii) soybean and (iv) sunn hemp. During the preceding crops growing period, soils (0-15 cm) were sampled at the week 1, 2, 4, 8 and 16 after planting for soil mineral N analysis. At the final preceding crop harvest, soil samples were collected at 0-15 cm soil depth for chemical analysis and the crops were evaluated for yields, the stovers were collected and incorporated before sugarcane planting. Obtained results revealed that soil in this experiment was sandy soil and low in fertility. During the preceding crops growing period, soil mineral N of all treatments at 0-15 cm soil depth were higher than those before the preceding crop planting, especially upland rice and soybean treatments. At the final harvest, the upland rice treatment had grain yield of 2.86 t ha-1. Soil data at harvest before sugarcane planting indicated that organic matters were not significantly different among treatments. However the upland rice treatment had considerably higher available P content than the other treatments. Moreover upland rice treatment provided the highest exchangeable Ca but it was not significantly different from those in the control and sunn hemp treatments. Thus, upland rice is one of the alternative crops that can be grown as a preceding crop before the next sugarcane planting cycle. It would not only increase the economical income of the farmer but also provide more household food supply and thus might lead to enhance food security in sugarcane cropping system.

Keywords: soil fertility, soil mineral N, grain yield, soil available P

1. Introduction

The northeast of Thailand is the region which produces the most sugarcane in the country. The soil in the region are sandy and low in organic matter and only one or two ratoon crops can be harvested. Generally, the farmers plant sugarcane during October to December and harvest in December to April of the following year. Hence, the period between the last ratoon crop harvest and the next sugarcane planting, there is a 6–8 months time gap. This period will cover one whole rainy season and is considered to have a potential for crop rotation. Soil fertility can be improved, when a legume crop is grown and ploughed under during this period [1]. However, growing a legume crop may not always provide food security for the farmers [2]. Upland rice is one of the crops that can be grown under rainfed upland conditions [3] and this management practice may not only improve soil fertility and sustainability of sugarcane planting system but also enhance food security for farmers' households. The objective of this experiment is to study the effect of some preceding legumes and upland rice planting on soil chemical properties before succeeding sugarcane planting.

2. Materials and methods

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The experiment was conducted in a farmer's field at Khon Khen province in northeastern Thailand from June to mid-October 2011. The experimental design was RCBD with 4 replications. The implemented treatments were:

(i) control

Weeds were allowed to grow without weed control.

(ii) upland rice

Upland rice was planted at 25x25 cm spacing. Chemical fertilizers were applied at recommended rate (31.6 kgN ha-1, 31.25 kg P2O5 ha-1 and 31 kg KCl ha-1)

(iii) soybean

Soybean was planted at 50x20 cm spacing. Chemical fertilizers were applied at 18.75 kgN ha-1, 37.5 kg P2O5 ha-1 and 18.75 kg K2O ha-1

(iv) sunn hemp

Sunn hemp seeds were sown at a recommended rate (31.25 kg seed ha-1).No chemical fertilizers were applied.

2.1. Data collection

The soils samples were collected for chemical properties analysis before experiment (0-15 cm soil depth). During the preceding crop growing period, soils were sampled from upper soil depth (0-15 cm depth) at weeks 1, 2, 4, 8 and 16 after planting for soil mineral N analysis by Flow Injection Analyzer (FIA). At the final harvest, soil samples were collected at 0-15 cm soil depth for chemical analysis and the crops were evaluated for yields, the stovers were collected and incorporated before sugarcane planting.

2.2. Data analysis

Data were subject to a randomized complete block (4 replications) analysis of variance. One factor ANOVA was used to analyze the main effect of the treatments and standard error of the difference (SED) between treatment means are presented

3. Results and Discussion

3.1. Soil before experiment

Soil characteristics of the experimental site were (0-15 cm): soil texture was sandy with 95.96% sand, 2.93% silt and 1.11% clay, soil pH was 5.49 (1:1 water), CEC 2.50 me 100g-1, EC 0.01 mS cm-1, organic matter 0.34 mg kg-1, available P 17.06 µg kg-1, exchangeable K 31.72 µg kg-1 and exchangeable Ca 92.50 µg kg-1.

3.2. Mineral N during the preceding crop growing period

Mineral N of soybean treatment gave the significant highest value ($P \leq 0.01$) at week 1 after planting. In the following week (2 weeks after planting), soybean and upland rice treatments had the highest mineral N ($P \leq 0.01$). Soybean treatment provided mineral N more than the other treatments but only significantly more than upland rice treatment at week 8. At the last sampling date (week 16 after planting), mineral N values were not significantly different among treatments (Figure 1). The reason why soybean and upland rice treatments had the highest mineral N could be from the effect of basal fertilizer application.

3.3. Final harvest

Plant samples were collected for dry weight measurement at the final harvest. The weed in control treatment had 2.97 t ha-1 dry matter. Stover and grain yields of upland rice were 4.03 and 2.87 t ha-1, respectively. Stover and grain yields of soybean were 2.18 and 1.12 t ha-1, respectively. Final sunn hemp dry weight was 0.53 t ha-1.

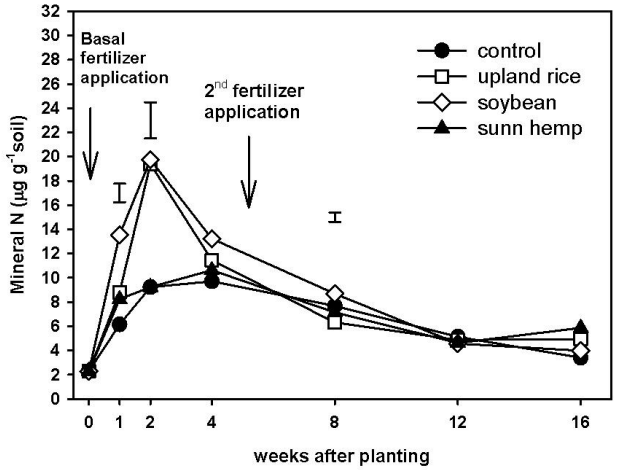

Fig. 1. Soil mineral N (µg g-1soil) during different pre-sugarcane planting management at 0-15 cm soil depth. Vertical bars represent standard error of the difference (SED).

Table 1. Dry matter in each treatment

	Dry matter (t ha^{-1})	
	Stover	Grain
Control	2.97	-
Upland rice	4.03	2.87
Soybean	2.18	1.12
Sunn hemp	0.53	-

3.4. Soil chemical properties at the final harvest

Soil organic matters were not significantly different among treatments. However, the upland rice treatment gave significantly higher in available phosphorus than the other treatments ($P \leq 0.05$). Moreover, the upland rice treatment provided the highest exchangeable Ca but not significantly more than the control and sunn hemp treatments ($P \leq 0.05$). However, Yadav [4] who studied the effect of preceding sesbania and rice on soil mineral N and organic matter before sugarcane planting found that sesbania treatment had mineral N and organic matter significantly higher than rice treatment.

Table 2. Soil chemical properties (0-15 cm) at the final harvest

Treatments	pH (1:1 H_2O)	EC (1:5 H_2O; dS m^{-1})	Organic matter (%)	Total N (%)	Available P		Exchangeable K	Exchangeable Ca		CEC (c mol kg^{-1})
					(mg kg^{-1})					
Control	5.28	0.007	0.45	0.024	7.48	b	27.30	120.0	ab	3.09
Upland rice	5.25	0.010	0.43	0.021	23.74	a	25.44	135.0	a	3.68
Soybean	5.16	0.009	0.42	0.022	12.46	b	25.20	100.0	b	3.26
Sunn hemp	5.27	0.007	0.40	0.021	7.44	b	23.03	115.0	ab	2.79
SED	0.07	0.001	0.02	0.001	4.19*		3.48	10.14*		0.48
CV (%)	2	25.48	7.16	9.68	46.36		19.48	12.2		21.3

Treatment results in a column followed by a common letter are not significantly different according to Duncan Multiple Range Test with $\alpha = 0.05$: * = significantly different at $P \leq 0.05$.

4. Conclusion

Soil data collected at preceding crop harvest before sugarcane planting at 0-15 cm soil depth indicated that organic matters were not significantly different among the treatments; although the upland rice treatment had significantly highest available P content. Moreover, upland rice treatment provided the highest exchangeable Ca but was not significantly more than those in the control and sunn hemp treatments. Thus, upland rice could be one of the alternative crops that can be used as a preceding crop before sugarcane planting. It would not only increase the economical income of the farmer but also provide more household food supply and thus might lead to enhance food security in sugarcane cropping system.

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6. References

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