Nutrients Leached under Lychee Cultivation of an amended Northern Thai Highland Acrisol

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Abstract

Lychee cultivation in northern Thailand is a popular method to earn income for farmers. Fertilizer and soil amendments will always be recommend for improving soil properties. This experiment examines responses of selected soil amendments and NPK fertilizer on nutrients leached under lychee canopies of an Acrisol soil. An experiment was conducted with resin buried at 30 and 60 cm depth for 4 months. Chemical application cause more leaching of nutrients than other treatments. The amount of elements absorbed by resin at 30 cm. was large compared with 60 cm depth for all extractants. The contents of nutrients extracted by 0.5N HCl gave lower values than BrayII and NH_4OAc pH 7.0. The amounts of nutrients leached were at low levels for fly ash application. In addition, extractable S at 60 cm depth ranged from 73 to 133 mg/kg being higher than the amount of S at 60 cm depth of 54 to 86 mg/kg. The treatments resulted in various leaching conditions under lychee canopies for the Acrisol soil. More nutrients and heavy metals including trace elements should be analyzed.

Key Words

Nutrient, leaching, lychee and Acrisol.

Introduction

Nowadays, Lychee (*Litchi chinensis* Sonn.) cultivation areas in northern Thailand have been extended to many provinces (Sethpakdee 2002). Lychee orchards are the popular fruit trees to earn higher profit than others land uses. For the past decades, many areas have increasingly realized the effects of global climate change. As a result of this phenomenon in northern Thailand, lychee orchards migrated to higher elevations in order to experience a preferred climate. This increases the occurrence of deforestation and other environmental problems such as soil degradation and water pollution resulting from the use of chemical substances like fertilizers, pesticides and herbicides. In this condition, a sustainable development program should be developed on conserving the entire watershed environment by limiting agricultural activities that cause soil erosion and allow poisonous leachates to infiltrate streams and groundwater. Such events are dangerous for mankind, animals and the environment (Inthasan 2006). Leaching under lychee canopies should be measured. Various soil amendments such as dolomite, fly ash and chicken manure were selected for research and compared with chemical fertilizer applications. The capability of resin to adsorb elements should indicate subsoil leaching of nutrients in the Acrisol.

Methods

Research area

The experimental area was 35 km north of Chiang Mai, at Mae Sa Mai Valley in the Mae Rim district. The agricultural area covers over 1,000 hectares with most of it over 1,000 m above sea level. The period of rain starts from mid of April and continues for at least 6 months providing about 1,500 mm annually. Soil types in this research study is classified as Acrisol and is different from those highland soils in which pH is higher (6.0-6.5). A detailed geological map shows that this area is occupied by gneiss, granite and migmatite including some limestone, marble and freshwater limestone (Schuler *et al.* 2006).

Main study

Resin samples were buried at 30 and 60 cm depth under lychee canopies at the time of fertilizer application and left for 4 months (July-October 2007) within the rainy season. The lychee trees selected for this research work were contained in four replications of four treatments on the basis of one lychee plant per treatment. A randomized complete block design was assigned for this experiment. Those treatments were arranged as follows:

TRT 1. Control = C; farmer practice with N-P-K 2.5 kg/tree/year of 15-15-15

TRT 2. C+ dolomite 1.5 kg/tree/year

TRT 3. C+ fly ash (lignite fly ash) from electric power plant 1.0 kg/tree/year

TRT 4. Chicken manure 10 kg/tree/year

Analyses

All resins were taken from the soil after 4 months. Extractable P was determined by extracting the resin samples with Bray II and 0.5 N HCl and the concentration measured by spectrophotometer (Watanabe and Olsen 1962). NH_4OAc 1 N, pH 7.3 and 0.5 N HCl were used for K, Ca and Mg extraction. Exchangeable K was analysed by flame spectrophotometer. Exchangeable Ca and Mg were determined by Atomic Absorption Spectrophotometer (Jackson 1958), while extractable S was only analysed in 0.5N HCl extracts using a turbidimetric method (Black *et al*. 1965).

Results

The concentrations of P, K, Ca and Mg were higher for BrayII and NH_4OAc pH 7.0 extracts than 0.5N HCl (table 1 and 2). Extractable P (BrayII) at 30 cm ranging from 55 -293 mg/kg and significantly decreased to 26-58 mg/kg at 60 cm. The same trends were demonstrated for extractable K, Ca and Mg (by NH_4OAc pH 7.0). The application of fly ash with NPK fertilizer caused the lowest concentration all nutrients both at 30 and 60 cm compared with Control, C+dolomite and chicken manure additional. The increase in extractable K at 60 cm was significant. Dolomite application causes the highest content at 1,005 mg/kg but was not different from the chicken manure treatment that showed 925 mg/kg. Generally, dolomite caused higher amounts of extractable Ca and Mg in resin samples both at 30 and 60 cm than for other treatments. The contents were 2709 and 1,601 mg/kgCa and 407 and 296 mg/kgMg at 30 and 60 cm depth respectively. Content of extractable Ca in resin samples at 60 cm, in particular, was significantly higher. Similarly with 0.5N HCl extracting, the certain nutrients at 30 cm depth were detected less than 60 cm depth. The concentrations of extractable P, K, Ca and Mg were not significantly affected ranging from 29-74 mg/kgP, 200-665 mg/kgK, 185-1871 mg/kgCa and 68-296 mg/kgMg at 30 cm depth. The contents of extractable P and Mg at 60 cm depth were not significantly different. While, the amount of extractable K and Ca ranged from 30 to 839 mg/kgK and 93 to444 mg/kgCa at 60 cm depth. Fly ash application provided the lowest concentrations of extractable K and Ca with significant differences among treatments. Moreover, extractable S was not significantly different at both 30 and 60 cm depth. Control treatment provided the larger concentration of extractable S and fly ash application caused the lowest amount of extractable S. Moreover, fly ash application showed the lowest concentrations of extractable P, K, Ca and Mg at 30 cm depth with 29, 200, 185 and 68 mg/kg respectively.

Table 1. Nutrients in resin four months after application of fertilizers and soil amendments estimating by Bray II and NH_4OAc extractants.

Treatment	Extractable P (mg/kg)	Extractable K (mg/kg)	Extractable Ca (mg/kg)	Extractable Mg (mg/kg)
	With BrayII	With NH_4OAc pH 7.0		
Samples at 30 cm depth				
Control (NPK)	293	771	1860	398
C + Dolomite	176	783	2709	407
C + Fly Ash	55	228	869	127
Chicken Manure	146	831	1248	191
LSD(P=0.05)	117.83	NS	NS	NS
Samples at 60 cm depth				
Control (NPK)	58	375	1021	167
C + Dolomite	28	1005	1601	323
C + Fly Ash	26	47	549	32
Chicken Manure	44	925	883	211
LSD(P=0.05)	26.73	623.69	952.99	NS

Table 2. Nutrients absorbed by resin four months after application of fertilizers and soil amendments and extracted by 0.5N HCl.

Treatment	Extractable P (mg/kg)	Extractable K (mg/kg)	Extractable Ca (mg/kg)	Extractable Mg (mg/kg)	Extractable S (mg/kg)
	With 0.5N HCl				
Samples at 30 cm depth					
Control (NPK)	74	617	426	164	64
C + Dolomite	46	627	1871	296	54
C + Fly Ash	29	200	185	68	86
Chicken Manure	47	665	742	112	57
LSD(P=0.05)	NS	NS	NS	NS	NS
Samples at 60 cm depth					
Control (NPK)	15	300	278	89	133
C+Dolomite	14	839	444	157	73
C+Fly Ash	27	30	93	39	100
Chiken Manure	14	769	426	107	85
LSD(P=0.05)	NS	480.44	345.43	NS	NS

Conclusion

Nutrients concentration estimated with Bray II and NH_4OAc pH 7.0 than 0.5N HCl extractions showed that nutrients had leached to subsoil and been absorbed by resin. Concentration at 30 cm depth showed in height comparing with 60 cm depth. Control treatment or NPK fertilizer under lychee canopies caused more leaching of nutrients than other treatments. The addition several soil amendments affected leaching of nutrients both at 30 and 60 cm depth. The next experiment should include heavy metals leached.

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