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Effectiveness of micro-nutrient fertilization in off-season longan production in Northern Thailand

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Abstract

Longan (*Dimocarpus longan,* L.) is one of the most important fruit trees of Northern Thailand. Most of the fruits are produced during the main season (January until July) for fresh market, while only a minor part is conserved. An increased production area has lead to a massive decay of in-season longan prices. Therefore, more and more farmers shift to off-season production by chemically induced flowering during June to August, so the harvest can be done in December to March. When fruit price is better.

Most of longan fields are in the low lands of Ping River Basin or the lower foothills along the valley on soils with a poor nutritional status. Especially true regarding the supply with micro-nutrients, which for a long term have not been considered essential by local farmers. Nowadays, foliar application of micro-nutrient cocktails is practiced by many farmers. However, most of them do not distinguish between on-season and off-season production. Micronutrient cocktails are expensive and need to be scheduled carefully to ensure effective uptake by the trees.

The aim of this study was to find out the differences between different phenological stages with respect to micro-nutrient supply and compare them between in and off-season production. In cooperation with local farmers, ten longan orchards in Chiang Mai and Lamphun Provinces, Northern Thailand, have been surveyed. Fertilizer treatments have been recorded. Soil samples were analyzed on their nutritional status. Longan leaves have been analyzed for B and Zn contents for the periods of flowering time fruit development after harvest.

It turned out that Zn deficiencies in the soil can be easily overcome by foliar application. B found that deficient in many orchards. It could only be overcome by frequent application of foliar application.

Keywords: *Dimocarpus longan*, Zn , B

Introduction

Longan (*Dimocarpus longan*, L.) is one of the most important fruit trees of Northern Thailand. Most of the fruits are produced during the main season (January until July) for fresh market, while only a minor part is conserved. In 1997 it was discovered, that the application of KCl can reliably induce off-season flowering in longan trees. Subsequently, the production area of longan in Thailand was more than doubled. This has lead to a massive decay of in-season longan prices. Therefore, more and more farmers shift to off-season production by chemically induced flowering during June to August, so fruits can be harvested during December to March. Through off-season production farmers still obtain higher prices (ONGPRASERT et al., 2007).

Formerly, most of longan fields were situated in the fertile low lands of the Ping River Basin. Nowadays, the cultivated area has expanded to the lower foothills along the valley on soils with a poor nutritional status (ROYGRONG et al., 2007). This is especially true regarding the supply with micro-nutrients, which for a long term have not been considered essential by local farmers. Nowadays, several studies have shown the importance of micro nutrients for productivity (ZHUANG ET AL., 1995) and health status (VISITPHANICH ET AL., 1999) of longan trees. Foliar application of micro-nutrient cocktails is practiced by many farmers. However, most of them do not distinguish between on-season and off-season production. Micronutrient cocktails are expensive and need to be scheduled carefully to ensure effective uptake by the trees and positive influence on production. The variation of micro-nutrients in the leaves is reflected in the production cycle and the intensity of the production (CHEN, 1997).

The aim of this study was to find out the differences between different phenological stages with respect to micro-nutrient supply and compare them between in- and off-season production cycles.

Material and Methods

The survey was carried out on ten farmers' orchards in Chiang Mai and Lamphun provinces (Table 1). All trees are 'e-daw' longans between eight and ten years old.

Samples were taken for the in-season and off-season production cycle during the stages of flowering, fruit growth and at harvest. Three orchards have been sampled with ten replications (trees) at each phonological stage. Ten mature leaves of the last flush were collected. At each sampling date a soil sample of the top-soil (0-20 cm) was collected.

In the laboratory the leaf samples were washed, oven dried at 70^{o} C for three days and subsequently milled. The concentration of B in the leaves and soil was measured using the Azomethine-H method (BINGHAM, 1982). The leaf samples were incinerated at 450 - 500^{o} C. Then the ash was dissolved 0.5 M H_2SO_4. The color change was measured by Inductive spectrophotometry (Hitachi CECILL). The soil samples were directly dissolved in 0.5 M H_2SO_4 and the concentration was determined by inductive spectrophotometry.

For the determination of the Zn concentration in the leaves the samples were disintegrated with HNO_3-$HClO_4$ at 80^{o} C and subsequently adjusted to 120, 240 and 280^{o} C during two hours. Then they were analyzed by use of an atomic absorption spectrophotometer (AAS). In the soil the Zn concentration was determined by the DTPA method (BAKER and AMACHER, 1982), dissolving the soil sample in 1:1 HCl (v/v). Then the samples were analyzed by AAS.

Table 1 Selected information of the surveyed orchards

Orchards	Location	Soil types	Tree age	Fertilizer	Foliar App.	Tree health	Produc-tion
Loungkhum	Foothill	Sandy skeleton soil	8 y	mainly 15-15-15	no	poor	
Saing I	Foothill	Deep sandy soil	6 y	Vary with tree stages, excess	Freq.	good	
Saing II	Foothill	Deep sandy soil	10 y	Vary with tree stages, excess	Freq.	good	
Ban Bong	Foothill	Sandy skeleton soil		Vary with tree stages, limited	no	fair	Off season
Pawin	Foothill	Sandy skeleton soil	4 y	Vary with tree stages, limited	no	good	Off season
Sakchai	Foothill	Sandy skeleton soil	?	mainly 15-15-15	Freq.	good	Off season
Dang	Valley	Dark heavy clay	?	Vary with tree stages, limited	rarely	fair	Off season
Sanchai	Valley	Deep loamy soil	6 y	Vary with tree stages, limited	no	good	Off season
Inthanon	Valley	Deep loamy soil	8 y	Vary with tree stages, limited	rarely	fair	Off season

Results and Discussion

The results of the soil analysis showed, that the soils of most fruit orchards in the target region are deficient in micro-nutrients. Boron was only found in traces and was severely deficient in all soils. Zinc was deficient in five of the nine examined sites. Three of the four sites that are not lacking in Zn are situated at the foot-hills and have generally poor soil-physical properties. The only soil in the valley that had enough Zn supply is still at the lower end of the optimum range (Table 2). There was no difference between flowering, fruit growth or harvest during in-season and off-season production (Table 3).

Table 2 Concentration of B and Zn in the soil of longan orchards during the in-season production cycle. Standards for optimum supply according to KHAOSUMAIN et al. (2005). Deficiencies printed in red.

	B concentration in soil (ppm)		Zn concentration in soil (ppm)	
	flowering	fruit growth	flowering	fruit growth
Loungkhum	0.3		5.4	
Saing I	0.3		1.16	
Sanchai	0.4	0.5	4.09	3.17
Lower optimum	4.00		3.00	
Upper optimum	6.00		15.00	

The concentration of B in the leaves showed big variations. In the in-season production cycle all tested leaves showed deficient B concentrations (Table 4). In the off-season production cycle one orchard was well supplied and one was even above the optimum level of B supply (Table 5). The Zn concentration in the analyzed leaves was found to be sufficient in all samples, except a slight deficiency in one in-season orchard during flowering (Table 4) and one after harvest of off-

season longans (Table 5). A general tendency of the changes between the different phenological stages in in- and off-season could not be detected.

Table 3 Concentration of B and Zn in the soil of longan orchards during the off-season production cycle. Standards for optimum supply according to KHAOSUMAIN et al. (2005). Deficiencies printed in red.

	B concentration in soil (ppm)		Zn concentration in soil (ppm)	
	fruit growth	harvest	fruit growth	harvest
Ban Bong		0.6		6.29
Dang		0.7		2.71
Saing II		0.4		0.83
Pawin	0.6	0.5	6.00	5.08
Intanon	0.4	0.3	0.93	0.73
Sakchai	0.5		2.26	
Lower optimum	4.00		3.00	
Upper optimum	6.00		15.00	

Table 4 Concentration of B and Zn in the leaves of longan trees in the in-season production cycle. Standards for optimum supply according to KHAOSUMAIN et al. (2005). Deficiencies printed in red.

	B concentration in leaves (ppm)		Zn concentration in leaves (ppm)	
	flowering	fruit growth	flowering	fruit growth
Loungkhum	3.75		19.74	
Saing I	13.94		25.47	
Sanchai	7.79	8.31	16.52	25.30
Lower optimum	15.32		16.99	
Upper optimum	34.49		30.13	

Table 5 Concentration of B and Zn in the leaves of longan trees in the off-season production cycle. Standards for optimum supply according to KHAOSUMAIN et al. (2005). Deficiencies printed in red, over supply printed in blue.

	B concentration in leaves (ppm)		Zn concentration in leaves (ppm)	
	fruit growth	harvest	fruit growth	harvest
Ban Bong		8.18		23.45
Dang		13.15		22.90
Saing II		20.98		18.08
Pawin	39.64	44.17	18.88	14.08
Intanon	8.66	5.64	19.43	22.75
Sakchai	27.43		28.83	
Lower optimum	15.32		16.99	
Upper optimum	34.49		30.13	

Especially the B supply in the leaves reflected clearly the management of the orchards. The orchards, were regular micro-nutrient spraying is practiced, are well supplied or have slight deficiencies, while orchards, that are not treated with micro-nutrient cocktails are generally B deficient. This is especially true for in-season production where low longan priced have led to a decrease in production intensity (Table 4).

Conclusion

The micro nutritional status in the soil of most fruit orchards of northern Thailand was found to be low. This is in agreement with the findings of ROYGRONG et al. (2007). As micro-nutrients are generally applied to the leaves, the management was found to have little influence on the micro-nutritional balance. The fact that especially good soils in the valley position are lacking in Boron is possibly due to the longer production history without micro-fertilization, as traditionally Thai farmers only fertilized macro-nutrients (N, P, K) and many of the lowland fruit orchards are situated on former paddy fields.

The micro-nutritional status in the leaves is the effect of the management. There is still a big difference between farmers, that practice rather traditional orchard management with only macro-nutrient compound fertilizers and farmers that also apply micro-nutrients. The latter are also those who practice off-season farming at a higher intensity level, as off-season prices are high enough to pay-off for the more expensive management.

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