Effect of Magnesium Fertilizer on Sustaining Upland Agricultural Development in Guangxi Province

By Tan Hongwei, Du Chenglin, and Zhou Liuqiang

The rainfed upland soils of Guangxi province in south China are subject to high rainfall and heat, as well as an intense climate that has effectively made most agricultural soils nutrient poor. When fertilized, these soils can support a wide variety of high value crops. It is apparent, however, that the future profitability of the region depends on balanced fertilization. This article describes how insufficient soil magnesium (Mg) is limiting crop yield, quality, and use efficiency of nitrogen (N), phosphorus (P) and potassium (K).

Plant available Mg in the main upland soils of Guangxi province is quite variable (10.9 to 370.6 mg exchangeable Mg/kg), but soils commonly used for crop production...such as lateritic red earth, latosols and silicosols...often test less than 70 mg exchangeable Mg/kg.

This study found a negative correlation between soil exchangeable Mg levels and applied Mg. That is, at high levels of soil Mg, application of Mg fertilizer reduced yields. This is expressed in the following

Table 1. Influence of Mg fertilizer application on cash crop yields, kg/ha.

		Treatment					
Crops		NP	NPMg	NPK1	NPK1Mg	NPK2	NPK2Mg
Cassava	Yield	8,400	9,516	19,270	21,207	23,697	27,788
	Yield incr.		1,116		1,937		4,091
	%		13.3		10.1		17.3
Kenaf	Yield	—	—	1,940	2,366	2,619	3,012
	Yield incr.	—	—		426		393
	%	—	—		22.0		15.0
Sugarcane	Yield	60,937	64,875	82,610	99,426	85,483	93,176
	Yield incr.		3,937		16,815		7,693
	%		6.5		20.3		9.0
Watermelon	Yield	24,724	34,695	41,991	44,584	44,284	46,371
	Yield incr.		9,971		2,593		2,087
	%		40.3		6.2		4.7
Pineapple	Yield	35,563	37,969	44,906	49,063	45,163	52,219
	Yield incr.		2,406		4,156		7,056
	%		6.8		9.3		15.6

Improved pineapple growth due to balanced fertilization is shown at Guangxi.

equation: $Y=10.95e^{-0.30x+\ln x}$, where Y=yield, e=constant (2.7183), and x=content of exchangeable Mg.

The average yield response to Mg fertilizer in cash crops, oil crops, grain crops, and vegetables was 4.7 to 40.3; 1.5 to 39.1; 4.6 to 11.4; and 1.7 to 25.5 percent, respectively, (**Tables 1** to **4**). It is important to note that most crops had large yield responses to K fertilizer as well, but addition of Mg to the NPK treatments resulted in further yield gains.

Application of Mg fertilizer not only increased yield, but also had a positive effect on quality. Sugar content in sugarcane increased 0.9 percent, fiber intensity of kenaf increased, and soluble sugar content in watermelon increased 0.90 to 1.79 percent.

All the crops absorbed more N and P when Mg was applied, while K uptake was increased only in some cases. Generally, Mg application reduced both K and calcium (Ca) uptake. It is important these facts be considered in a fertilizer recommendation that includes Mg so that proper balances are kept for healthy plant growth and to maintain soil fertility.

Table 2. Influence of Mg fertilizer application on oil crop yields, kg/ha.

Crops		Treatment NPK1	NPK1Mg	NPK2	NPK2Mg
Peanut	Yield	3,083	3,934	4,526	4,592
	Yield incr.		851		66.0
	%		27.6		1.5
Soybean	Yield	1,380	1,920	2,134	2,299
	Yield incr.		540		165
	%		39.1		7.7

Table 3. Influence of Mg fertilizer application on grain and tuber crop yields, kg/ha.

Crops		Treatment NPK1	NPK1Mg	NPK2	NPK2Mg
Corn	Yield	3,833	4,036	4,716	5,117
	Yield incr.		203		401
	%		5.3		8.5
Sweet potato	Yield	11,261	11,914	12,688	14,139
	Yield incr.		652		1,451
	%		5.8		11.4
Rice	Yield	4,890	5,115		
	Yield incr.		225	—	—
	%		4.6		

Balancing Magnesium in the Uplands of Guangxi Province

Only a small amount of Mg (2.04 kg/ha per year) is supplied to the region's rainfed upland crops through precipitation. Additionally, the stability of Mg-containing soil minerals is poor. Since the area endures high temperatures and heavy rainfall, sources of soil Mg are subject to rapid weathering and leaching resulting in large Mg losses. This negative balance was further amplified with the introduction of improved crop varieties that were both higher yielding and Mg-loving. For instance, cassava may take up more than 19 and sugarcane 130 or more kg MgO/ha/yr (**Table 5**). Higher NPK fertilizer use producing higher yields has also resulted in greater crop removal of Mg from these soils.

Table 4. Influence of Mg fertilizer application on vegetable crop yields, kg/ha.

Crops		Treatment NP	NPMg	NPK1	NPK1Mg	NPK2	NPK2Mg
Tomato	Yield			63,150	67,380		
	Yield incr.	—	—		4,230	—	—
	%				6.7		
Eggplant	Yield			43,500	45,570		
	Yield incr.	—	—		2,070	—	—
	%				4.8		
Cabbage	Yield	38,042	47,745	41,127	42,845	47,370	48,195
	Yield incr.		9,703		1,718		825
	%		25.5		4.2		1.7
Chinese cabbage	Yield			63,094	65,625		
	Yield incr.	—	—		2,531	—	—
	%				4.0		

Table 5. Balance of soil Mg with fertilizer application, kg/ha.

Crops	Treatment	Application rate	Uptake	Input/output balance
		kg MgO/ha		
Sugarcane	NPK1	0	102.0	-102.0
	NPK1Mg	63.0	117.5	-54.5
	NPK2	0	130.0	-130.0
	NPK2Mg	63.0	137.0	-74.0
Cassava	NPK1	0	19.4	-19.4
	NPK1Mg	40.5	19.9	+20.6

It is apparent that the problem of soil Mg deficiency has not been solved in the uplands of Guangxi province. As a result, sustained high yielding crop production cannot be achieved. Magnesium deficiency also reduces the effectiveness of other applied plant nutrients. Thus, the positive effects on yield and farmer income from balanced NPK fertilizer use cannot be brought into full play. Guangxi's development of its agricultural uplands requires attention to Mg fertilizer application. Otherwise, farmers will continue to struggle with poor NPK fertilizer use efficiency, low yields, poor crop quality, and lower profits. **BCI**

Tan Hongwei and Zhou Liuqiang are with the Soil and Fertilizer Institute, Guangxi Academy of Agricultural Sciences, Nanning, People's Republic of China. Du Chenglin is with the Institute of Soil Science, Academia Sinica.