Level of Water-Insoluble Phosphorus Is Not Affecting the Performance of Superphosphate Fertilizers

By G.L. Mullins and C.E. Evans

The quality of phosphate rock (PR) used to manufacture fertilizer for North American farmers is slowly declining. Lower grade PR can result in the formation of impurity compounds, primarily iron (Fe) and aluminum (Al) phosphates, in the final phosphate fertilizer products. Identified impurity compounds have been shown to be insoluble in water and vary in citrate solubility. Thus, the use of lower grade PR can result in a decrease in the percentage of water-soluble phosphorus (P) in a fertilizer. There is some concern that increasing levels of water-insoluble P may be detrimental to fertilizer effectiveness. Results from this study do not support that concern.

GREENHOUSE and field tests were conducted to evaluate the performance of commercial superphosphate fertilizers as affected by the level of water-soluble P and metallic impurities. Samples of six commercial triple superphosphates (TSP) and one commercial normal superphosphate (NSP) were collected for study. Three of the fertilizers were produced from Florida PR, one from North Carolina PR, one from Idaho PR and two from Moroccan PR. The U.S. sources were representative of commercial TSP currently available to farmers in the U.S. and Canada.

In a greenhouse test, these fertilizers were compared to reagent-grade monocalcium phosphate (MCP), approximately 100 percent water-soluble. Monocalcium phosphate is considered to be the primary form of water-soluble P in commercial TSP. Water-soluble P in the phosphate fertilizers ranged from 80 to 97 percent (**Table 1**). The concentrations of Al and Fe (metallic impurities) in the U.S. fertilizers averaged four to six times higher, compared to the Moroccan TSP.

Greenhouse Study

A greenhouse study evaluated each source applied to a 3.3 lb pot of Mountview silt loam soil (pH = 6.5) at rates to supply 0 to 50 parts per million (ppm) P. Sorghum-sudangrass was used as a test crop and was harvested 28 and 56 days after planting. Forage yields (**Figure 1**) and P uptake by the plants were

Table 1. Chemical composition of TSP fertilizers used in field and greenhouse studies.

Source Number	PR Source	Total P	Citrate Insoluble P	Water-Soluble[1] P	Al	Fe
		percent				
1	Florida (FL)	19.2	0.59	80	0.92	1.43
2	Florida (FL)	20.8	0.78	86	0.75	1.43
3	Florida (FL)	20.7	0.99	83	0.99	1.47
4	North Carolina (NC)	20.7	0.78	87	0.28	1.13
5	Morocco (MR)	21.2	0.75	92	0.19	0.20
6	Morocco NSP	7.9	0.20	93	0.20	0.11
7	Idaho ID	19.7	0.02	92	0.82	0.60
8	Reagent grade MCP	26.1	0.01	97	<0.01	<0.01

[1]Percentage of available P that is soluble in water. "Available" P = water + citrate soluble P.

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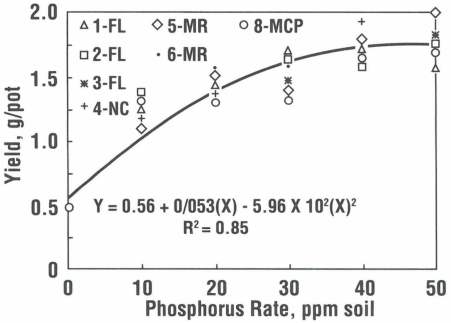

Figure 1. Yield of sorghum-sudangrass 56 days after planting as affected by the rate and source of superphosphate. Reprinted by permission of Marcel Dekker, Inc.

increased by increasing rates of added P. However, forage yields and P uptake were not affected by the P source. Results indicated that the commercial fertilizers tested were as effective as reagent grade MCP and that fertilizer performance was not related to the level of water-soluble P or the level of metallic impurities (Al and Fe).

Field Study

A field study was also conducted using TSP sources manufactured from RP sources 1, 3, 4 and 5 (**Table 1**). The three-year test was conducted on a Hartsells and a Malbis soil. White potato was used as the test crop because of its high P requirement and its consideration as a crop that may require a high percentage of water-soluble P. The TSP was band-applied on each side of the potato seed pieces at planting.

Potato yields were consistently increased by added P (**Figure 2**). During the three-year study, potato yields were increased by as much as 163 cwt/A by the application of P. Yields were not affected by the source of added P or the level of water-soluble P in the fertilizers during the three-year study. The concentration of P in the potato leaf tissue likewise was not affected by the source of applied P.

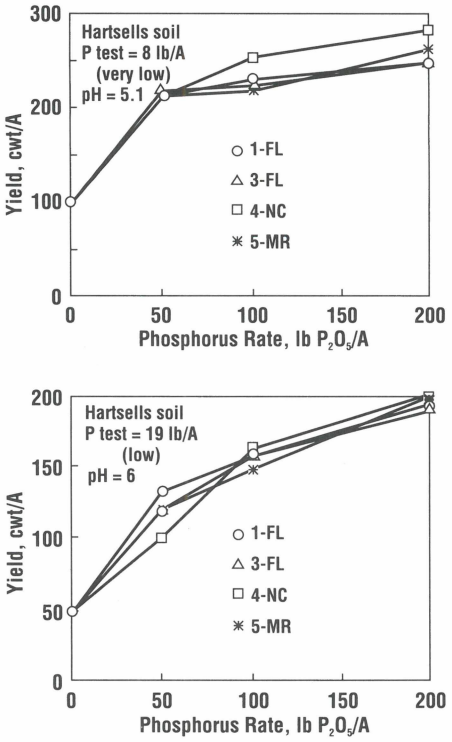

Figure 2. Potato yields on a Hartsells and a Malbis soil in 1989 as affected by the rate and source of commercial triple superphosphate. Reprinted by permission of Kluwere Academic Publishers.

Summary

Results of these studies show that commercial TSP fertilizers vary in their content of water soluble P and metallic elements. However, greenhouse and field evaluations of commercial sources of TSP showed that fertilizer performance was not related to the level of water-soluble P or the content of metallic impurities. The results demonstrate that current levels of water-insoluble P (impurity compounds) in TSP produced from North American rock phosphate sources are not an agronomic problem. ■