Coating of Phosphorus Fertilizers with Polymers Increases Crop Yield and Fertilizer Efficiency

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Polymer-coated phosphorus (P) fertilizers produced greater yields and fertilizer efficiences than non-coated P fertilizers in greenhouse and field studies with Alberta soils.

RECOVERY of P fertilizer by small grains usually varies from 5 to 25 percent in the year of application. Low recovery of P results from its quick adsorption and precipitation in the soil. Generally, the better the P fertilizer is mixed into the soil, the poorer the recovery by the crop. Placing the fertilizer in narrow bands close to the seed usually produces the highest yield and greatest P recovery in cereal grains and oilseed crops. Nevertheless, first year P efficiency seldom exceeds 25 percent and is usually much less under field conditions.

We speculated that if exposure of P fertilizers to the soil is eliminated or minimized while exposure to plant roots is maximized, the recovery of P would be increased. We tested that idea with monoammonium phosphate (MAP) and diammonium phosphate (DAP) in two agricultural soils in a pot experiment, sown to barley. The fertilizers were dissolved in water and the solutions added through slender tubes in each pot. The tubes discharged the P solutions beside the barley seed. Phosphorus fertilizer was added at seeding or every other day.

Apparent recovery of P fertilizer was approximately twice as great when the P was applied in small doses every second day as compared to application of the full dose on the day of sowing (**Table 1**). That was true for both a Black Chernozem and a Gray Luvisolic soil, and for both MAP and DAP. Apparently, the frequent, dilute additions of P allowed the plant to take up more P before it was "fixed" by the soil.

We also tried wrapping single granules of MAP with thin, perforated kitchen film. There was more plant recovery of fertilizer P from the wrapped MAP than the non-wrapped MAP.

Table 1. Adding regular, small doses of fertilizer increases apparent P recovery in 45 day old barley grown in potted soils.

Fertilizer	Time of Application	Apparent P recovery, % Black Chernozem	Gray Luvisol
MAP	All at seeding	13	18
MAP	Added every other day	24	36
DAP	All at seeding	8	14
DAP	Added every other day	17	39

Application rate: 18 lb P_2O_5/A

Coated Fertilizers

Phosphorus fertilizer with commercially coated polymer was also evaluated. Thin and thick coated MAP and DAP were used in an array of greenhouse experiments with barley grown in pots with a Gray Luvisolic soil. Results from one experiment are shown in **Table 2**. Fifty two days after P application, yield was substantially greater and apparent P recovery was 60 percent greater with the thin coated MAP compared to the non-coated MAP. This and other experiments indicated that polymer coating of P fertilizer granules resulted in a fairly slow, but steady supply of

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Table 2. Polymer-coating increased yields and P efficiency in a barley pot study.

Fertilizer	Plant yield, g/pot		Apparent P recovery, %	
	26 days	52 days	26 days	52 days
Check	1.2	7.8	–	–
MAP, not coated	5.3	19.0	26	27
MAP, thin coat	5.2	24.4	34	44
MAP, thick coat	3.6	18.6	20	32

Application rate: 28 lb P_2O_5/A

plant-available P as it diffused or leaked through the coating. This principle was much the same as that of using frequent small doses of P in solution.

In 1994 we set out two field experiments. The soils were near neutral Black Chernozems of silty loam texture. Monoammonium phosphate was commercially coated with two different kinds of polymer material. The yield was increased slightly by the thin coating of Polymer 1 but substantially by thin coating of Polymer 2 (**Table 3**). Polymer coating had a greater effect on P efficiency than on yield, with P recovery increasing from 26 percent for non-coated MAP to 54 percent for thin coating with Polymer 2.

Summary

Our results in the greenhouse and field have demonstrated that slowing the release of fertilizer P into the soil by coating fertilizer granules can markedly increase yield and P recovery by the crop. Apparently, different materials can form successful coatings. Increased P efficiency through coated fertilizers may improve the profitability of P fertilization, especially in areas with high P fixing soils. ■

Table 3. Polymer-coated P fertilizer increased barley dry matter and P efficiency in field grown barley.

Fertilizer	Dry matter yield, tons/A	Apparent P recovery, %
Check	1.07	–
MAP, not coated	1.60	26
MAP, thin coat of Polymer 1	1.77	36
MAP, thick coat of Polymer 1	1.56	30
MAP, thin coat of Polymer 2	2.10	54
MAP, thick coat of Polymer 2	1.30	28

Application rate: 16 lb P_2O_5/A

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inlet sample for comparison. The sample was taken as flush irrigation water reached the bottom of the field. The flush irrigation occurred immediately after a post-emerge application of 38 lb/A of P. Post-emerge application of P is an acceptable management practice, but may need to be reevaluated. Most of the other increases occurred early in the season shortly after preplant application of P. It should be pointed out that there were some concentration increases even when no P applications were made.

In this study, 98 percent of the test fields had total seasonal P losses of less than 0.5 lb/A. Two percent had losses ranging from 0.5 to 1.5 lb/A. The 20 fields studied received 0 to 60 lb P/A, the range that might be expected for Texas rice production. Data indicated that P lost from rice fields presents no problem to the environment. ■