WESTERN CANADA

Improving Fertilizer Phosphorus Use Efficiency

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The efficiency of fertilizer P use by crops ranges from 10 to 30% in the year that it is applied. The remaining 70 to 90% becomes part of the soil P pool which is released to the crop over the following months and years. While this pool contributes to future crop production, increasing the efficiency of fertilizer by improving crop recovery in the year of application could potentially improve crop yields and economic returns.

Polymer coating of monoammonium phosphate (MAP) improved plant recovery of fertilizer phosphorus (P) and provided a modest barley grain yield advantage relative to uncoated MAP.

Coating P fertilizer could limit the contact of applied P with soil, possibly reducing its precipitation and/or adsorption on soil colloids, and increase its availability to developing plant roots. One of the perceived advantages of matching fertilizer P release with crop demand is that it could increase yield and recovery of applied P. However, this may not be as easily achieved as it sounds, since different crops have varying patterns of P uptake. In fact, slow release of fertilizer P could result in early season deficiencies for crops like wheat, a symptom which has been observed to severely limit crop yield potential (see *Better Crops with Plant Food,* 2001, Vol. 85, 2:18-23).

The development of thin polymer coatings has improved the opportunity to coat fertilizer granules and increased the predictability of when nutrients become available from the controlled-release product.

Greenhouse experiments were conducted at the University of Alberta in Edmonton, Alberta. Barley was grown in a P-deficient soil medium that had been supplemented with nitrogen (N), potassium (K), and sulfur (S). Treatments included a no P control, uncoated MAP, thin and thick polymer coated MAP (Agrium Fertilizers, Redwater, Alberta), and a mixture that included 25% thin coated MAP, 50% thick coated MAP, and 25% uncoated MAP. The P rate evaluated was equivalent to 21 lb P_2O_5/A. Barley plants were harvested at 45 days after planting, and biomass and P concentration were determined.

Field studies were conducted at sites in Alberta and Saskatchewan with malting barley. The treatments involved a no P control, uncoated MAP, and MAP with a polymer coating similar to the thin coated MAP described in the greenhouse study. Rates of P evaluated were 0, 13, 26, and 39 lb P_2O_5/A; however, only the average response is reported here. The MAP was seed row applied in 1995 and side banded in 2000. The N, K, and S were preplant banded in 1995 and side banded at seeding in 2000. Plots were harvested and grain yield determined.

With the exception of the no P control, all greenhouse grown barley plants were headed when harvested at 45 days after seeding. While not significant, dry matter yield (DMY) tended to be higher with P addition (**Table 1**). Addition of MAP increased total P uptake (TPU) over the no P control. Use of the thin coated MAP, alone or in the mixture, improved plant P uptake relative to the uncoated P fertilizer. To estimate the contribution of fertilizer P to total P uptake, the net P uptake (NPU) was calculated as the portion of P uptake in excess of the no P control for each of the fertilizer treatments. Once again, the advantage in plant P recovery with the thin coat polymer and mixture treatment is shown by the increase in plant P recovery.

Did the polymer coating improve the recovery of fertilizer MAP? To determine this we calculated the estimated fertilizer P efficiency (EFPE), by dividing the NPU by the P rate applied and multiplying by 100. From the results in **Table 1**, it appears that the EFPE was increased substantially in the greenhouse by the coating, or use of a mixture of coated and uncoated fertilizer MAP.

Field trials comparing uncoated and thin coated MAP were set out at locations where pre-seeding soil analysis indicated that a response to P was likely. The increased crop response to uncoated MAP ranged from 3 to 121% over the no P control, with only one site showing a yield reduction (**Table 2**). Similarly, the controlled-release P (CRP) had one negative response, while the remaining sites had yield increases ranging from 6 to 192%. Relative to uncoated MAP, use of thin coat CRP improved the response of barley to P fertilizer addition in five of the seven trials. On average, the CRP increased barley yield by 3 bu/A, or 4%, over the uncoated MAP.

In order for a coated phosphate product to work, it must reduce short-term P fixation by the soil, yet provide adequate release for rapid P uptake in the critical early season period. This delicate balance appears to have been met by the thin coated P product in the greenhouse and some of the field trials. The proportion of P coming from the MAP was improved with coating, reducing the plant's dependence on soil P supply. However, there were a few occasions when the polymer coating did not release P quickly enough, usually when a thick coating was applied. Continued field research using a blend of uncoated and coated MAP may open doors to improving both short- and long-term fertilizer P efficiency. BC

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TABLE 1. Barley DMY, TPU, NPU, and EFPE from greenhouse-grown plants harvested 45 days after planting (average of two soils).

Treatment	DMY, g/pot	TPU, mg P/pot	NPU, mg P/pot	EFPE, %
Control, no P	9.70	23.02	–	–
Uncoated MAP	11.70	25.61	2.59	16.5
Thin coated MAP	12.55	28.14	5.12	32.6
Thick coated MAP	11.68	26.99	3.97	25.3
MAP mixture	12.49	27.79	4.77	30.3
$LSD_{0.05}$	NS	1.74	1.69	–

TABLE 2. Response of barley to added MAP and CRP.

Year	Site	No P control	MAP	CRP	Response over no P control, % MAP	Response over no P control, % CRP
		bu/A	bu/A	bu/A		
1995	Humbolt	74.1	79.9	85.0	8	15
	Asquith	84.4	89.8	88.4	6	5
	Neerlandia	103.9	107.4	112.6	3	8
	Calmar	70.1	68.9	74.1	-2	6
2000	Bruderheim	13.6	30.0	39.7	121	192
	Birch Hills	49.0	52.6	56.4	7	15
	Lamont	77.1	81.0	74.7	5	-3
	Mean	67.5	72.8	75.8	8	12