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Phosphorus Math for Dummies

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Comparing the costs of P_2O_5 in different phosphorus fertilizers?

Several reasons come to mind why we would want to calculate the value of P_2O_5 in different phosphorus (P) fertilizers. One question we are asked frequently concerns the cost of 10-34-0 when used as a starter fertilizer. Can the same starter benefit be achieved with liquid N without 10-34-0? If not, what extra cost is incurred with 10-34-0? Another common question is which is a cheaper source of P; monoammonium phosphorus (MAP) or diammonium phosphate (DAP)? Maybe surprisingly, you cannot tell just from the cost per ton.

Back to the starter fertilizer question. Our recent research has shown 2x2 starter fertilizer results in lower harvest grain moisture in most situations and increased yield in some cases.[1] Most of our trials compared mixes of 2x2 placed urea ammonium nitrate (UAN) and 10-34-0 to a no starter control. Quite a lot of earlier research found a synergy between co-applied nitrogen (N) and P that stimulated plant growth and increased N and P uptake. In our work, we did not try to distinguish whether the P component was necessary, but there is good reason to think the combination is better than N alone. In any case, some growers want to leave it out because it increases the cost of the starter fertilizer. How much does the P_2O_5 in 10-34-0 really cost compared to P_2O_5 in typical broadcast P fertilizers – MAP, DAP or triple super phosphate (TSP)?

In the following text we outline the approach to figuring the comparative cost of P_2O_5 from the different fertilizers and the accompanying Excel spreadsheet allows easy calculation of these values. Briefly, in any comparison one needs to subtract out the value of the N from the per ton cost of the fertilizer, then calculate the P_2O_5 cost. The N value is based on how much of the N applied with the P fertilizer is estimated to be available to the crop and the cost of N in an at-plant or sidedressed N application. Unfortunately, in most situations less than half of the N applied in late-fall, winter, or early-spring remains in the soil for crops planted in April and May so it should not always be fully credited. After crediting the value of N in the P fertilizer, the remaining cost of the fertilizer is attributed to the P_2O_5 content.

If you don't want to learn how to do the calculations by hand, skip to the end of the article and download the Excel spreadsheet.

[1] Summary of Starter Fertilizer Trials – 2014-2018.

Comparing P_2O_5 cost from 10-34-0 and DAP

Written out below are examples comparing the cost of P_2O_5 from 10-34-0 to the cost of P_2O_5 from DAP, crediting 0%, 50%, or 100% of the DAP N value.

Step 1: Calculate the cost of a pound of N from UAN.

In this example, UAN 28% costs $285 per ton and contains 560 pounds of N. Therefore the price per pound of N is $0.51 ($285 per pound divided by 560 pounds).

Step 2: Subtract the value of N in 10-34-0 from the per ton price, based on the price of UAN.

In this example, 10-34-0 costs $495 per ton and contains 200 pounds of N and 680 pounds of P_2O_5.

200 pounds of N times $0.51 per pound equals $102. Thus $393 ($495-$102) of the cost of a ton of 10-34-0 is attributed to the P_2O_5 content of the 10-34-0.

Step 3: Calculate the cost of P_2O_5 in 10-34-0 after subtracting out the N value.

$393 per ton divided by 680 pounds of P_2O_5 per ton equals $0.58 per pound of P_2O_5.

Calculating P_2O_5 cost from DAP with different credits for N

We take the same approach with MAP or DAP, except the value of the P_2O_5 is also dependent on how much of the N is likely to be available to the crop. If the fertilizer is spread shortly before planting then most of the N would be available to the crop (100% credit), but if it is spread in late-fall or early-winter, then nearly all of the N could disappear before the crop needs it (0% N credit).

For example consider DAP (18-46-0) at $490 per ton. DAP contains 360 pounds of N per ton and 920 pounds of P_2O_5 per ton.

Calculating P_2O_5 cost from DAP with 0% N credit:

If 0% of the N is credited from a fall application of DAP, then calculating the cost of P_2O_5 in MAP or DAP is easy - just divide the cost of the fertilizer by its P_2O_5 content (identical to Step 1 above, except based on the P_2O_5 content and per ton price, only).

$490 per ton divided by 920 pounds of P_2O_5 per ton equals $0.53 per pound of P_2O_5.

Calculating P_2O_5 cost from DAP with 100% N credit:

If none of the N is lost from DAP the calculation is identical to that for 10-34-0 above (Step 1-3). First subtract out the value of N from the per ton cost and then assign the remaining cost to the P_2O_5 content of the fertilizer. With these prices, and no N loss, the cost of P_2O_5 from DAP is $0.33 per pound.

Calculating P_2O_5 cost from DAP with 50% N credit:

Research in Illinois and Minnesota has shown that we might expect 50% N loss of late-fall applied DAP or MAP with 'normal' winter weather. If we credit 50% of the N to the next crop, then we deduct only 50% of the value of N from the cost of the fertilizer and then calculate the P_2O_5 cost as described in Step 1-3. DAP costs \$490 per ton and contains 360 pounds of N and 920 pounds of P_2O_5.

Step 1: If 50% of the N is assumed to be lost after application, we only credit 180 pounds per ton.

180 pounds of N times \$0.51 per pound of N from UAN equals \$92. Thus \$398 (\$490-\$92) of the cost of a ton of DAP is attributed to the P_2O_5 content of the DAP (960 pounds of P_2O_5).

Step 2: Calculate the cost of P_2O_5 in DAP after subtracting out 50% of the N value.

\$398 per ton divided by 920 pounds of P_2O_5 per ton equals \$0.43 per pound of P_2O_5.

Darn math! Instead of paper, pencil and a calculator, download this Excel spreadsheet, choose your N and P sources, enter per ton prices, choose a level of N loss dependent on the timing of application and perceived N credit, and compare the per pound costs of P_2O_5 without strain on the brain. To get the comparisons on a per acre basis choose the comparison of interest and enter the rate of fertilizer to be applied. If you are specifically interested in the comparison of 10-34-0 to another P source, then only include the rate of 10-34-0 in gallons to determine the cost differential per acre. Any questions or problems please email jcambera@purdue.edu.

Calculator for comparing the cost of P_2O_5 from different P fertilizers				
after adjusting for the potential recovery and value of N in the P fertilizer				
Created by Jim Camberato, Agronomy Dept, Purdue University, jcambera@purdue.edu				
Click on fertilizer, then click on "down" arrow and choose a different fertilizer source	Enter a price per ton of fertilizer			
Primary N source	**Price per ton**	**Price per lb of nutrient**		
UAN-28%	285	\$0.51	\$/lb N	
Usual P source				*Choose an estimate of N credit for the usual P source*
DAP-18-46-0	490	\$0.43	\$/lb P_2O_5	*50%*
Alternative P source				*Choose an estimate of N credit for the alternative P source*
10-34-0	495	\$0.58	\$/LB P_2O_5	*100%*
Click on the box below and choose the comparison of interest, then enter the rate in the box to the right	**10-34-0**		P_2O_5, lbs/acre	Available N, lbs/acre
The alternative P source at this rate to my usual P source	5	gallons per acre	20	6
	DAP-18-46-0			
The equivalent quantity of my usual P source	43	pounds per acre	20	4
Extra cost or savings per acre of using	**10-34-0**	**instead of**	**DAP-18-46-0**	**\$2.88**
N credit for 10-34-0 is typically 100% when applied as a starter fertilizer so the calculation of value is insensitive to N credit chosen for this source.				
N credits should be chosen based on timing of application and weather. 100% if applied shortly before planting. 50% or 0% if applied in the fall or winter. Assumes difference in N application will be made up with the primary N source.				

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