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FACTSHEET ON SOIL FERTILITY AND NUTRIENT MANAGEMENT

N-P-K FERTILIZERS—Cost Calculations and Best-Buy Options

George Silva

Fertilizer cost is the single biggest input cost for grain production. Fertilizers are added to supplement nutrients that are naturally occurring in the soil. Nitrogen (N), Phosphorus (P) and Potassium (K) are the three major nutrients that are added in large quantities for grain production (Table 1). These three nutrients are absorbed by roots as positively or negatively charged ions. Unlike N which is expressed in its elemental form, P and K analysis is typically expressed in the oxide form (P2O5 and K2O). This is a carry-over of early practices when chemists ignited fertilizer samples and weighed the oxides. Attempts to change to elemental forms for all three nutrients have progressed only slowly. Simple conversion factors convert the oxide form to elemental form:

Equation 1. $P = P_2O_5/2.29$

Equation 2. $K=K_2O/1.21$

Fertilizers are available in different forms and grades. They provide either single or multiple nutrients. Because of world trade and increased fertilizer demand in developing countries, retail fertilizer prices have substantially increased since 2010. Growers should be aware of the potential volatility of prices and understand their best options for purchasing fertilizer to suit their cropping system.

Table 1. **N-P-K characteristics and nutrient removal by corn and soybeans**

Nutrient	Dry Matter composition % range	Ionic form absorbed	Nutrients removed by harvested portion of 150 bu corn (lb./A)	Nutrients removed by harvested portion of 40 bu soybean (lb./A)
Nitrogen	1.0 -6.0	NO_3^-, NH_4^+	135	152**
Phosphorus*	0.1 -0.5	$H_2PO_4^-$, HPO_4^{--}	56	32
Potassium*	0.5 -6.0	K^+	41	56

* Nutrient removal expressed in the oxide form

** MSU does not recommend any N fertilizer on soybeans. Most of the N in soybeans is derived by bacteria in the root nodules.

When choosing a fertilizer type, multiple factors need to be considered. The most important are price per unit of nutrients, availability, application equipment, timing, ease of storage, potential for nutrient losses and personal preferences. In this article we will determine the price per unit of nutrients and calculate the cost-to-value ratios.

Cost of Single Nutrient Fertilizer

The cost per pound of a nutrient in single nutrient fertilizers is shown in Table 2. The price per ton is based on February 2011 figures obtained from a local elevator and USDA reports. Keep in mind that these figures vary throughout the year and are used only as examples. Data from single nutrient

fertilizers urea, triple superphosphate and muriate of potash are used to set standard costs for individual nutrients N, P and K, respectively. In this example, a pound of N cost $0.55, a pound of P2O5 cost $0.69 and a pound of K2O cost $0.48.

Table 2 . Cost of single nutrient fertilizers

Single Nutrient Fertilizer	Grade	Nutrient	% Nutrient content	Cost $/ton fertilizer*	Nutrient content lb./ton	Cost $/lb. of nutrient
Urea	46-0-0	N	46	506	920	0.55
Anhydrous Ammonia	82% N	N	82	785	1640	0.48
UAN	28%	N	28	335	560	0.59
Triple Super Phosphate	0-46-0	P205	46	633	920	0.69
Muriate of Potash	0-0-60	K20	60	575	1200	0.48

*Price per ton on February 17, 2011. These figures vary throughout the year.

Cost of Multiple Nutrient Fertilizers

The grade of a fertilizer refers to the percentage of N, $P_2 0_5$ and $K_2 0$ present on a weight basis. The cost per ton of several multiple nutrient fertilizers is shown in Table 3. The cost was divided by 2000 to obtain the cost per pound of fertilizer.

Table 3. Cost of multiple nutrient fertilizers

Multiple Nutrient Fertilizer	Grade	Nutrients	Cost $/ton*	Cost $/lb. fertilizer
Diammonium Phosphate (DAP	18-46-0	N and P	676	0.34
Monoammonium Phosphate (MAP)	11-48-0	N and P	704	0.35
Ammonium Polyphosphate	10-34-0	N and P	680	0.34
Bulk	19-19-19	N, P and K	596	0.30
Bulk	6-24-24	N, P and K	571	0.29

Value of Nutrients in a Multiple Nutrient Fertilizer

Next the value of N, $P_2 0_5$ and $K_2 0$ in each multiple nutrient fertilizer is determined by multiplying the amount of each nutrient in a pound by the standard cost per pound for each nutrient (shown in Table 2) and then adding together the N, P and K values (Table 4). This reflects the value of nutrients that you get for your investment.

Table 4. Value of multiple nutrient fertilizers

Nutrient Fertilizer	Grade	Value of N $/lb. fertilizer	Value of P $/lb. fertilizer	Value of K $/lb. fertilizer	Value of N-P-K $/lb. fertilizer
DAP	18-46-0	0.18 X 0.55 = 0.10	0.46 X 0.69 = 0.32	0	0.42
MAP	11-48-0	0.11 x 0.55 = 0.06	0.48 x 0.69 = 0.33	0	0.39
Ammonium Polyphosphate	10-34-0	0.10 x 0.55 = 0.06	0.34 x 0.69= 0.23	0	0.29
19-19-19	19-19-19	0.19 x 0.55 = 0.10	0.19 x 0.69 = 0.13	0.19 x 0.48 = 0.09	0.32
6-24-24	6-24-24	0.06 x 0.55 = 0.03	0.24 x 0.69 = 0.17	0.24 x 0.48 = 0.12	0.32

Cost-to-Value Ratio of Multiple Nutrient Fertilizers

The cost-to-value ratio of each multiple nutrient fertilizer is determined by dividing the cost per pound of a multiple nutrient fertilizer (Table 3) by the value of its three nutrients (Table 4). The cost-to-value ratios of the multiple nutrient fertilizers are shown in Table 5. The lowest cost-to-value ratio is the best buy, because you get more value for what you pay, assuming that the fertilizer being evaluated supplies all the nutrients needed. In this example, DAP demonstrates its best buy potential because it has the lowest cost/value ratio. As the ratio increases the unit price of nutrients becomes more costly.

Table 5. Cost-to-Value ratio of multiple nutrient fertilizers

Multiple Nutrient Fertilizer	Cost $/lb. fertilizer	Value $/lb. fertilizer	Cost/Value Ratio
DAP	0.34	0.42	0.81
MAP	0.35	0.39	0.90
Ammonium Polyphosphate	0.34	0.32	1.17
19-19-19	0.30	0.32	0.91
6-24-24	0.29	0.32	0.91

Other Considerations

As previously mentioned, several other factors also enter into consideration when deciding on a fertilizer type. Anhydrous ammonia is the cheapest N source and despite its hazardous nature, it is used extensively to sidedress corn. Anhydrous ammonia has to be injected into soil and requires more power for application than its N counterparts. The UAN solution, which is a mixture of urea and ammonium nitrate in water, can be sprayed or dribbled on the surface of soil. When urea or UAN solutions are surface applied, there is an additional investment on urease inhibitors that may be used to prevent ammonia volatilization losses. Crop responses to liquid and dry fertilizer are similar, provided the amount and placement of nutrients are the same.

Recently the consumption of triple superphosphate has decreased because of the competitiveness and better storage properties of DAP and MAP. The DAP with its high ammonium content can cause seedling injury if placed in direct contact with seed. In contrast, MAP which has less ammonium is a better choice as a starter fertilizer. Ammonium polyphosphate (10-34-0) is popular in starter and pop-up applications because it is a liquid and therefore easier to customize lower application rates and mixing with pesticides. For fall application of P and K for build-up or maintenance, a bulk fertilizer high in P and K such as 6-24-24 would be preferred.

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