

Fertilizer Sources: Nutrients Needed by Plants



All plants require the same 17 nutrients to grow and reproduce. Three of these nutrients [carbon (C), hydrogen (H), and oxygen (O)] come from the air and water, leaving 14 to come from the soil plants grow in. These 14 nutrients fall into three categories: primary, secondary, and micronutrients.

- **Primary nutrients:** Nitrogen (N), phosphorus (P), and potassium (K).
- **Secondary nutrients:** Sulfur (S), calcium (Ca), magnesium (Mg).
- **Micronutrients:** Boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), zinc (Zn), chlorine (Cl).

Primary nutrients are those most often applied each season in crop production systems, including grain crops, hay/silage crops, and pastures. When plant materials are removed (i.e., harvesting grain, baling hay, chopping silage, or grazing), these nutrients are also removed from the system. The soil does supply additional nutrition over time—soil nutrients will eventually be mined to very low levels. These levels are determined through soil testing. To increase soil nutrients for plants, the application of fertility products is advised based on soil levels and nutrients required for the production system.

A common misconception is that certain fertilizer sources are safer for plants and the environment than other products. Improper fertilizer application of any kind can contribute to surface and groundwater pollution, may induce a plant nutrient deficiency or toxicity, or cause salt burn. Properly used, all fertilizers are safe for plants and the environment.

Traditional Fertilizer Sources

Traditional fertilizer sources have been given various names over the years—synthetic, commercial, inorganic, mineral, etc. These sources are often single, higher concentrations of defined nutrients. Due to this higher concentration, these

sources can be used in lower amounts than the sources discussed later in this document. These products are not man-made or unnatural products. Indeed, they come from the air or minerals in the earth.

The numbers on a fertilizer label refer to the concentration (percent) of the three primary nutrients in the material: nitrogen, phosphorus as phosphate (P_2O_5), and potassium (K_2O). These three numbers are required by national and state laws to reflect the minimum percentages of each nutrient contained in the product.

Nitrogen: Through the Haber-Bosch process, hydrogen (H_2) and nitrogen (N_2) gases react under high pressure and temperatures to form ammonia gas (NH_3). The produced NH_3 can be used as anhydrous ammonia fertilizer, or for the manufacture of other nitrogen fertilizer products.

Phosphorus: Most materials for phosphorus fertilizers come from mined rock phosphate. Rock phosphate is mined from raw ore deposits in various areas of the world.

Potassium: Often referred to as potash, potassium fertilizers are mined from potassium salt deposits found beneath the earth's surface, in the beds of dried lakes and seas, and from saltwater reserves. After removal, the salts are purified and treated, yielding fertilizer compounds.

Organic vs Certified Organic Sources

Organic/natural sources: These sources tend to have nutrients at lower and more variable concentrations than traditional sources, so they need to be used in larger amounts. These sources tend to come from animal and plant byproducts. These materials include animal manures, bonemeal, blood meal, sawdust, straw, and crop residue. The publication, *Approximate Composition of Select Natural Fertilizer Materials (MF3374)*, <https://bookstore.ksre.ksu.edu/item/MF3374>, can help determine manure nutrient availability and the approximate nutrient content for some sources.

Commonly Available Fertilizers and Their Analysis

Product Name	Chemical Form	% Nutrient	Product State
Nitrogen Sources			
Anhydrous ammonia	NH ₃	82-0-0	High-pressure liquid, low pressure gas
Urea	(NH ₂) ₂ CO	46-0-0	Solid
UAN (urea plus ammonium nitrate solution)	CH ₆ N ₄ O ₄	28-0-0 or 32-0-0	Liquid solution
Ammonium nitrate	NH ₄ NO ₃	34-0-0	Solid, highly controlled
Ammonium sulfate	(NH ₄) ₂ SO ₄	21-0-0-23S	Solid
P₂O₅ Sources			
Monoammonium phosphate (MAP)	NH ₄ H ₂ PO ₄	11-52-0	Solid
Diammonium phosphate (DAP)	(NH ₄) ₂ HPO ₄	18-46-0	Solid
K₂O Sources			
Potassium chloride (potash)	KCl	0-0-60	Solid

Note: This is not an exhaustive list. Additional forms may be available in local areas and regions.

Additionally, the analysis of the specific manure used, method of application, time delay between manure application, tillage, application equipment calibration, and other specific field/crop conditions all affect the amount of manure nutrients that become available to the crop. Unless all these factors are considered, the crop nutrients in the manure will not be used efficiently, and questions pertaining to environmental stewardship may remain. Sampling organic sources is necessary to determine nutrient makeup and application amounts, as these sources vary.

Certified Organic sources: These sources are required in certified organic production systems. These fertilizer sources are vigorously screened and must be used to remain compliant with the USDA Organic program standards. Materials in this category can be found in NOP 5034-1, *Guidance: Materials for Organic Crop Production*, published by the USDA Agricultural Marketing Services.

Plants can only take up these essential nutrients when they are in the correct form, regardless of the source. A significant portion of nutrients in organic (certified or not) sources

are in organic forms and not initially available for plant uptake. The nutrients have to go through mineralization, which is the conversion of organic forms of nutrients to plant-available, inorganic forms of nutrients by soil microbes during decomposition of organic materials such as manure. Because soil microbial activity is affected by uncontrollable factors such as soil temperature and moisture, crediting the amount of crop-available nutrients provided by organic applications cannot accurately be predicted.

Additional Resources

Approximate Composition of Select Natural Fertilizer Materials, MF3374 (bookstore.ksre.ksu.edu/item/MF3374)

Estimating Manure Nutrient Availability, MF2562 (bookstore.ksre.ksu.edu/item/MF2562)

Fertilizing Gardens in Kansas, MF2320 (bookstore.ksre.ksu.edu/item/MF2320)

Soil Test Interpretations and Fertilizer Recommendations in Kansas, MF2586 (bookstore.ksre.ksu.edu/item/MF2586)

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