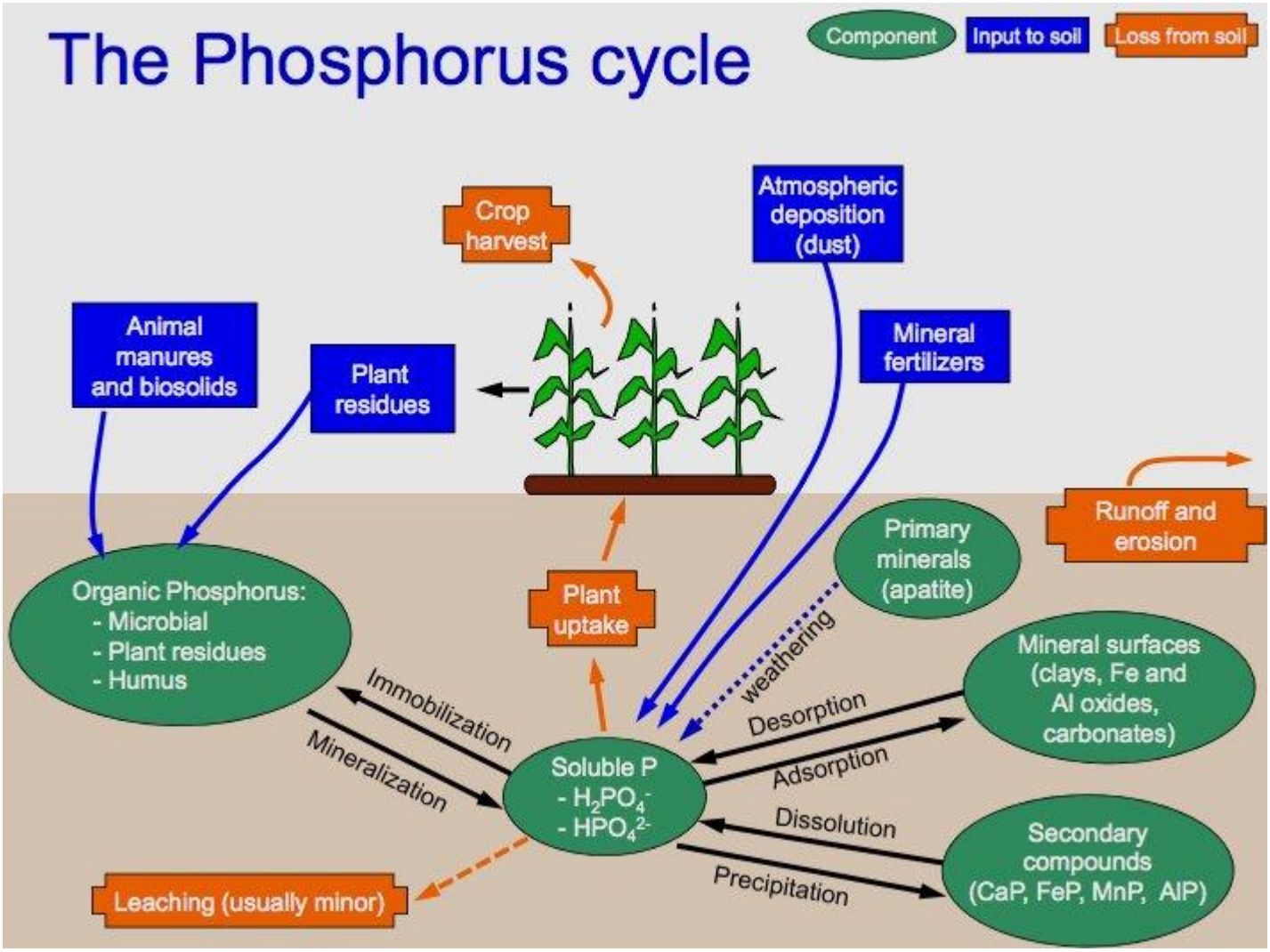
Biosolid Facts – Supplement 2

Phosphorus Management

Phosphorus is an essential nutrient for plant life and growth. Found naturally in soils and in phosphate-heavy rock, phosphorus is also found in human and animal waste, fertilizers, and plant residues. Phosphorus has also become a topic of concern in water quality, because high levels of phosphorus entering fresh water systems can drive excessive algae growth and hypoxic conditions in some lakes. Farmers, state and federal agencies, and universities work toward ensuring proper phosphorus management on agricultural lands. This document provides a short summary of how phosphorus acts in and can potentially run off or leach from soils, and how it is managed through testing and responsible application of fertilizers, manure, and biosolids.

One key to understanding how phosphorus is added, bound, becomes plant available and is potentially lost, is to review the basic phosphorus cycle:

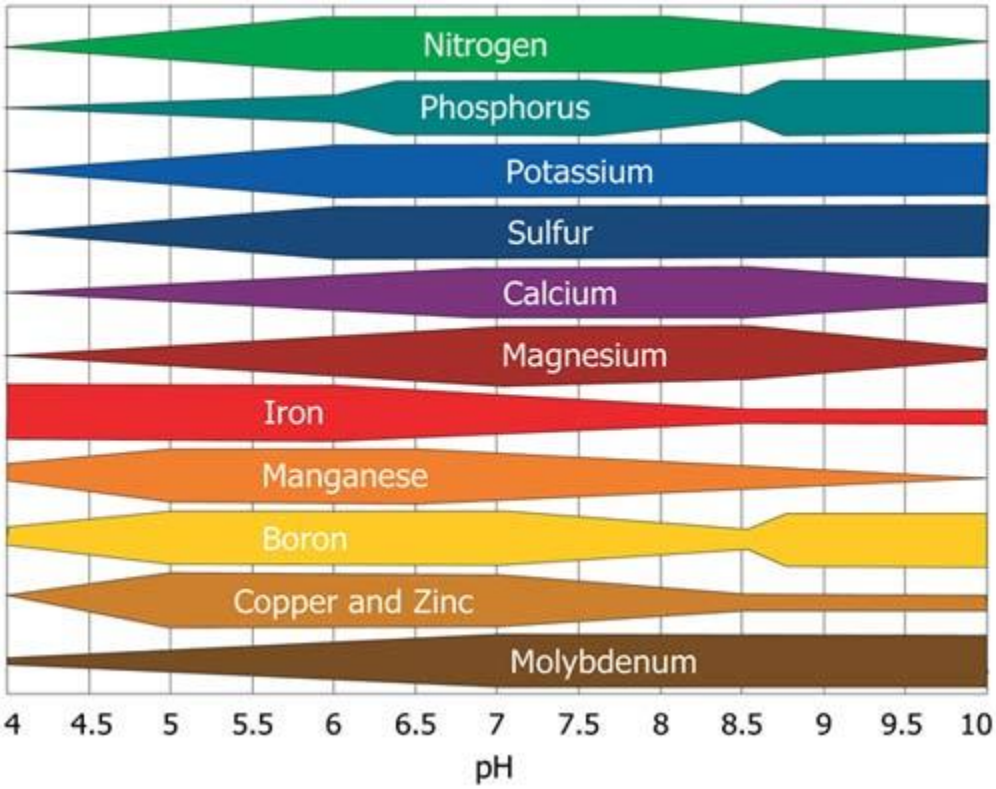


(www.wikipedia.com)

Sources of phosphorus and how phosphorus becomes plant available

Phosphorus is most commonly added to soils from fertilizers, animal manures, and biosolids from municipal wastewater treatment plants (WWTPs). Depending on the crop and expected yield, different amounts of the major plant nutrients, nitrogen (N), phosphorus (P) & potassium (K), are needed. Soils may provide part or all of the necessary nutrients, and soil tests are performed to measure available nutrients to determine if and how much additional nutrient is needed. Some of the most common tests to determine phosphorus levels are the Mehlich 3 and Bray P1 tests.

Different sources of phosphorus behave differently in different soil types. Additionally, phosphorus and other nutrients and minerals become most soluble at different levels of acidity or alkalinity of the soil:



(www.pioneer.com)

Soil pH, texture (the balance of clay, sand and loam), chemical properties, and organic content should therefore all be taken into consideration when planning nutrient application, including phosphorus. For more information on phosphorus forms and nutrient application considerations, many resources are available, including the following:

The U.S. Department of Agriculture provides information on phosphorus in fertilizer from *Advances in Agronomy*: The Impact of Soil and Fertilizer Phosphorus on the Environment and from *Fertilizer Research*: The Environmentally Sound Management of Agricultural Phosphorus.

USDA additionally provides resources on manure phosphorus such as The Agricultural Waste Management Field Handbook. Michigan State University has several publications on manure phosphorus, including: Utilization of Animal Manure for Crop Production, Part I: Management of Manure Nutrients and Water Quality and Utilization of Animal Manure for Crop Production, Part II: Manure Application to Cropland

The Water Environment Federation provides information about the phosphorus in biosolids: Phosphorus in Biosolids Fact Sheet and Phosphorus in Biosolids: How to Protect Water Quality While Advancing Biosolids Use.

Nutrient Recommendations

When reviewing nutrient recommendations for phosphorus, the form of phosphorus and purpose for application is extremely important to determine proper amounts. The mix of nutrients available in the form applied, and the essential goal of the application will make application rates vary greatly.

Fertilizer:

When applying fertilizer, farmers must account for the monetary cost of the fertilizer and so the purpose of recommendations for nutrient application is agronomic: to apply the minimum amount of nutrient needed for crop production goals. See Nutrient Recommendations for Field Crops in Michigan or Nutrient Recommendations for Vegetable Crops in Michigan, from Michigan State University, Generally Accepted Agricultural and Management Practices for Nutrient Utilization from the Michigan Department of Agriculture and Rural Development (MDARD), or Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa from Purdue University, Ohio State University, and Michigan State University for examples.

Manure:

The ability to selectively increase or decrease the amount of nutrients contained in manure is limited. For many crops, more manure must be applied to meet nitrogen needs than would be necessary to apply solely for phosphorus needs. Additionally, manure can frequently be obtained for little or no cost. Therefore, instead of setting minimum crop uptake recommendations for all nutrients like with fertilizer, manure recommendations focus on crop uptake needs for the most limited nutrient found in manure: nitrogen.

However, applying manure *only* at nitrogen crop uptake rates would require applying at a rate that the phosphorus levels in the receiving soil would eventually rise high enough to increase the risk that phosphorus would run off or leach from the soil. Therefore, manure application recommendations are tied to nitrogen needs, but must stay below the level of soil phosphorus at which the risk of runoff begins to increase. Whereas fertilizer recommendations are based on an economic or agronomic standard, manure recommendations are based on an environmental protection standard.

Risk of phosphorus runoff varies by all of the soil factors mentioned above, but most guidance points to the level of soluble, or plant available, phosphorus beginning to pose a leaching risk at Bray P1 test levels above 300 pounds per acre (150 parts per million (ppm)), or Mehlich 3 soil test levels above 340 pounds per acre (170 ppm). Therefore manure recommendations incorporate that limit and provide guidance for farmers on how to avoid exceeding this level of phosphorus in the soil when applying manure on agricultural lands. See Generally Accepted Agricultural and Management Practices for Manure Management and Utilization from MDARD, Manure Management – Tile Drained Land from Michigan State University, the Nutrient Management Standard 590 from the USDA Natural Resources Conservation Service, and for livestock farms operating under permit from the Department of Environmental Quality, see Concentrated Animal Feeding Operations Permits.

Biosolids:

Biosolids are a nutrient form somewhat similar to manure, so the purpose of nutrient recommendations is the same: environmental protection. Also, the method of setting recommendations is the same: apply at crop uptake rates for nitrogen, but only up to Bray P1 test level of 300 pounds per acre (150 ppm), or a Mehlich 3 soil test level of 340 pounds per acre (170 ppm) of soluble phosphorus in the soil. However, the key difference between manure and biosolid application rates is that while in most cases manure application rates are

recommendations, biosolild application rates are a requirement under federal and state laws and rules. Michigan's biosolids application restrictions include testing for phosphorus in addition to nitrogen, which is stricter than the federal standard's requirement to test for nitrogen.

Under the Part 24 Rules, biosolids must be applied at "agronomic rate," which means: "the calculated biosolids application rate (dry weight basis) which provides the amount of plant-available nitrogen needed by the crop or vegetation grown on the land; which minimizes the amount of nitrogen that passes below the root zone of the crop or vegetation grown; and which considers the amounts of phosphate (P2O5) and potash (K2O) added by the biosolids as part of the total nutrient management plan."

Biosolids cannot be applied to agricultural land if the Bray P1 soil test level exceeds 300 lbs P/acre (150 ppm) or if the Mehlich 3 soil test is greater than 340 lbs P/acre (170 ppm). For forestland and tree farms, biosolids cannot be applied if the Bray P1 soil test level exceeds 200 lb P/acre (100 ppm) or the Mehlich 3 soil test level exceeds 220 lb P/acre (110 ppm). See Part 31 of the Natural Resources and Environmental Protection Act (NREPA), at Sec. 324.3131 et. seq., Part 24 Rules of the Michigan Administrative Code, and Title 40 of the Code of Federal Regulations (CFR), Part 503 for more information.

Nutrient Application

How nutrients are applied can reduce or increase the chance of phosphorus running off or leaching from the soil and presenting water quality risks. Many of the above referenced guidelines include recommendations for application, both to maximize potential crop yield and to minimize the risk of nutrient loss. As with other forms of nutrients, while most are guidelines, biosolids application is strictly regulated and depending on the treatment level of the material, requires setbacks from surface water and wells, limitations on soil conditions on which it can be applied, and may also require incorporation. The Michigan Water Environment Association (MWEA) has provided fact sheets and supplements summarizing the requirements for biosolids application, as a convenient tool to supplement information provided in the requirements referenced above. See Biosolids Facts, and Biosolids Facts – Supplement 1 for more information.

In addition to requirements for biosolids land application, MWEA has developed recommendations to assist biosolids land appliers with additional practices to help minimize odors, dust, and other concerns that may cause problems for nearby residents. See Land Application of Biosolids in Michigan: Management Recommendations for more information.

Questions or concerns can be directed to the biosolids generator, or to DEQ or MDARD:

Mike Person, Michigan Department of Environmental Quality (DEQ) Biosolids Program, Statewide Program Coordinator: (989) 297-0779, personm@michigan.gov, or www.michigan.gov/biosolids (to reach regional staff in the Biosolids Program, see: https://www.michigan.gov/documents/deq/wrd-biosolids-staff_402800_7.pdf).

Kristin Esch, Michigan Department of Agriculture and Rural Development (MDARD), Produce Safety Specialist: (517) 930-6592, eschk@michigan.gov, or www.michigan.gov/producesafety.