Biosolids Use for Row Crop, Forage, and Hay Lands

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Biosolids use in agriculture

Biosolids contain all essential plant macro- and micro-nutrients and can serve as a substitute for or reduce the use of chemical fertilizers. The basis for biosolids application rate is usually to supply crop nitrogen (N) needs. Because biosolids N is comprised of both organic and inorganic forms, they provide both readily-available and slowly-released nitrogen that can meet short and long-term crop N needs. Additional biosolids constituents that benefit crop production are described in fact sheets on nutrients, organic matter, and biostimulants.

Biosolids use for row crops

Traditional row crops (i.e., corn, wheat, soybean) have received many of the benefits of land-applied biosolids. Binder et al. (2002) determined that corn grain yields from biosolids application were similar to or exceeded chemical fertilizer in all four years of their trial. In the same study, they found that biosolids applied at rates of 9.1 to 18.2 Mg biosolids dry weight ha-1 (4-8 tons/acre) were similar to or exceeded chemical fertilizer treatments receiving 120 to 150 kg fertilizer N ha-1 (107-134 lbs/acre). Binder et al. (2002) estimated that the cumulative N fertilizer value of a single biosolids application in a 4-year period to be $136 ha-1 ($55/acre) for irrigated maize and $68 ha-1 ($28/acre) for rainfed sorghum. Montovi et al. (2005) found that biosolids gave similar yields as chemical fertilizer when applied to grain corn and sugar beet. Currie et al. (2003) found that the application of biosolids to soybean increased yields in comparison to non-amended soybean. Cotton has also shown to benefit from biosolids application. Samaras et al. (2008) found that biosolids increased cotton N and phosphorus (P) uptake and yield compared to chemical fertilizer.

Field trials conducted in Virginia (Li et al., 2013; Zhang et al., 2013, Bamber et al., 2016) have demonstrated greater yields for corn and winter wheat from biosolids than chemical fertilizers. Corn ear leaf N, corn stalk nitrate N, and grain yield were greater in biosolids-amended soils in comparison to chemical fertilizer (Li et al. 2013). Zhang et al. (2013) found that biosolids increased corn grain yield compared with chemical fertilizer. They suggest that the biosolids likely provided a benefit greater than the essential plant nutrient supply, e.g., biostimulant effect on plant physiological response to drought. Bamber et al. (2016) compared application of biosolids and urea to soft red winter wheat in Virginia. They found that lime-stabilized biosolids applied in the fall at 100 kg of plant available N per hectare (89 lbs N/acre) provide higher N use efficiency and grain yield than chemical fertilizer for winter wheat.

Ozores-Hampton et al. (1998) found that biosolids increased crop yields of tomatoes, squash, and beans. Zubillaga and Lavado (2002) found composted biosolids caused a 20% and 40% increase in lettuce dry weight and fresh weight. In this study, lettuce served as a test crop due to its sensitivity to heavy metals, whose concentrations in lettuce were below U.S. EPA and European Union toxicity standards (USEPA, 1993; Council of European Communities, 1986).

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Biosolids use regulations for row crops

There are no restrictions for harvesting of crops when exceptional quality (Class A treatment plus Alternative Pollutant Limit) biosolids are applied. If Class B treated biosolids are used in the production of food crops, the U.S. EPA (1994) has provided the following restrictions:

1. Food crops with harvested parts that touch the biosolids/soil mixture (such as melons, cucumbers, squash, etc.) shall not be harvested for 14 months after application.
2. Food crops with harvested parts below the soil surface (root crops such as potatoes, carrots, radishes) shall not be harvested for 20 months after application if the biosolids is not incorporated for at least 4 months.
3. Food crops with harvested parts below the soil surface (root crops such as potatoes, carrots, radishes) shall not be harvested for 38 months after application if the biosolids is incorporated in less than 4 months.
4. Food crops, feed crops, and fiber crops shall not be harvested for 30 days after biosolids application.

Biosolids use for pasture and hay lands

Forage crops are grown as animal feed and can either be directly consumed in pastures or cut and preserved/stored as hay before the plant goes to seed to maximize the nutritional quality (U.S. Forage Export Council, 2019). Biosolids applications should be timed so nutrients are available immediately before maximum nutrient uptake. For cool season grasses, this occurs in early spring (March-April) or late summer (August-September). This timing also minimizes smothering effects of biosolids on cool season forage growth. Applications to warm season grasses must occur during the active growing season (March 15 through September 15) to prevent the runoff of nutrients.

Cogger et al. (2013) found that 10 years of annual biosolids application increased long term (9 subsequent years) soil fertility as well as tall fescue yield compared to chemical fertilizer. Biosolids improved bahiagrass pasture growth and quality over chemical fertilizer, while increasing crude protein concentrations (Tiffany et al., 2000) and yield and quality (Sigua et al., 2005). Castillo et al. (2011) determined that the incorporated biosolids and surface-applied ammonium nitrate yielded similar elephantgrass biomass. Mullen et al. (2005) observed lower winter wheat forage yields from biosolids than ammonium nitrate due to lower than expected plant available nitrogen from the biosolids.

Much research has been conducted to assess the potential risk associated with biosolids application and molybdenum in forages. Molybdenosis, a disease in ruminant animals (such as cows) caused by excessive intake of molybdenum, is due to copper deficiency. Pierce et al. (1998) and Sullivan (2008) found that biosolids increased the copper:molybdenum ratios in forages, which improved biomass and nutritional quality. Mullen et al. (2005) observed an increase in soil copper:molybdenum ratios and found minimal risk of molybdenosis to livestock from biosolids applied to winter wheat. Conversely, Gaskin et al. (2003) found copper:molybdenum ratios to decrease over time. They suggested this effect can be ameliorated by feeding a copper supplement to the ruminant.

Biosolids use for pasture and hay lands

For Exceptional Quality, Class A biosolids there is no time interval required between application of biosolids and hay harvest or grazing. If Class B biosolids are used, the time interval between application and hay harvest or grazing is 30 days for non-lactating cattle and 60 days for lactating dairy cattle to reduce direct ingestion of possible pathogens (USEPA, 1994; VADEQ, 2008).

Conclusions

In summary, both Class A and Class B biosolids have been used successfully in commercial row crop, pasture and hay land agriculture. They increase yields and quality of crops by supplying essential plant nutrients, improving soil properties, and inducing biostimulant benefits under environmentally stressful conditions, such as drought.

Resources

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