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Northwest Biosolids Management Association

Biosolids and Wheat Production: Summary of On-Farm Research at 11 Sites

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Background

Dryland grain crops such as wheat and barley are well suited to biosolids applications, and fertilizing these crops is an important use of biosolids in the Pacific Northwest. Agronomic and environmental factors make dryland grain production sensitive to nitrogen application rates. It is important to understand how dryland grain crops respond to biosolids fertilization across a variety of environments, so that we can apply biosolids at rates that will yield the greatest benefits.

Objectives

Evaluate biosolids effects on grain yield, grain quality, and post-harvest soil nitrate-N in wheat-fallow cropping systems, and estimate the economic value of biosolids fertilization to farmers.

Methods

We established 11 experiments on commercial wheat farms in the dryland grain production area of Washington and Oregon. Five sites were located in central Washington (Douglas and Kittitas Counties), four in eastern Washington (Adams, Lincoln, and Spokane Counties) and two in north-central Oregon (Sherman County). The farms were on silt loam or loam soils, except for the Spokane County farm, which was on a sandy loam.

All experiments were laid out in randomized, replicated designs. At most of the sites treatments were applied to large strip plots, approximately one acre in size. Three of the sites had smaller plots. Each experiment included at least two biosolids rates, at least one inorganic N rate, and a zero-N control. This note summarizes results from the lowest biosolids rates that could be spread evenly at each site, approximately 2.5 to 5 tons/acre dry

Methods

weight of biosolids, or 200 to 400 lb total N/acre. The crop at all sites was soft white winter wheat grown in a 2-year wheat-fallow rotation. Biosolids were applied during the fallow, usually to stubble from the previous crop. Cooperating farmers at each site managed the plots according to their normal practices. We measured grain yield, protein, and test weight at harvest, and sampled soil for nitrate-N after harvest.

Results

Grain yield. At four of the eleven sites the biosolids treatment had greater grain yields compared with inorganic N. At five sites grain yield with biosolids was equal to grain yield with inorganic N fertilizer. The remaining two sites showed no response to either inorganic or biosolids N, probably because of high N levels in the soil. Three of the four sites with superior yields from biosolids had good soil moisture and enough timely rainfall to boost yield potential. At the fourth site (the sandy soil), slow release of N from biosolids was able to compensate for N lost from the rooting zone during snowmelt in the fallow year.

Grain quality. Biosolids increased grain protein compared with the inorganic N treatment at seven of the 11 sites. Across all locations, average grain protein was 11.3%, compared with 9.5% for inorganic N. Increased grain protein is beneficial for hard red and hard white wheat, but not for soft white wheat, which is the type most commonly grown in the Northwest.
Biosolids applications decreased test weight at four of the eleven sites. Test weight is a measure of grain plumpness, and depends on moisture available to the crop during the grain filling period. More vigorous growth of plants fertilized with biosolids may lead to increased moisture stress and reduced test weight in some situations.

Post-harvest soil nitrate. High levels of post-harvest soil nitrate-N are often the result of excess available N supplied to the crop. At eight sites post-harvest soil nitrate N was similar for the biosolids and inorganic N treatments, indicating that in most cases biosolids N can be applied and utilized at rates that do not increase nitrate leaching potential. Of the three sites where post-harvest nitrate levels increased with biosolids, two were sites with the highest rates of biosolids N applications.

Significance

Biosolids effectively replaced inorganic N across a range of dryland wheat production conditions. For the biosolids rates used in these experiments the economic value of the biosolids was about $1 per wet ton, based on an inorganic N fertilizer replacement value of $15 at equivalent yield. In some years increased yield would lead to additional economic benefits.

Biosolids applied at the target agronomic rates supplied more N than the standard inorganic N fertilizer applications. While all varieties of wheat benefit from biosolids applications, growers are likely to gain the greatest economic benefits from those varieties that are most suited to biosolids applications. These include varieties that are resistant to lodging and varieties that increase in value with increased protein. Wheat breeders at Washington State University are currently developing high protein hard white and hard red wheat varieties that are adapted to different Northwest dryland grain environments. These varieties could provide additional economic benefits on land fertilized with biosolids.

Keywords: nutrient management, nitrogen, dryland agriculture **Revision Date**: August, 2003