Biosolids-based Fertilizers in California Wheat

Konrad Mathiesius, Agronomy Advisor, UCANR; Makena Savidge, PhD candidate and Research Assistant, UC Davis Department of Land, Air and Water Resources; Daniel Geisseler Associate CE Specialist, UC Davis Department of Land, Air and Water Resources

Abstract

Biosolids-based fertilizers can be cost-effective sources of nitrogen (N) for wheat and other agronomic crops. As more California municipalities begin to prioritize the diversion of waste products from landfills into agricultural systems, it is pressing for growers to understand how to utilize new inputs such as liquid-injected biosolids-based fertilizer (LBF) in their operations. The use of biosolids as a fertilizer can also prevent unnecessary disposal of phosphorus, nitrogen, and carbon into landfills. Field trials comparing the performance of LBF to conventional N sources were conducted over the course of three planting seasons in wheat in the southern Sacramento Valley. Laboratory incubations were also carried out to examine the impact on soil chemistry of the LBF relative to a pelleted biosolids-based fertilizer (PBF), and conventional urea. Results indicate that LBF produces equivalent yield and protein results in wheat when compared to conventional forms of fertilizer as an N source. Other findings indicate that there may be some ancillary benefits associated with the use of LBF by providing a source of phosphorus (P), carbon, micronutrients, and water. This suggests that LBF may be a reasonable option for N fertilization for rotational growers in the south Sacramento Valley.

Methods

Field trials were conducted between 2018 and 2021 in the southern Sacramento Valley to evaluate the yield and protein outcomes of fall-planted wheat fertilized with biosolids-based materials across different soil types and moisture regimes. LBF was compared side-by-side with similar rates of conventional mineral N fertilizers. Treatments included 0 or 3 rates of LBF and an application of conventional fertilizer (anhydrous ammonia, UAN32, or urea) at a rate that matched one of the biosolids rates in terms of total N applied per acre. LBF was injected and integrated to a depth of 6 inches on 22.5 inch spacing. Yield and protein data were collected from grain harvest using grower-collector combines and weigh wagons. Soil and plant tissue data were collected to document the impact of the material on soil and plant nutrients in-situ. Lab incubations were also carried out (at field capacity, 75%) to document changes in key soil attributes (N mineralization rate, Olsen P, EC, and pH) between LBF, pelleted biosolids-based fertilizer (PBF), and urea.

Site Details

<table>
<thead>
<tr>
<th>Values represent total lbs of N / acre applied</th>
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<tbody>
<tr>
<td>Year 2018 2019 2020</td>
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<tr>
<td>LBF Low 57 66 73</td>
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<tr>
<td>LBF Medium 90 82 146</td>
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<tr>
<td>LBF High 98 219</td>
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<tr>
<td>Conventional Fertilizer 90 ‘mod 120 ‘high 130 ‘mod</td>
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<tr>
<td>Fertilizer Type Anhydrous UAN 32 Anhydrous</td>
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<tr>
<td>Relative Rainfall Pattern Average-Drought Above Average Extreme Drought</td>
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<td>Location Upland: Binh's Landing Valley: Dixon Area Valley: Rio Vista</td>
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</tbody>
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Results: Yield and Protein

Predominantly insignificant yield and protein differences were seen between treatments; however, there were occasional differences that hint at slightly slower N mineralization rates which can lead to improved protein uptake (increases in wheat protein are typically associated with N-uptake in the latter stages of a growing season). In the drought years of 2018 and 2020 the addition of LBF treatments associated with the LBF treatments may have facilitated earlier stand establishment during high drought-stress periods.

![Figure](image)

Differences in Plant and Soil Measurements

Plant and soil measurements taken from the sites indicate that there were relatively few significant differences between treatments. Soil phosphorous levels did show some indication of a response to relatively high levels of phosphorous associated with biosolids materials.

![Figure]

Lab Incubations

Lab incubations reflected some of the patterns witnessed in the field: Increases in phosphorus, slower N mineralization rates, and otherwise similar soil chemistry outcomes relative to that of conventional fertilizer, particularly after 12 weeks.

Key findings:

- Liquid-injected biosolids-based fertilizers (LBF) were insignificantly different to conventional forms of N in terms of yield and protein when used at similar rates of total applied N.
- Nitrogen use efficiency trended slightly higher in LBF treatments relative to conventional forms of N (LBF: 95.6%, Conventional: 92.4%), but was insignificantly different.
- LBF and pelleted biosolids-based fertilizer (PBF) fertilizers both had a rapid initial release of N, followed by a slow and steady release curve that, relative to urea, released about 40% less N by the end of the 12 week incubations.
- Soil nitrate values at tilling were largely insignificantly different, but trended slightly higher in biosolids treatments at equivalent rates of lb N/acre in an above average rain year (2019). Incubations indicated that LBF and PBF treatments increased soil phosphorous, these patterns were visual in some of the soil and plant data as well.
- LBF and PBF caused less of an increase in soil salinity relative to conventional urea.
- LBF and PBF caused less of an initial drop in pH relative to conventional urea, but pH became insignificantly different between treatments by week 6 (likely due to soil buffering).

Ongoing Research and Caveats

Preliminary results from 2023 indicate lower sufficiency index (SI) ratings from LBF relative to anhydrous ammonia fertilizer. SI indicates crop nitrogen status (as NDER) relative to a well-fertilized reference zone, where SI values below 0.87 are considered possibly deficient and SI values below 0.93 are considered deficient. These outcomes are possibly related to the exceptionally high rainfall in 2022-2023, and the water-logged conditions of the soil at the site, but these data, combined with those from previous seasons reinforce the importance of active N-management and N-monitoring in small farms. Future research will help clarify LBF’s potential as an N source in agricultural operations.