PERFORMANCE OF PUBLIC AND PRIVATE FERTILIZER RECOMMENDATIONS FOR CORN, ALFALFA, AND SMALL GRAINS

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ABSTRACT

There are many sources that growers utilize to determine fertilizer needs for crops such as private and public labs, crop advisors, and fertilizer dealers. In many cases, these sources provide recommendations for a specific crop that can vary greatly, and the resulting fertilizer and application rates recommended can lead to large differences in costs for the grower. Evaluating the effectiveness and economics of current fertilizer guidelines and recommendations will help growers to make better-informed decisions about recommendation sources and fertilizer levels. An experiment was established in 2021 with 12 sites across the state of Utah in alfalfa, small grains forage, and corn to test and compare fertilizer recommendations from five labs. The recommendations tested were from two public labs (Utah State University and the University of Idaho) and three private labs located in the Western United States. Based on a large composite soil sample sent to multiple labs, the corresponding macronutrient and micronutrient rates recommended by each lab were then applied in four replications at each site. All fertilizer products were broadcast-applied as granular products in the spring of 2021. Results from 2021 showed little to no differences in crop yield or forage quality between the five recommendations and the nonfertilized control. Trials at seven of the sites were repeated in 2022 to confirm results, with little to no differences being observed in the second year. Thus, over two seasons and 37 total harvests, there were few differences in yield and forage quality between fertilizer recommendations and the nonfertilized control. In the few cases where production was improved, the nonfertilized control was still the most profitable. The cost for each of the recommendation treatments varied greatly ($350-$1,800 per acre). These results do not indicate that fertilizers are unnecessary, but that there are large differences in recommendations and room for improvement and public-private coordination.

INTRODUCTION

Fertilizer bills can contribute to some of the highest input costs on the farm. Applying the right amount, at the right time, and in the right way can drastically influence farm profits. Too little or too much fertilizer can hurt the bottom line, prompting many growers to seek outside help for making these important decisions.

The most common sources for fertilizer recommendations are from private and public soil testing labs, crop advisors, fertilizer dealers, and university extension services. Private labs are sometimes criticized for being too liberal with their fertilizer recommendations and public labs for being too conservative. These differences make it difficult for farmers to know where to get the best recommendations from. While both public and private advisors actively try to avoid or correct nutrient deficiencies to help growers thwart yield and profit loss, these efforts can sometimes lead to excessive and unprofitable fertilizer recommendations. Unbiased comparisons of the most common fertilizer recommendations from public and private sources are needed to help growers improve their nutrient management practices. This need prompted a set of on-farm research trials in Utah to investigate how various fertilizer recommendations perform. Few previous studies have compared how various recommendations perform (Follet and Westfall,

1986; Follet et al., 1987; and Jacobsen et al., 2002). The objective of this research is to evaluate and compare the fertilizer recommendations from several public and private soil testing labs based on how they impact crop yield, quality, and economic returns.

METHODS

The field research for this experiment was conducted in 12 fields on farms across the state of Utah in corn, alfalfa, and small grains in 2021 to test and compare the fertilizer recommendations of five labs. The recommendations tested were from two public labs [Utah State University (Cardon et al., 2008) and University of Idaho] and three private labs located in the Western United States. A single, large composite soil sample from the 0-12 inch depth from each field was dried, ground, split, and sent to each of the labs for analysis. Each of the labs was also given information such as previous crop, current crop to be grown, and yield goal to calculate recommendations. The macronutrient and micronutrient rates recommended by each lab were then applied in four replications at each of the 12 fields. A control with no fertilizer applied was also included.

All fertilizer products were broadcast-applied in the early spring of 2021 as dry granular products due to difficulty in applying isolated liquid fertilizers to small plots. Fertilizer products were chosen to isolate nutrients as much as possible so that precise amounts of nutrients could be applied together. For example, triple super phosphate and ammonium nitrate were used to isolate phosphate and nitrogen rather than more commonly used fertilizer mixes.

In 2022, the trials were repeated at 7 of the 12 sites to confirm results. Due to logistics and additional time to plan and prepare for trials in 2022, a composite sample was collected for each of the six treatments rather than a single composite for the entire plot area. Soil test values from the 2022 samples were used to develop and apply the new recommendation in 2022. This was completed by treatment and the treatment locations were not changed. The dry, granular micronutrients (Zn, Mn, B, and Cu) were replaced with liquid forms of the isolated nutrients to provide more uniform application of the micronutrients over the plots.

In both years, crop yield was measured in all plots using standard hand-harvest methods or farm-scale machinery. All yield samples were dried, ground, and scanned with NIRS to determine common crop quality parameters for corn, alfalfa, and small grain forage. Fertilizer prices were obtained from local fertilizer cooperatives, and we utilized separate fertilizer prices in both years for the economic assessment, so prices were reflective of the conditions in the study years. The 2021 prices (spring of 2021 when fertilizer was purchased) were much lower than in 2022 due to the rapid increase in fertilizer prices during 2021-2022.

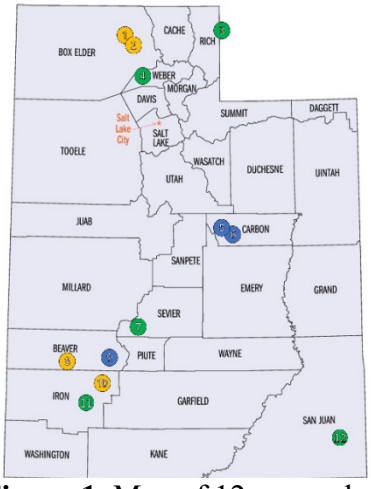

Figure 1. Map of 12 research sites. Green = alfalfa, Blue = small grain forage, Yellow = corn.

The 12 fields in this experiment represented a large range of soil organic matter levels (0.9 – 3.1%) and a range of soil textures (gravelly sandy loam to silty clay loam). They were also located in several regions of Utah and represented various elevations and growing environments (Figure 1).

Table 1. Background information for site locations.

Farm #	Crop	Soil pH	Organic Matter %	Soil Texture	Max Difference in Costs Among Labs 2021 ($/ac)	Max Difference in Costs Among Labs 2022 ($/ac)
1	Corn	8.2	2.2	Silt Loam	564	1771
2	Corn	7.5	3	Loam	704	1328
3	Alfalfa	8.2	2.6	Silt Loam	233	443
4	Alfalfa	7.7	0.9	Loamy Fine Sand	791	1222
5	Small Grains	8.1	2.5	Silty Clay Loam	224	878
6	Small Grains	8.1	2.9	Silty Clay Loam	201	740
7	Alfalfa	8	1.8	Gravely Sandy Loam	657	845
8	Corn	7.9	2.5	Silty Clay Loam	362	853
9	Small Grains	7.6	3.1	Loam	341	351
10	Corn	8.1	2.5	Loam	418	962
11	Alfalfa	8	1.9	Silty Clay Loam	540	1333
12	Alfalfa	7.8	1.9	Fine Sandy Loam	439	836

RESULTS AND DISCUSSION

How much did soil test values vary among labs?

For the single composite samples analyzed in 2021, soil nutrient levels varied among labs. A moderate level of variation is expected because the same soil cannot be analyzed twice. Most measured soil nutrients (K, Zn, Mn, B, Cu) varied about 20% among labs, others (N and P) varied around 35%, and sulfur (S) varied the most at 62% among labs.

These variations in soil nutrient concentrations caused some of the differences in the amount of fertilizer recommended, but most of these differences were due to differing calibrations and critical values utilized by each lab. The nutrients recommended and fertilizer rates varied greatly among labs. For example, the three macronutrients (N, P, K) varied across the 12 fields by an average of 118, 66, and 140% among labs, respectively. Micronutrients were recommended by private

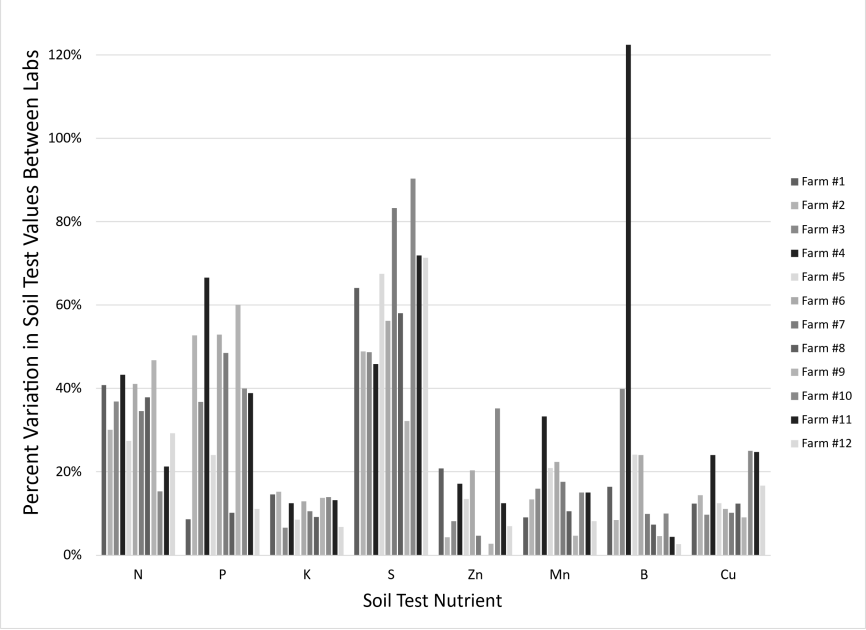

Figure 2. Variation in soil test results among for three private labs (#1, 2, and 3) and two public labs (Utah State University and University of Idaho).

labs more frequently than by public labs and varied by more than 200% among the five labs. Zinc, Manganese, Sulfur, and Boron were commonly recommended by the private labs.

How much did recommendations vary among labs?

The variation among labs between recommended nutrients and application rates resulted in large cost differences among recommendations. The two public labs cost an average of $320 to $530/acre across the 12 fields and the three private labs varied $375 to $1,120/acre. The difference in the fertilizer recommendation costs among the five labs ranged from $350 to $1,770/acre across the 12 fields. Application costs are based on fertilizer prices paid in late-spring 2022.

Soil test values from samples collected in the spring of 2022 from 10 sites from each of the six treatments were compared to those from 2021 to monitor changes in soil nutrient concentrations. For some of the main nutrients (N, P, K, and S), the nonfertilized control often experienced the smallest percent changes in soil test values (Figure 3). On average, soil test nitrogen values changed 17-151% in treatments where lab recommendations were applied, compared to 11% in the control plots. Labs recommended 40-115 lbs/acre of N on average across all sites. Phosphorus changed 29-105% for fertilized plots (70-220 lbs/acre) compared to 24% for the control. Potassium concentrations decreased 12-27% for lab treatments (17-136 lbs/acre) and the control decreased 12%. Sulfur value changes ranged from -31% to 42% for fertilized (9-47 lbs/acre) plots and decreased 5% for the control plots.

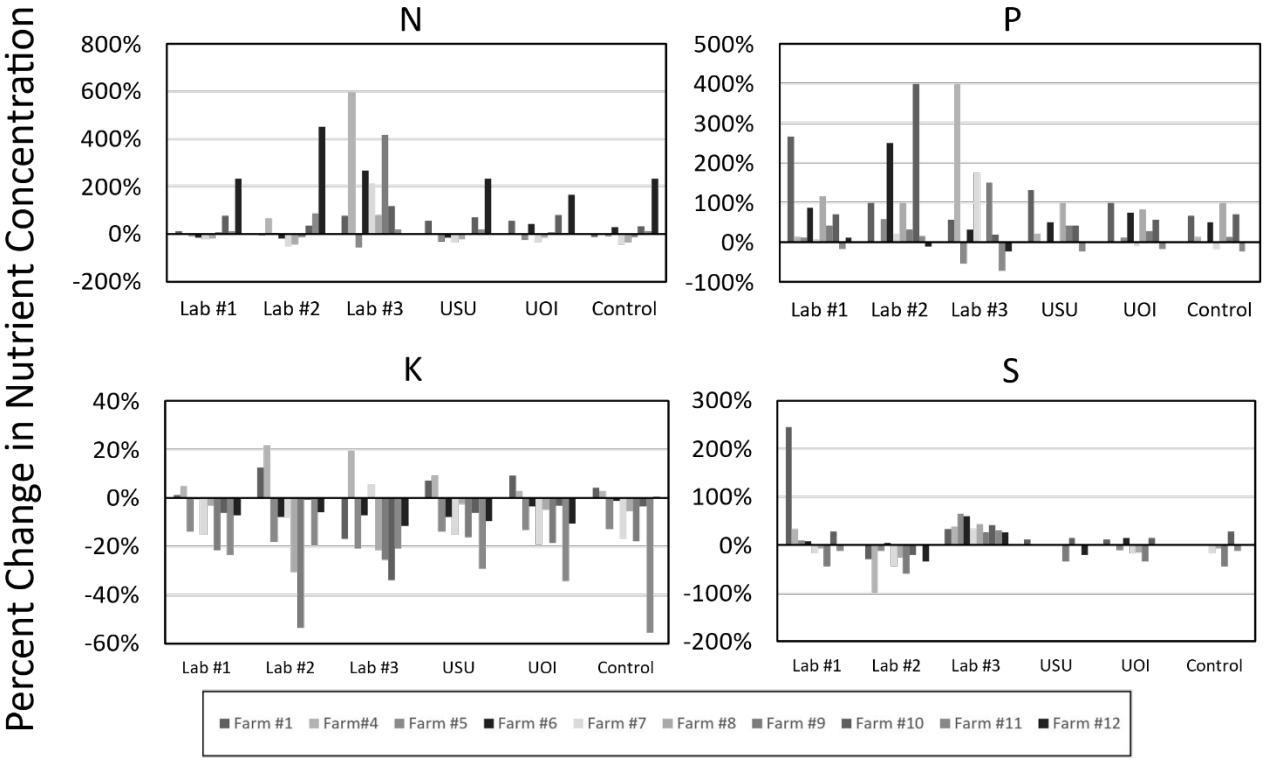

Figure 3. Percent change of soil test nutrient concentrations from 2021 to 2022 by treatment for three private labs (#1, 2, and 3) and two public labs (Utah State University and University of Idaho).

How did recommendations perform?

Results from 2021 indicated that there was little to no statistical difference in crop yield among the five fertilizer recommendations and the control, where no fertilizer was applied. Across the four corn fields, there was no statistical difference in crop yield or forage quality between treatments. Due to fertigation by cooperating growers, all plots, including the control were fertilized with nitrogen. This addition of nitrogen on the control plots may be why no improvements with the lab treatments were observed but results still indicate that no other nutrient besides nitrogen was needed to improve corn yield.

The five fertilizer recommendations also had no effect on alfalfa yield or forage quality at five fields with a total of 16 alfalfa cuttings (2-4 cuts at each field). No effects of treatments were observed at two of the three small grains fields. At one small grain site, Farm #6, one private and one public lab recommendation (Lab #1 and USU) increased small grain yield by 1 ton dry matter/acre above the nonfertilized control (Figure 4). The public lab's fertilizer recommendations improved yield enough to make it more profitable than the nonfertilized control, but the private lab's yield increase was not substantial enough to cover additional fertilizer costs.

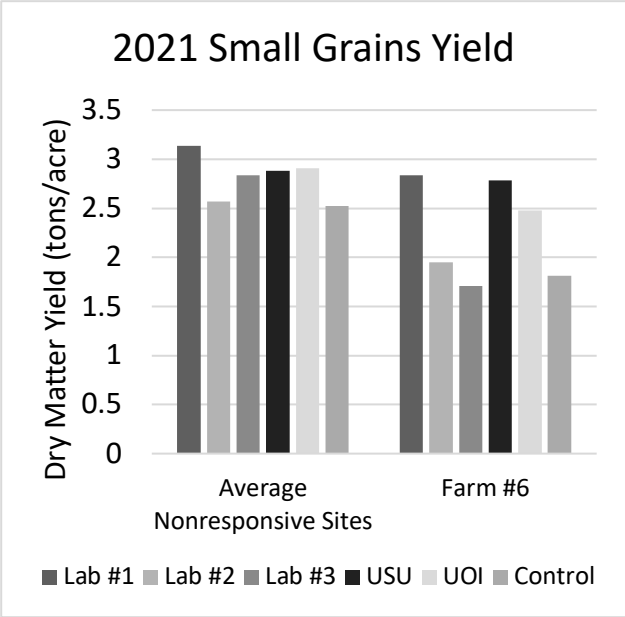

Figure 4. Differences in small grains forage yield due to fertilizer treatments in 2021.

Results from 2022 were similar to those from 2021, with little to no statistical difference in crop yield or forage quality at the seven sites where the experiment was repeated. In the two corn sites, the fertilizer treatments had no effect. No differences between treatments were observed at two of three alfalfa sites or at either of the small grains fields. In one alfalfa field, USU's recommendation yielded slightly lower than any of the other treatments. No differences in forage quality between treatments were observed at any of the sites. In most cases, yield increases resulting from the lab recommendations were not large enough to make the treatments more profitable than the nonfertilized control. In 2022, there was one field where the USU treatment was more profitable than the nonfertilized control, and several other cases where lab recommendations came very close.

CONCLUSIONS

In summary, over two seasons and 37 total harvests, few differences in yield or forage quality were observed between the five fertilizer treatments and the unfertilized control, but the cost of these treatments varied greatly. Even in cases where treatments improved production, the nonfertilized control was still almost always the most profitable. In several fields, the USU recommendation had comparable return to N as the control and in one case it had greater return to N than the control. This suggests that Utah State University guidelines are among the most profitable but that there are still cases where fertilizer recommendations need to be reduced or adjusted.

The results of this study do not indicate that fertilizer can always be withheld on these or similar fields. Many nutrients can have long-lasting impacts on crop production for several years. It does mean that there is a large opportunity to improve public and private fertilizer recommendations. It also demonstrates vast differences in fertilizer recommendations and costs among private and public labs, and points towards the need for better synchrony among recommendations.

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