

Field deployment and evaluation of conventional and precision application systems for liquid and anhydrous fertilizer in Sacramento Valley cropping systems.

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Introduction

Whether a uniform rate or variable rate of fertilizer is being applied to a field, accuracy of the application is critical to optimizing crop response and profit. The basic premise of “precision agriculture” is that prescriptions of how much fertilizer to apply to specific areas of the field will be based on historical data of previous years’ application rates and crop response. This analysis assumes that the fertilizer rate (either constant or variable) at specific locations in the field is accurately known. Often, this is not true. Especially when handling materials such as anhydrous ammonia, the growers only know average application rates since they may only be able to measure or record tank refills per field or some other relatively crude quantity. If the actual, correct rates of applied fertilizer are not known, then future calculations of crop response to application rates will not be correct and the foundation of a precision agriculture program will be weak.

Even if a grower is not practicing the complete cycle of precision agriculture by altering fertilizer rates in response to measured crop and soil properties, accuracy and uniformity in fertilizer application is important for environmental and economic considerations. Especially, if a grower is observing variations in yield, it is important that any unrealized variations in fertilizer application rate not be confused with soil or crop variability.

This project is implementing application monitoring and improved metering systems in the field. New technology and typical commercial application equipment are being used to make large-scale applications in cooperating growers' fields. A system is being developed to create "as-applied" maps with greater accuracy, resolution and more machine-performance information than that from existing commercial equipment. This "stand-alone" application monitor will be developed for recording vehicle location, ground speed and application rate. These mapping systems will be used to compare the grower's intended application rates to the actual rate across the field. Additionally, the benefit of the improved technology will be determined. The maps will also provide insight into vehicle and worker productivity.

Data from the monitoring system will be used to document accuracy and precision of fertilizer rates and more importantly, determine the cause of any inaccuracies or errors. For example, speed variations, poor calibration of systems and accidental flow variation will be detected and recorded by the system. Various designs and manufacturers of rate control equipment will also be examined for performance against desired rates.

Objectives

1. Develop a stand-alone monitoring system that can be fitted to any application to record vehicle location, speed, fertilizer flow rate, liquid pressure and, in the case of anhydrous ammonia, ammonia temperature and pressure at critical locations in the system.
2. Install the monitor on the cooperating applicators' and growers' fertilizer application systems and record the characteristics of typical application jobs using both conventional and improved rate control methods.
3. From the collected data records, develop maps and summary statistics showing the accuracy and uniformity of the fertilizer application and the conditions of the machine across the field.
4. Use the results and maps to compare application techniques and guide recommendations for improving accuracy of fertilizer application and comparing rate controller system design and manufacture.

Project Description

This project is designing a "black box" for fertilizer application that will log all the important data during application. From the data, we will be able to map the accuracy of fertilizer rates whether the grower is using any electronic equipment or not. While there are commercial systems that create "as applied" maps, they

are limited to data from existing rate controllers that have delays and limitations on the data they provide.

Information from the “black box” will be used to compare application equipment, determine sources of errors and how to best improve application of fertilizer.

Results and Conclusions

Some feasibility work has been completed on the concept of quality control and mapping of agrochemical applications. In this case, a simple data collection system and laptop computer were used to make limited tests to develop the concept. While the system is too complex for grower use it does provide information that we are using to develop the more simple and rugged model.

Example results of a test run are shown in Figure 1, which is a south to north transect of an application pass across a north-south oriented field. A conventional automatic rate controller was used and set to maintain a constant application rate of liquid. The controller, a standard model commonly sold in California, is designed to increase liquid supply pressure in accordance with speed changes. In this test run, the operator started at 3.5 mph, then at approximately 1/3 of the way into the field, increased the speed to 13 mph and then 2/3 of the way into the field decreased the speed to 6.5 mph. During this run, the ground speed (from a GPS system) and the liquid pressure were monitored and recorded.

Delays in the controller response were obvious. During the entire time that the speed was at the 13 mph level, the pressure was increasing as the controller attempted to adjust the liquid flow rate to maintain the desired application rate. This delay in response and insufficient pressure represents a significant underapplication. Likewise, the system was slow in responding to the decrease in speed and produced a significant overapplication of product. If a grower was conducting yield monitoring and noted variation in yield in this field after this application, the grower might incorrectly attribute the variability to some other parameter such as soil conditions or pest damage. This map is revealing in that areas of underapplication, overapplication and nonuniformity are present even though the grower might incorrectly assume that the use of a rate controller would guarantee uniform, constant applications rates.

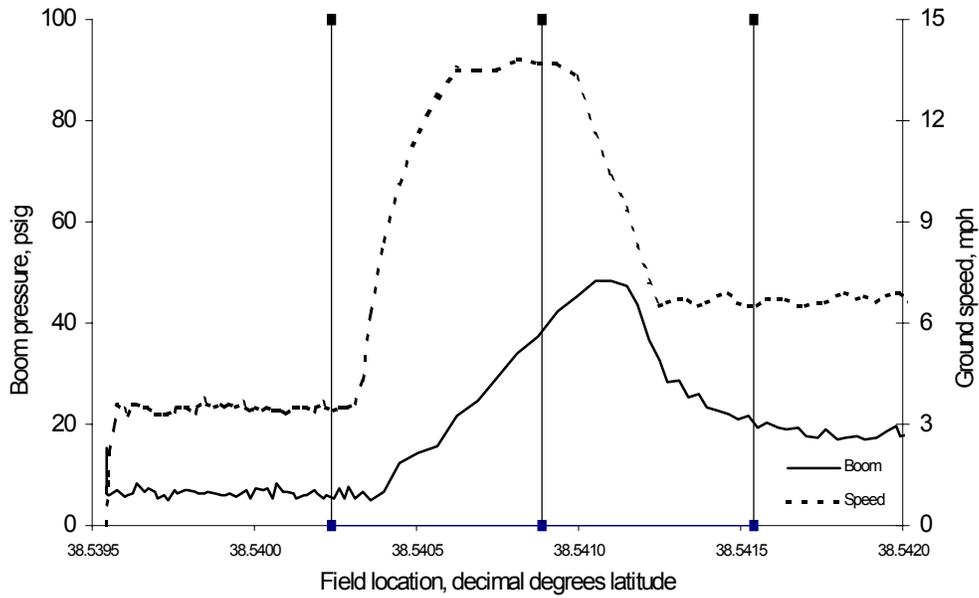


Figure 1. Transect representation of a desired constant rate liquid application with a conventional electronic rate controller where varying ground speed resulted in varying pressure with poor response to ground speed changes.