Virginia Cooperative Extension
Virginia Tech • Virginia State University

Publication CSES-90P

Sensor-Based, Variable-Rate Nitrogen Applications in Virginia

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Introduction

Variable-rate applications (VRA) of nitrogen (N) fertilizers are a new option to assist producers with real-time fertilizer rate decisions. Two commercially available systems that allow variable-rate nitrogen applications are GreenSeeker (Trimble Navigation Limited; www.ntechindustries.com/greenseeker-home.html) and the OptRx Crop Sensor (Ag Leader Technology; www.agleader.com/products/directcommand/optrx/). A discussion of the science behind these systems, potential economic benefits, and other methodologies to make VRA is discussed in Virginia Cooperative Extension publication 442-505, "Precision Farming Tools: Variable-Rate Application" (Grisso et al. 2011).

In research published in the journal Precision Agriculture, Thomason et al. (2011) demonstrated that the use of variable-rate applications of nitrogen fertilizers in wheat can save Virginia farmers an average of 4 pounds of nitrogen per acre, which is 7 percent of the second spring nitrogen application made at growth stage 30. Similar results for corn demonstrated that 21 pounds of nitrogen per acre could be removed from the side-dress application for corn while maintaining similar yields. Individual results may be higher or lower based on your field, climatic conditions, varieties, or one of the many other growth factors important for crop production. The Virginia nitrogen rate algorithms developed for wheat and corn were also validated by other states in the Mid-Atlantic region and are commonly used by producers utilizing VRA.

An algorithm is a way to describe a set of logical steps to solve a problem. A few crucial pieces of information must be supplied by the grower to assist the computer software with proper generation of algorithms for the wheat or corn crop. The important thing to understand is that the information needed for VRA is the same information needed by a farmer to make decisions about fertilizer that are always made, but computer software can help make numerically calculated management decisions. Information needed includes time elapsed from planting, amount of nitrogen previously applied, type of fertilizer being used, and so forth (table 1). However, care needs to be taken that information is entered accurately to ensure optimal algorithm decision-making.

Setting Up the Field

To properly set up a field, the producer needs to establish adequate reference strips to ensure proper algorithm calibration. The reference strips are needed to correct for the "greenness" of different crop varieties, weather conditions, soil texture, growth stage, overall plant health, etc. Reference strips should be implemented at the first spring nitrogen application for wheat (growth stage 25) and at planting for corn. Make sure to mark the reference strips with flags or georeferences in case the green differences are hard to see (or you are colorblind).

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Produced by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2014

VT/0614/CSES-90P

Table 1. Crop management information needed for proper implementation of Virginia wheat and corn algorithms using GreenSeeker.

Crop:				
Field name or ID:				
Acres:				
Fertilizer to apply (Name):				
Value	**Abbreviation**	**Unit**	**Default value**	**Farmer value**
Nitrogen use efficiency	NUE	---	0.55	
Days from planting	DFP	days	0.00	
N already applied	N_pre	pounds/acre	0.00	
Yield potential	Max yield	bushels/acre	0.00	
Fertilizer N	%N by weight	%	20.00	
Maximum fertilizer to apply	Max	GPA* or pounds/acre	0.00	
Minimum fertilizer to apply	Min	GPA or pounds/acre	0.00	

**Gallons per acre.*

Eventually, experience will aid in proper techniques for reference strip establishment, but a few suggestions for what you will need to get started include:

- A 300-foot strip as wide as the fertilizer applicator with a two-times (2X) fertilizer application. For most producers this equates to:

  - 120 pounds of nitrogen per acre for wheat (if you do two spring splits averaging 60 pounds of nitrogen per acre each).

  - 100 pounds nitrogen per acre for corn (if you average 50 pounds of nitrogen per acre in your starter and/or broadcast fertilizer application at planting).

- A 300-foot strip with no fertilizer application.

Information Input for the Algorithm

For our purposes, we will demonstrate the information needed for a producer using the GreenSeeker RT 200 variable-rate application system.

1. The first screen seen after selecting "New Application Job" is depicted in figure 1. On this screen, the operator has the option to name the current field, configure any necessary computer ports (this is necessary at installation and not usually altered thereafter), and set the sprayer/spreader swath width. Save the new settings on this screen by hitting "OK."

2. The next screen is the "Select Measurement Method" screen in figure 2. This screen requires the input of nitrogen-rich and nitrogen-poor strips that were applied at growth stage 25 for wheat and at planting for corn. First, select how you will "Get Cal Info" and which strip you are capturing. Press "Go" to capture data by moving over that area, and press "Stop" when you finish collecting data. "OK" will accept the reference strip data into the algorithm.

3. After reference strip information is input, the "Crop Measurement Method" screen for this fertilizer application appears and includes crop input data necessary to complete the algorithm (figs. 3 and 4). On this screen, the "Location Name" and "Ref_Lo" and "Ref_Hi" will be prepopulated from previous inputs. The first selection necessary is whether you are applying this fertilizer to wheat (fig. 3) or corn (fig. 4) by choosing the correct Virginia Tech (VTech) algorithm.

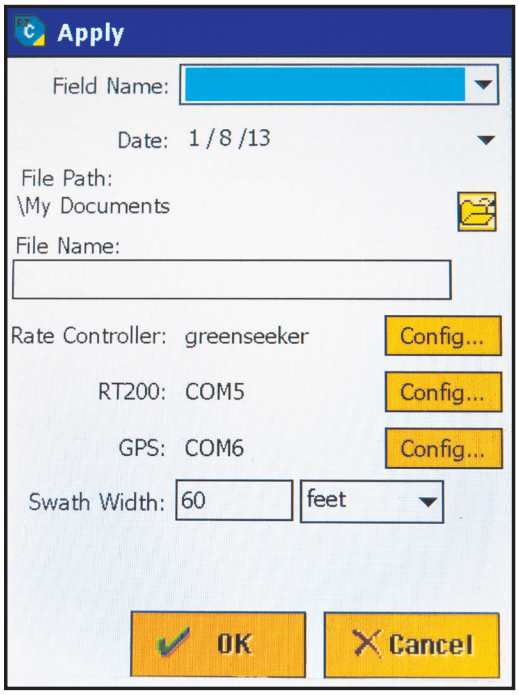

Figure 1. Initial screen when turning on GreenSeeker computer.

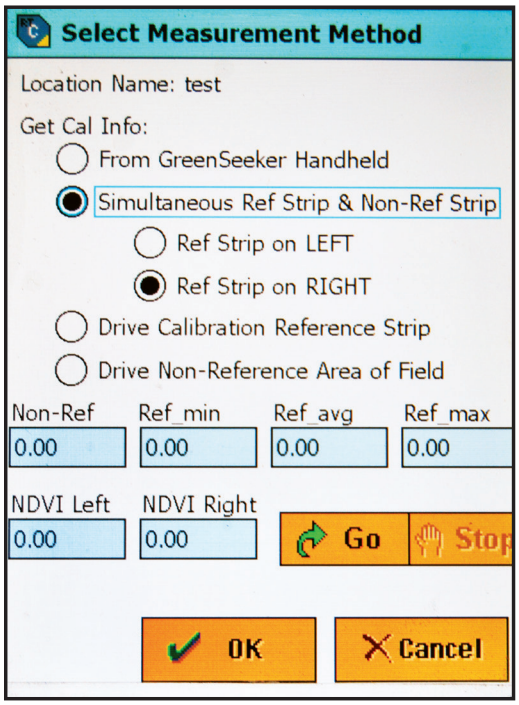

Figure 2. Selection of reference strip input method.

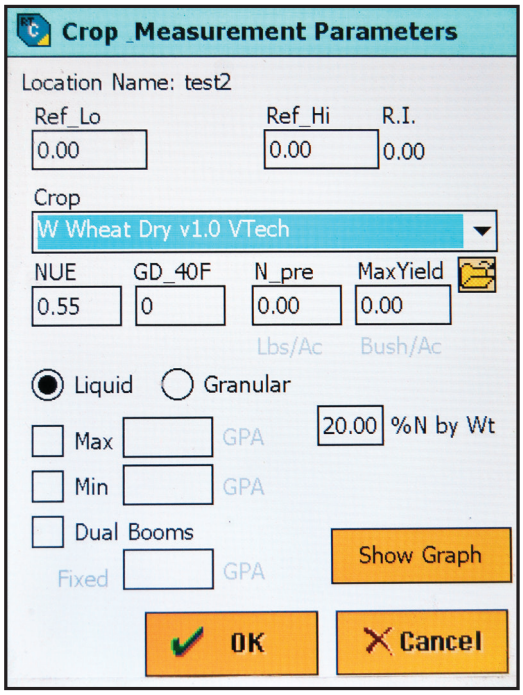

Figure 3. Virginia wheat algorithm crop input information.

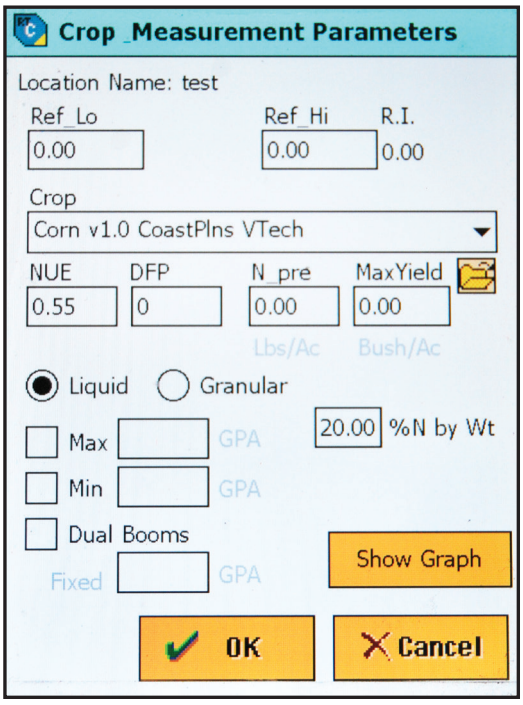

Figure 4. Virginia corn algorithm crop input information.

Table 2. Example of crop information for corn application.

Crop:	Corn			
Field name or ID:	Home Place – South side of driveway			
Acres:	58			
Fertilizer to apply (Name):	Liquid nitrogen (Urea-ammonium nitrate)			
Value	**Abbreviation**	**Unit**	**Default value**	**Farmer value**
Nitrogen use efficiency	NUE	---	0.55	0.55
Days from planting	DFP	days	0.00	36.00
N already applied	N_pre	pounds/acre	0.00	20.00
Yield potential	Max yield	bushels/acre	0.00	180.00
Fertilizer N	%N by weight	%	20.00	30.00
Maximum fertilizer to apply	Max	GPA* or pounds/acre	0.00	180.00
Minimum fertilizer to apply	Min	GPA or pounds/acre	0.00	0.00

**Gallons per acre.*

4. Next, the following parameters are needed and are also summarized in table 2.

- NUE – Nitrogen use efficiency, which is commonly 0.55 (55 percent) for Virginia. This number should only be changed if you have research information or data supporting that your particular field has higher or lower nitrogen use efficiency.

- DFP – Days from planting. Simply count the number of days that have passed between planting and the current day of fertilizer application.

- N_pre – Nitrogen rate in pounds per acre that was applied to the first spring split of wheat (growth stage 25) or applied at planting for corn in the manure (amount considered available), starter, pop-up, or as a broadcast blend fertilizer.

- Max yield – The realistic maximum yield potential for wheat or corn. This information should be based on knowledge of the field and variety. Inputting an unrealistic value will cause overapplications of nitrogen.

- Select whether you are using a liquid or granular fertilizer product and input the nitrogen concentration as a percent of product.

- Max – If you want to limit nitrogen applications on the high end, you can check the "Max" box and input your fertilizer max application in gallons or pounds per acre.

- Min – If you are worried about putting out no nitrogen, you can control the minimum amount applied. Check the "Min" box and input the lowest fertilizer amount in gallons or pounds per acre that you feel comfortable applying.

- After these crop parameters are input, you can "Show Graph" to see the algorithm (fig. 5). Click "Hide Graph" to return to the Crop Measurement Parameters screen and click "OK."

The "RT Commander" screen will pop up after all crop and fertilizer information is input (fig. 6). At this point, the fertilizer applicator is ready to go. The operator will see the normalized difference vegetative index (NDVI)

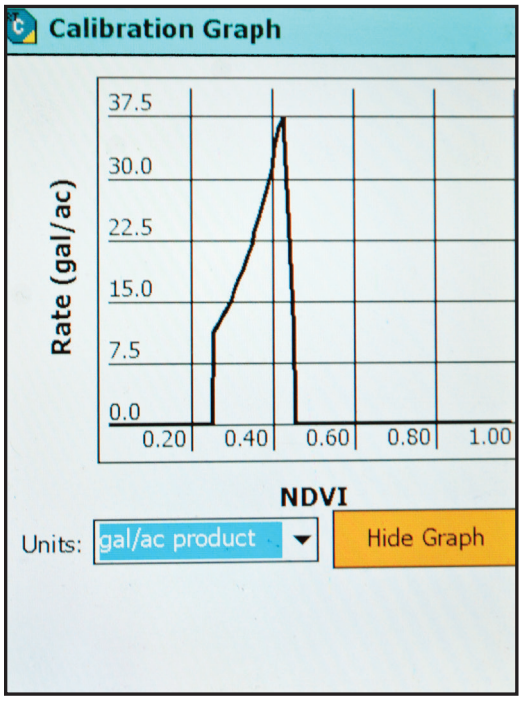

Figure 5. Example of algorithm calibration graph.

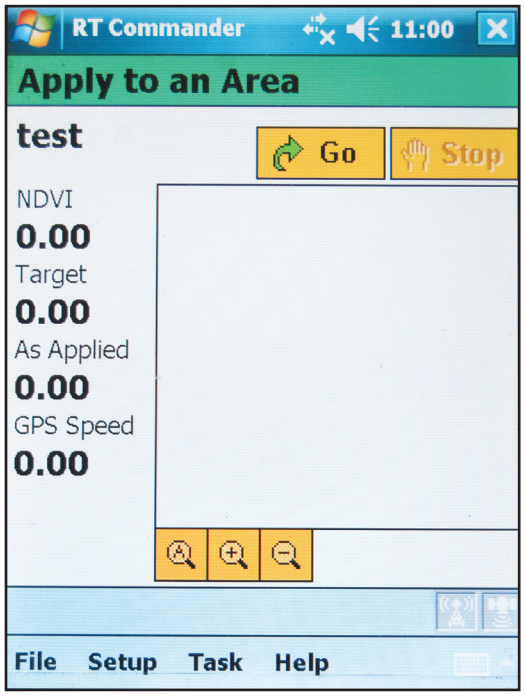

Figure 6. Screen seen after all crop and fertilizer data is input.

change as he or she moves across the field as well as the computer map being painted as the fertilizer applicator is being moved across the field, if georeferenced. With all of the proper algorithm inputs in place, nitrogen variable-rate applications can be completed quickly and efficiently with little extra work or worry by the farmer or fertilizer applicator.

Acknowledgements

The authors would like to thank the National Fish and Wildlife Foundation's Chesapeake Bay Stewardship Fund – Innovative Nutrient and Sediment Reduction Grants program for providing funds to purchase sensor equipment used to generate this publication.

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Grisso, R., M. Alley, W. Thomason, D. Holshouser, and G. T. Roberson. 2010. *Precision Farming Tools: Variable-Rate Application*. Virginia Cooperative Extension. Publication 442-505. http://pubs.ext.vt.edu/442/442-505/442-505_PDF.pdf.

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