2006 Beltwide Cotton Conferences, San Antonio, Texas - January 3 - 6, 2006

DEMONSTRATION RESULTS OF SPATIALLY VARIABLE PGR AND DEFOLIATE APPLICATIONS TO LOUISIANA COTTON PRODUCERS DURING 2005

R. D. Bagwell, B. R. Leonard and J. Sharp
LSU Agcenter
Winnsboro, LA
J. Temple, K. Paxton and R. Price
LSU AgCenter
Baton Rouge, LA
A. M. Stewart
LSU AgCenter, Dean Lee Research Station
Alexandria, LA

Abstract

Savings from SVP of PGR ranged from -$4.29 to $1.29/acre, with an average savings of -$0.23/acre (costs are for PGR only). Excluding the -$4.29/acre application, the average savings was $0.47/acre in PGR cost. Reductions in PGR use ranged from -17.9 oz/acre to 5.4 oz/acre, with an average PGR use reduction of -1.0 oz/acre. Excluding the 17.9 oz application the average reduction in PGR use was 2.0 oz/acre. The average PGR use savings in a similar 2004 variable rate demonstration was 5.7 oz/acre. The impact of SVP PGR application on lint yield was evaluated at the Big Rankin field. The SVP treatment used 5.4 oz/acre less PGR than the broadcast treatment. No significant differences in lint yield were observed in these two treatments. Treatment lint yields were 870 lbs lint/acre and 860 lbs lint/acre for the SVP and blanket treatments, respectively. Application of a SVP defoliation resulted in an average savings of defoliant cost of $1.58/acre. These savings ranged from (-$1.39) to $4.79/acre. The average savings from SVP defoliation observed in a 2004 project similar to this project was $4.74/acre. Several growers using variable rate defoliant application also indicated that the savings from SVP application of defoliant were not as significant in 2005 as in 2004. The application of defoliants in a variable rate manor did not result in a significant impact on any of the lint quantity or quality parameters evaluated. The cost of image acquisition and processing was evaluated on the Guedon Farms. NDVI images were acquired on eight days during the 2005 growing season. These images required an average of 2.26 hours to acquire, 18.1 gallons of fuel ($54.30), and 6.79 hours to process the imagery data. The grower estimates that during one flight hour, he could acquire images on 3500 acres. It is likely that growers with personal aircraft could obtain multi-spectral imagery at a considerable savings when compared to the cost from a provider. SVP of PGRs and defoliants reduced the amount of both materials applied on average. Savings during 2005, however, were not as significant as in previous years. At an estimated cost of $2.75 to $3.25 per acre for imagery and application, the savings from either PGR or defoliant was not high enough to pay for the additional costs. Initially the thought was that yield increases associated with SVP of PGR might offset the added costs. The data obtained from these demonstrations does not seem to support this idea.

Introduction

In 1999 a team from the LSU AgCenter, along with other groups, began developing and validating spatially variable (SVP) technology based on remote sensing. This technology was showcased in demonstrations on Louisiana cotton producers' farms in 2005, and this publication describes the results.

Remotely sensed imaging offers great potential as a method on which to base variable rate applications (SVP) of plant growth regulators (PGR) and defoliants. Normalized Difference Vegetative Index or NDVI is most often used as a method of remotely sensing plant vigor. NDVI is calculated as a ratio of light intensity in the near infrared wavelength to the light intensity in the red wavelength. This ratio provides a relative measure of plant biomass. NDVI values are thus used as the basis for changes in rate structures of PGRs and defoliants. Little research has been conducted on variable rate applications of PGRs or defoliants, presumably because of the intuitive relationship between NDVI and rate structure needs for PGRs and defoliants. Most research in this area indicates that PGR and defoliant rates can be varied without affecting lint yield or quality significantly.

There are, however, limitations to NDVI images, such as equal distribution of class data within the image and difficulty obtaining cloud free images. Equal distribution of class data within an NDVI means that comparisons cannot be made from field to field or on a single field over time. This technology uses visible light sources, so imaging is not possible on partly cloudy to cloudy days. During the average Louisiana day in June, there will be

only 1.5 to 2 hours (usually 10 a.m. to noon) when aerial imagery can be obtained. Outside this period, either the sun is too low on the horizon (shadowing) or the sky too cloudy.

Our initial evaluations of variable rate PGRs based on NDVI indicate a good relationship between PGR rate needs and NDVI values, but no significant reductions in total quantity of PGR use were observed. The lack of PGR use usually occurred because grower/consultants tended to select a variable rate structure where the average use rate was similar to the rate that would have been used had a broadcast application been applied. Thus, when given the opportunity to make a variable rate application, the producer/consultant opted to apply a higher rate on areas with a high NDIV and a lower rate on areas with a low NDVI compared to the broadcast application rate.

Research with variable rate applications of defoliants based on NDVI indicates defoliant savings ranged from 0 percent to 40 percent of the cost of defoliant without significant impact on lint yield or quality. The savings were directly related to the amount of in-field variability. The 40 percent reduction in defoliant cost occurred only when in-field variability was extremely high (30 percent to 95 percent open bolls with considerable natural defoliation occurring) and multiple defoliant applications were made. Savings of 20 percent to 30 percent (about $4 an acre) lower defoliant costs have been common for most variable rate defoliation research.

Materials and Methods

Demonstrations were conducted on cotton production farms in Louisiana. Farms and farm locations are listed in Table 1. At each site the producer, his aerial applicator and agricultural consultant were involved throughout the process to improve technology transfer.

Table 1. Location and Demonstration Type of 2005 Variable Rate Demonstrations.

Grower	Parish	SVP Demo Type
Bringol Farms	Franklin	PGR and Defoliant
Larry Casiday	Franklin	PGR and Defoliant
Graham Farms	Franklin	Defoliant
Guedon Farms	Concordia	PGR, Defoliant and Imaging
H&H Planting Co.	Tensas	PGR and Defoliant
Lane Farms	Morehouse	PGR
Morgan Farms	Madison	Defoliant
Parker Farms	East Carroll	PGR and Defoliant
Wright Brothers	Franklin	Defoliant

Remotely sensed NDVI images were supplied to the producers/consultants at their request for a SVP of either a plant growth regulator or defoliant. The producer, or a representative, was then supplied with the information necessary to understand an NDVI image and options for a SVP. The producer/representative then developed a rate structure for the variable rate application.

At some locations, a comparison blanket application was made. At these locations the producer/representative was asked to supply a rate for a blanket treatment. This rate was selected based on the rate the producer/representative would have used if SVP were not available.

An evaluation of variable rate PGR impact on yield was conducted at the Lane Farms. Treatments were arranged in a randomized complete block design with eight replications. Treatments consisted of PGR applied as a broadcast application and PGR applied as a SVP based on NDVI values. Plots sizes were at least 210 ft wide (three airplane swaths) X at least 1000 ft. Lint yields were determined by mechanically harvesting all plots using a John Deere 9996 cotton harvester equipped with yield monitors.

The impact of variable rate defoliation application on cotton yield and quality was evaluated at H&H Planting Co. Treatments were arranged in a randomized complete block design with four replications. Treatments evaluated were cotton defoliants applied either as a SVP based on a remotely sensed NDVI image or as a broadcast application. Rate structures for both treatments were determined by the producer. Plot sizes were at least 350 ft X 750 ft. Lint

yields were determined by mechanically harvesting all plots using a John Deere 9965 cotton harvester equipped with yield monitors. Lint quality parameters were determined by the USDA Cotton Classing Office in Rayville, LA. Bales from each plot were followed through the ginning and classing process.

Image Acquisition and Processing

Field images and prescriptions for these demonstrations were from one of three sources. Images used for Guedon Farms were provided by Guedon Farms. Images for Morgan Farms were provided by InTime (http://www.gointime.com/InTime/default.jsp). All other images and prescriptions in all other parishes were generated by the LSU AgCenter. Imagery for these demonstrations was obtained using an aircraft mounted Duncan Tech MS4100 (http://www.imageteck.net/overviewms4100.htm). Images geo-referencing and prescriptions were done in ArcView (http://www.esri.com). Images for Guedon Farms were captured using a Tetracam ADC (http://www.tetracam.com/) mounted on a Cessna 172 (http://se.cessna.com/) with Tetracam Tracker guidance software. Briv32 Viewer was also available for image processing but ArcView was used for program continuity.

Application Equipment

All treatments were applied with a commercial AT502 equipped with a hydraulically drive variable rate system from Satloc (http://www.satloc.com/) and Air Repair Inc. (http://www.airrepairinc.com/).

Plant Growth Regulators

Plant growth regulators selected by producers were all variants of 4.2 percent mepiquat chloride. These products were sold under the trade names of Mepex, Mepiquat and Mepiquat Chloride. A price of $30 per gallon of 4.2 percent mepiquat chloride was used to calculate PGR costs.

Defoliants

Defoliant treatments applied varied by producers. Defoliant prices were calculated based on DEF = $45/gal., Dropp SC = $350/gal. and SuperBoll = $30/gal.

Results

Plant Growth Regulator

Savings from SVP of PGR ranged from -$4.29 to $1.29/acre, with an average savings of -$0.23/acre (costs are for PGR only)(Table 1). Excluding the -$4.29/acre application, the average savings was $0.47/acre in PGR cost. Reductions in PGR use ranged from -17.9 oz/acre to 5.4 oz/acre, with an average PGR use reduction of -1.0 oz/acre. Excluding the 17.9 oz application the average reduction in PGR use was 2.0 oz/acre. The August 12 application to the Test field was considered as an anomaly because the farmer's consultant elected to make this application to make this application because variable rate application was available. The consultant would not have made this application if variable rate technology were not available (thus, the comparison broadcast area did not receive any PGR on this date). The average PGR use savings in a similar 2004 variable rate demonstration was 5.7 oz/acre.

Table 2. Comparison of Plant Growth Regulator Treatments.

		Rate (oz product/acre)		Savings
Field	Date	SVP	Broadcast	$/Acre
Hay Meadow	June 10	6.5 oz/acre	7.7 oz/acre	$0.28/acre
Calvitt	June 10	6.6 oz/acre	10.0 oz/acre	$0.80/acre
Test	June 21	5.9 oz/acre	8.0 oz/acre*	$0.49/acre
Island	June 22	7.3 oz/acre	7.3 oz/acre	$0.00/acre
Big Rankin	July 18	3.6 oz/acre	9.0 oz/acre	$1.27/acre
Test	August 12	17.9 oz/acre	0.0 oz/acre	(-$4.29/acre)
Test Mean[2]		8.0 oz/acre	7.0 oz/acre	(-$0.23/acre)
Test Mean[3]		5.0 oz/acre	7.0 oz/acre	$0.47/acre

[1] The June 21 broadcast application to the Test field was applied using a tractor.
[2] Test Mean determined using August 12 application to Test Field.
[3] Test mean determined without using August 12 application to Test Field.

The impact of SVP PGR application on lint yield was evaluated at the Big Rankin field. The SVP treatment used 5.4 oz/acre less PGR than the broadcast treatment. No significant differences in lint yield were observed in these two treatments. Treatment lint yields were 870 lbs lint/acre and 860 lbs lint/acre for the SVP and blanket treatments, respectively.

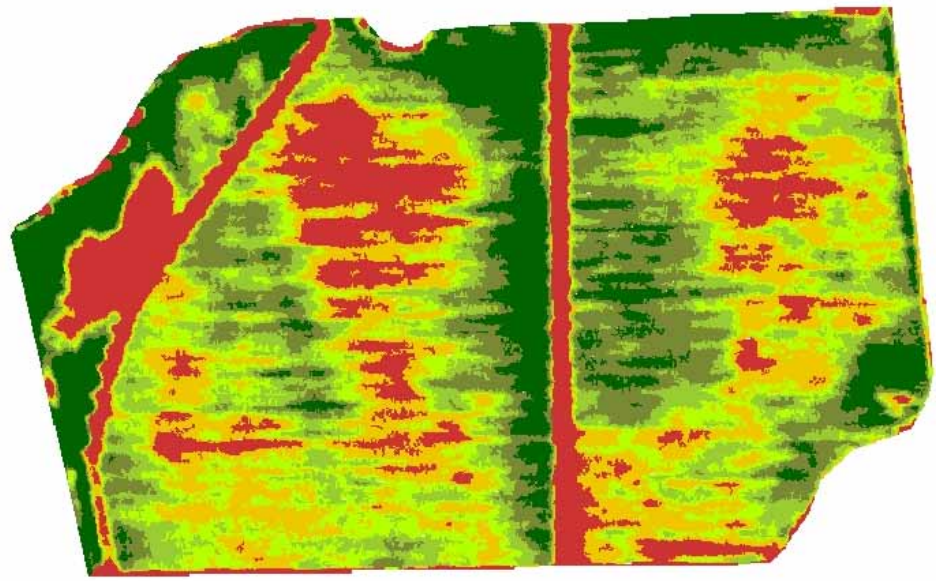

Figure 3. 5 Class NDVI Image from demonstration site in 2004.

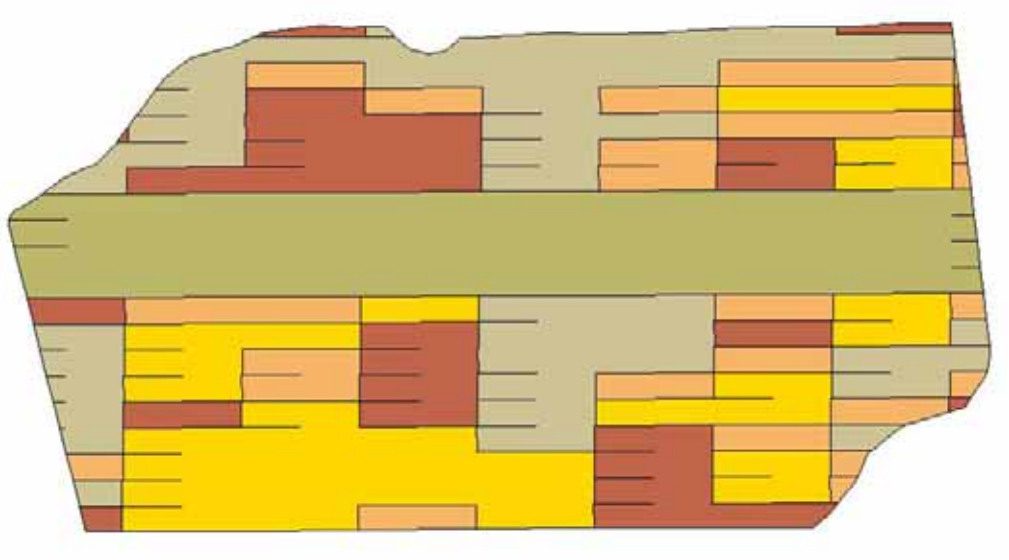

Figure 4. 4 rate prescription based on NDVI in Figure 3. (Solid tan line is blanket area).

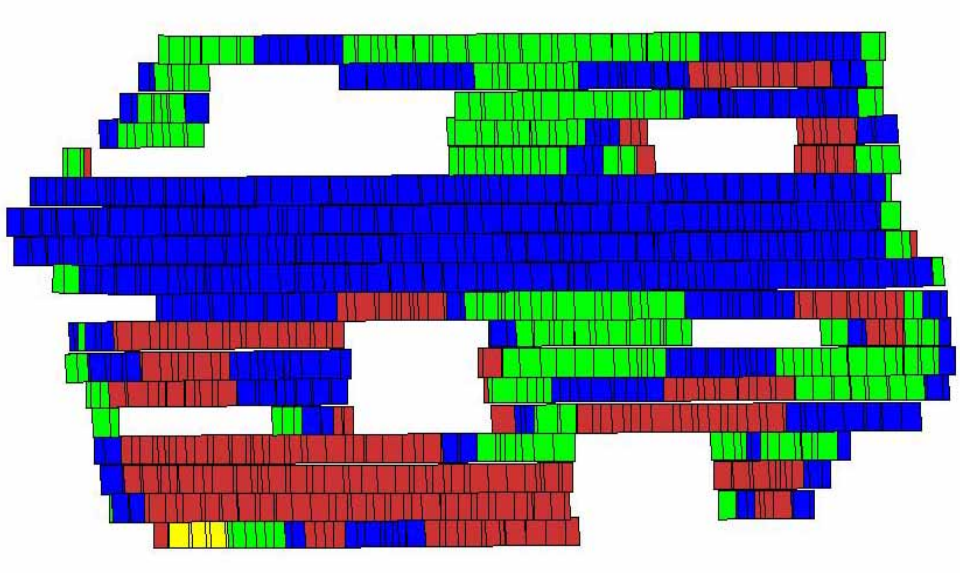

Figure 5. As-Applied aircraft output in gallons per acre.

Defoliation

Application of a SVP defoliation resulted in an average savings of defoliant cost of $1.58/acre (Table 3). These savings ranged from (-$1.39) to $4.79/acre. The average savings from SVP defoliation observed in a 2004 project similar to this project was $4.74/acre. Several growers using variable rate defoliant application also indicated that the savings from SVP application of defoliant were not as significant in 2005 as in 2004. The application of defoliants in a variable rate manor did not result in a significant impact on any of the lint quantity or quality parameters evaluated (Table 4).

Table 3. 2005 Comparison of Variable Rate Defoliation Application.

			Rate	$/Acre		
Field	Date	Defoliant	Oz./Acre	Broadcast	Variable	Savings
Test	Sept 15	Dropp + Prep	1.7 oz 17.7 oz	$9.01	$8.91	$0.10
Test	Sept 21	Dropp + Prep	1.3 oz 18.0 oz	$7.70	$4.10	$3.60
Lowentritt	Sept 21	Dropp + Prep	1.6 oz 19.1 oz	$8.85	$6.30	$2.55
Hay Meadow	Sept 25	Dropp + Prep	1.4 oz 17.1 oz	$7.89	$9.21	(-$1.39)
Beale	Sept 25	Dropp + Prep	1.8 oz 21.3 oz	$9.92	$9.78	$0.14
Hay Meadow	Oct 1	Dropp + Prep	1.3 oz 14.2 oz	$6.83	$6.45	$0.38
Beale	Oct 1	Dropp + Prep	1.3 oz 14.2 oz	$6.83	$2.04	$4.79
FLD 4	Oct 1	Dropp + Prep	1.6 oz 21.3 oz	$9.37	$9.06	$0.30
FLD 4	Oct 1	Dropp + Prep	1.6 oz 25.6 oz	$10.38	$5.59	$4.78
Eugene 1, 2, 3 and 4	Sept 21	Dropp + Prep	2.1 oz 32 oz	$13.24	$9.06	$4.18

Union Church	Oct 2	Dropp + Prep + DEF	1.6 oz 24 oz 4.9 oz	$11.72	$12.27	(-$0.57)
FLD 24	Sept 29	Dropp + Prep	2.1 oz 3.2 oz	$6.49	$5.23	$1.26
FLD 24	Oct 5	Dropp + Prep	2.1 oz 29 oz	$12.54	$9.80	$2.73
FLD 24	Oct 9	Dropp	1.4	$3.83	$4.65	(-$0.82)
Mean				$8.90	$7.32	$1.58

Table 4. Impact of Variable Rate Defoliant Application on Lint Quality and Quantity.

Treatment	Color	Leaf	Staple	Mic.	Loan Rate	Lint yield
Variable Rate	37.4	4.0	35.3	4.8	0.55	1070
Broadcast	38.7	3.9	35.1	4.8	0.55	1080
P>F	0.36	0.60	0.14	0.63	0.64	0.68

[1] Quality data determined as an average of all bales in each plot.
[2] Column headings are Color = Color grade, Leaf = Leaf Trash, Staple = Staple Length, Mic.= Micronaire, Loan Rate = Loan Rate in $/lb lint, and Lint Yield = lint yield in lbs lint/acre.

Additional Evaluations

The cost of image acquisition and processing was evaluated on the Guedon Farms. NDVI images were acquired on eight days during the 2005 growing season. These images required an average of 2.26 hours to acquire, 18.1 gallons of fuel ($54.30), and 6.79 hours to process the imagery data. The grower estimates that during one flight hour, he could acquire images on 3500 acres. It is likely that growers with personal aircraft could obtain multi-spectral imagery at a considerable savings when compared to the cost from a provider.

Table 5. Image acquisition and processing time and cost for Guedon Farms.

Acquisition Date	Flying Hrs.	Gallons Fuel	Fuel Cost	Processing Time
May 5, 2005	1.7	13.6	$40.80	5.1
June 3, 2005	2.1	16.8	$50.40	6.3
June 14, 2005	2.2	17.6	$52.80	6.6
June 15, 2005	2.1	16.8	$50.40	6.3
June 27, 2005	3.8	30.4	$91.20	11.4
July 22, 2005	2.1	16.8	$50.40	6.3
August 1, 2005	2.5	20.0	$60.00	7.5
Sept. 28, 2005	1.6	12.8	$38.40	4.8
Mean	2.26	18.1	$54.30	6.79

Discussion

SVP of PGRs and defoliants reduced the amount of both materials applied on average. Savings during 2005, however, were not as significant as in previous years. At an estimated cost of $2.75 to $3.25 per acre for imagery and application, the savings from either PGR or defoliant was not high enough to pay for the additional costs.

Initially the thought was that yield increases associated with SVP of PGR might offset the added costs. The data obtained from these demonstrations does not seem to support this idea. These data also do not consider the public perception benefit that agriculture receives because of this technology.

It should be noted that we measured the chemical costs and yield to access variable rate for the PGR evaluations and lint grade for the defoliation. Other effects of PGR applications such as earliness, incidence of boll rot and harvest

efficiency were not measured. There are no data to support variable rate application as providing these benefits compared with blanket applications. Similarly, potential benefits such as improved overall defoliation or re-growth inhibition may be positive effects for variable rate application.

Defoliation levels, however, were not quantified following SVP and there are no data that indicate SVP defoliation treatments increase overall defoliation or inhibit re-growth at economically meaningful levels. While it is intuitive that SVP may provide some benefits not measured for PGR and defoliation application, these are areas of research that should be considered to begin building a data set and further examining the practice.

Acknowledgements

The authors wish to thank NASA, Cotton Incorporated, The Cotton Foundation, Louisiana Cotton Producers Association, the LSU AgCenter, and the University of Louisiana at Monroe for partial support of this project.