W1416

Measuring the Efficacy of Plant Growth Regulators Application on Cotton

Avat Shekoofa, Associate Professor, Department of Plant Sciences
Kurt Wedegaertner, Graduate Student, Department of Plant Sciences
Tyson B. Raper, Professor, Department of Plant Sciences

Real. Life. Solutions.™

UT EXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Introduction

Plant growth regulators (PGR) are commonly used in cotton production to balance vegetative and reproductive growth. However, due to the large influence environmental conditions have on PGRs, managing the correct application timing and rate could be tricky. Thus, growers often struggle to properly control vegetative growth throughout a growing season.

Additionally, efforts have been directed toward developing cultivars with "aggressive growth" characteristics. Cultivars including Deltapine (DP) 1646 B2XF, DP 2038 B3XF, Nexgen (NG) 3729 B2XF, and Phytogen (PHY) 411 W3FE are among those considered less responsive to PGR application rates and often require maximum rates of PGR to be properly managed. Therefore, any reduction in the efficacy of a PGR application on these cultivars could lead to overly tall plants with too much vegetation, otherwise known as rank growth (Figure 1). Cotton with rank growth can have reduced picker harvest efficiency and, as a result, can suffer substantial yield loss. Therefore, it is important for growers to be able to measure if their potential PGR application rate or application timing was effective or not.

Figure 1. *Without adequate PGR application, "aggressive growth" cotton cultivars can easily achieve rank growth.*

Measuring Canopy Color to Monitor PGR Efficacy

When a growth-suppressing PGR such as Mepiquat Chloride (MC) (trade name: Pix) is applied to cotton, the main effect is a reduction in internode length, thereby reducing plant heights. This reduction is achieved through the inhibition of gibberellic acid, the plant hormone responsible for cell division and elongation. When plant cell size is reduced, the density of chlorophyll molecules increases. This causes leaves to develop a darker green color, sometimes referred to as the pix-effect (Figure 2). Based on this premise, we developed a hypothesis that a darker green canopy color is indicative of a higher degree of assimilated PGR.

Figure 2. *Cotton leaf treated with PGR (left) versus untreated cotton leaf (right). Notice the darker green color of the treated leaf.*

This darker green leaf color can be quantitatively measured with modern technologies such as unmanned aerial vehicle (UAV) imagery or with a hand-held soil plant analysis development (SPAD) chlorophyll meter which can effectively determine the greenness of an individual leaf.

To test our hypothesis that a darker green canopy color would indicate a higher degree of PGR efficacy, a study was conducted on an aggressive growth cultivar, DP 1646 B2XF. The cultivar was treated with a one-time application of progressively increasing PGR amounts, and then canopy color was measured to determine if higher PGR rates led to a darker green canopy.

Experiment Set-up and Findings

A PGR study was conducted at the UT AgResearch and Education Center at Milan (MREC) to measure the effects of varying amounts of PGR rates on cotton plant height and canopy color. The PGRs used in this study included Mepiquat Chloride (MC) widely known by the trade name, Pix (4.2 percent formulation, the label allows 48 ounces to be applied per acre per season), the most used PGR in cotton production. And Stance, a dual-action PGR that includes MC as well as an auxin inhibiting chemical known as cyclanilide (the product contains 8.4 percent MC and 2.1 percent cyclanilide, and use rate falls between 2 and 4 ounces per acre). Table 1 represents the PGR rates that were applied for each treatment. The cultivar included in this study was DP 1646 B2XF, chosen for its aggressive vegetative growth potential. Plant growth regulator treatments were administered 87 days after planting (DAP) and canopy and plant height measurements were collected 1, 2, and 4 weeks after PGRs application using both a hand-held SPAD meter (Konica Minolta, Tokyo, JP) and a Matrice 600 UAV (DJI, Shenzhen, CN) outfitted with a R10C RGB camera (Sony, Tokyo, JP) (Figure 3). SPAD measurements were always collected on two of the uppermost fully expanded leaves on an individual plant in each replication.

Table 1. Plant growth regulator (PGR) application treatments on cotton cultivar Deltapine 1646 B2XF at MREC.

PGR Treatment	Pix (oz/ac)	Stance (oz/ac)
1	0	0
2	0	2
3	12	0
4	12	2
5	24	0
6	24	2
7	34	0
8	34	2

Figure 3. *PGR treatments were applied with a Lee Spider (left), then canopy color measurements were made throughout the remaining growing season using a handheld SPAD meter (middle) and UAV imagery (right).*

The SPAD meter measures how much red light at 650 nm (the wavelength which chlorophyll absorbs) can pass through a given leaf. The resulting number is related to the amount of chlorophyll present in the leaf sample. A higher SPAD reading indicates a higher amount of chlorophyll per unit leaf area, which suggests that the PGR application was effective. In our study, as PGR rate was increased, SPAD tended to increase among all sampling dates (Figure 4).

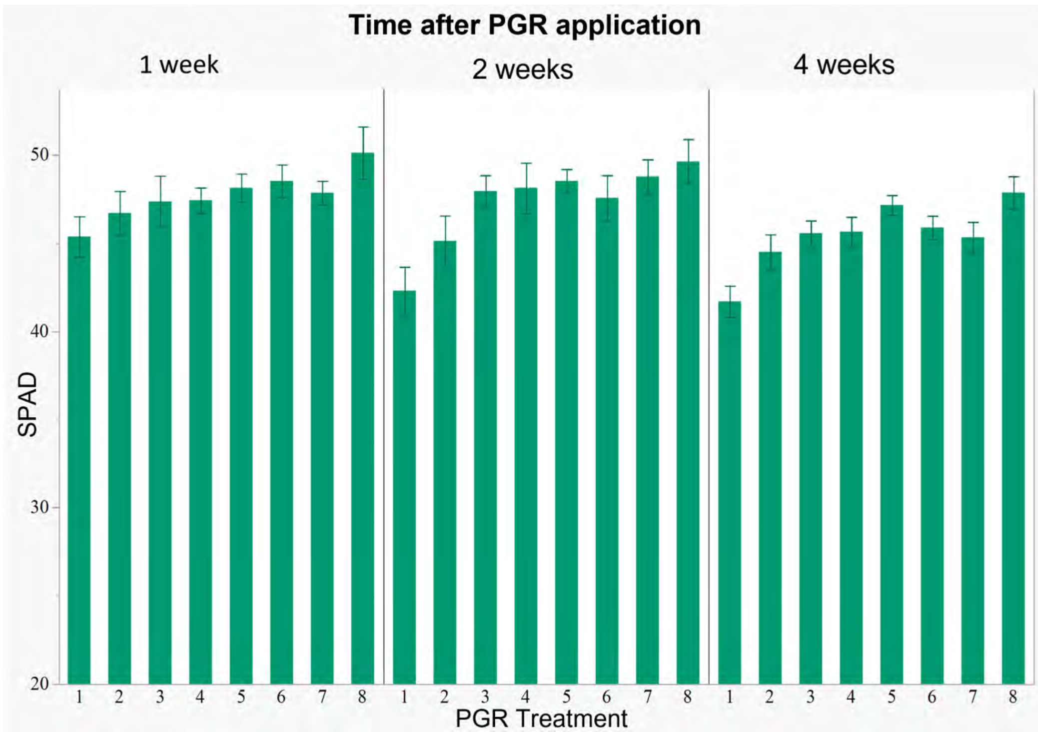

Figure 4. *Average SPAD reading among plant growth regulator (PGR) treatments on cotton cultivar Deltapine 1646 B2XF. A higher SPAD reading indicated a darker green leaf color. Error bars represent the standard error of the mean.*

Drone imaging can provide a wealth of information about crop health. For this study we chose to focus on three main color parameters, including green reflectance, yellow/blue index (b*) and saturation. These values provide information on the greenness of the canopy.

On each sampling date, as PGR rate increased, b* and saturation tended to decrease (Figure 5). This indicates that as PGR rate was increased, the cotton canopy had darker green leaves and had higher shift toward greenness, respectively. Additionally, strong positive correlations were measured between green reflectance and plant height on each day of measurement (Figure 6). This indicates that taller plants (less assimilated PGR) reflected more green light. This relationship may seem counterintuitive; however, a higher reflectance of green light indicates that less green light was absorbed by the canopy, leading to a perceived lighter-green canopy color. In other words, this relationship shows that taller plants tended to have a lighter green color.

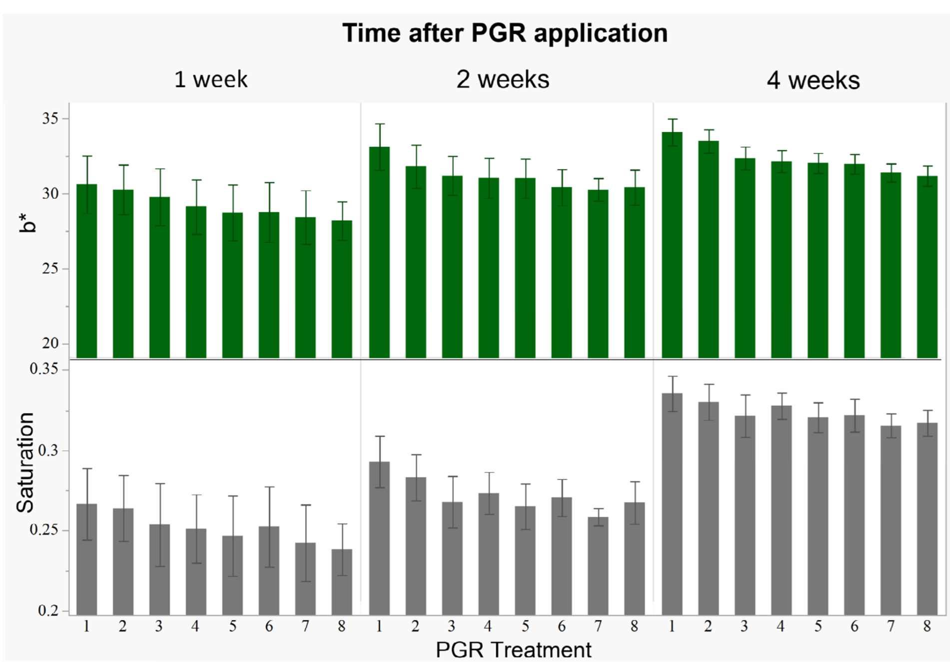

Figure 5. *Average yellow/blue index (b*) and saturation values of cotton cultivar DP1646 B2XF canopy among plant growth regulator (PGR) treatments. Lower values of b* and saturation indicate darker green leaves and had higher shift toward greenness, respectively. Error bars represent the standard error of the mean.*

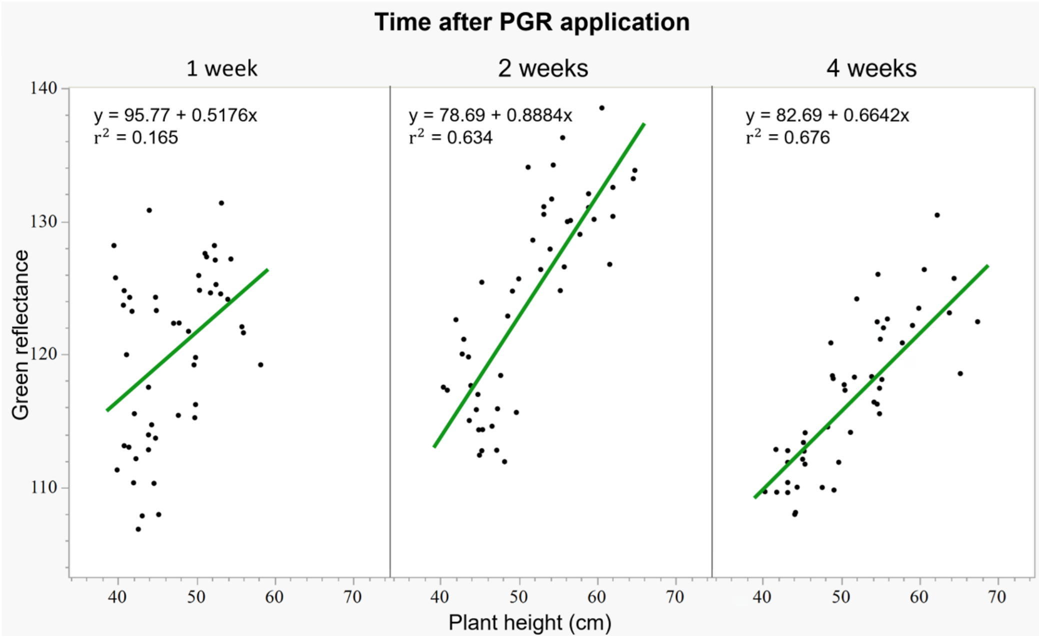

Figure 6. *Correlation between plant height (cm) and green reflectance of cotton cultivar Deltapine 1646 B2XF treated with increasing amounts of plant growth regulator. A higher green reflectance indicates a lighter green canopy color.*

Conclusion

Results suggest that increased PGR rate on an aggressive cotton cultivar can lead to measurable changes in canopy color (Figure 7), specifically a darker green color. As PGR rates increased, SPAD values increased, and b* and saturation values decreased. Additionally, taller plants, those less affected by PGR, had a positive correlation with green reflectance, which indicates a lighter green color.

This information indicates that growers can use UAV imagery or SPAD measurements to monitor a cotton crop after PGR application to determine if a recent PGR application has been successfully assimilated into the crop.

If a crop has failed to develop a darker-green color, or if sections of a field appear lighter green, this is a good indication that a PGR application has not been successful or follow up treatments may be necessary.

Our data shows that color differences were most noticeable two weeks after the PGR application, therefore, this is a good timeframe for beginning canopy color measurements after a PGR application.

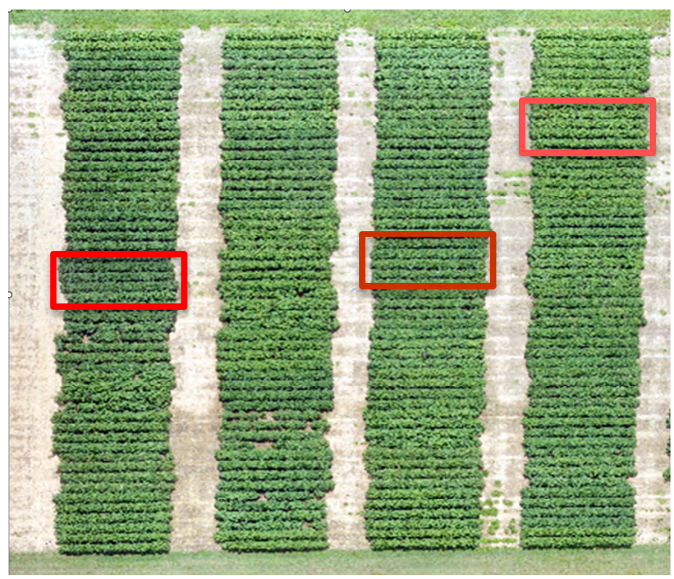

Figure 7. *Aerial image of various amounts of plant growth regulator on cotton cultivar DP1646 B2XF. Notice the variety of green colors among treatment plots, two-weeks after the application.*

Acknowledgements

The authors would like to thank Cotton Incorporated Tennessee State Support and the University of Tennessee Department of Plant Sciences for sponsoring this research. Also, we are grateful to the unwavering support from the technical staff f the UT AgResearch and Education Center at Milan throughout this research. We are also grateful to our UT cotton crew and crop physiology team for their support during our data collection.

Resources

- https://extension.missouri.edu/publications/g4258
- https://extension.okstate.edu/fact-sheets/plant-growth-regulators-in-cotton.html
- https://extensionpublications.unl.edu/assets/html/g1632/build/g1632.htm
- https://cdn-s3.sappi.com/s3fs-public/sappietc/Defi ing%20and%20Communicating%20Color.pdf
- https://sensing.konicaminolta.asia/what-is-cie-1976-lab-color-space/

INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

UTIA.TENNESSEE.EDU

Real. Life. Solutions.™

W1416 08/19 26-0191 Programs in agriculture and natural resources, 4-H youth development, family and consumer sciences, and resource development. University of Tennessee Institute of Agriculture, U.S. Department of Agriculture and County governments cooperating. UT Extension provides equal opportunities in programs and employment.