RESPONSE OF COTTON AT DIFFERENT STRESS LEVELS TO TRIMAX PRO

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Introduction

In almost all fields, cotton suffers some kind of abiotic or biotic stress sometime during the season. Bayer's neonicitinoid insecticide Trimax Pro and Provado (Imidacloprid) has been shown to alleviate stress and provide positive yield responses. This presentation presents the results of two years of trial work comparing applications of Trimax Pro / Provado to a competitor neonicitinoid (Centric/Thiamethoxam). The test locations were chosen to contain high levels of growth variability caused by various stresses based on previous years' remote sensing analyses.

Assumptions

Trimax Pro / Provado and competitor neonicitinoid treatments controlled relevant insects equally. Insect damage occurring before / after treatments was equal across treatments.

Hypothesis

Trimax Pro / Provado will increase cotton yields above the competitor neonicitinoid at the same levels of insect control/damage. The interaction between treatment and stress level will be significant i.e.: there will be a yield response under moderate stress but no response under minimal or severe stress.

Minimal stress = NDVI values > 0.7
Severe stress = NDVI values < 0.2

Background

Remote sensing of reflectance of near infrared (NIR) (800nm) and red (R) light (660 nm) can be used to measure plant stress levels. "Healthy" cotton plants poorly reflect red light due to absorption by chlorophyll. "Healthy" cotton plants reflect near infrared light well. The normalized ratio of NIR and R are a measure of plant stress. NDVI (Normalized Difference Vegetation Index) is calculated as (NIR – R)/(NIR + R) and ranges potentially between -1 and +1. For practical purposes, healthy vegetation (with soils interference) ranges between 0.0 and 0.8.

Methodology

Two different insecticide treatments were applied to two cotton fields in both 2006 and 2007 with a range of different stress levels based on previous experience:

Trimax Pro / Provado (*Imidacloprid*)
Competitor neonicitinoid (Centric, *Thiamethoxam*)

Main stress factors involved: drought, salinity and hypoxia caused by flood irrigation.

Trial	Imidacloprid	Other Neonicotinoid	Application Timing
2006			
AZ06	Provado	Centric	Early Bloom & Mid-Bloom
HO06	Provado	Centric	Early Bloom & Mid-Bloom
2007			
AZ07	Trimax Pro	Centric	Early Square & Early Bloom
PR07	Trimax Pro	Centric	Early Square & Early Bloom
Rates: Centric 40WG @ 2 oz/ac (56 g ai/ha) Provado 1.6F @ 3.8 oz/ac (53 g ai/ha) Trimax Pro @ 1.8 oz/ac (70 g ai/ha)			

Cotton vigor was determined by the following method. Raw Aerial Images were acquired prior to application from InTime, Inc. NDVI analysis was performed on the treatment area using Arcview 3.2 with Image Analyst Extension. Each image was categorized into 10 NDVI classes. Resultant categorization map was converted to a shape file preserving the average NDVI value for each polygon created

Yield information was collected using commercial John Deere cotton harvesters equipments with yield monitors (Agriplan 700, Ag Leader and John Deere). Shape files were generated from the proprietary software and imported into Arcview 3.2. Data from the different layers (NDVI, Treatment, and yield) were joined using the Arcview join feature. Data was reduced using Microsoft Excel 2007. All yield values without a corresponding NDVI value were eliminated. Data points with yields less than 0.3 bale / acres or greater than 7.0 bales per acre were eliminated.

Statistical analysis was performed using JMP IN Ver. 5.1 statistical software from SAS institute. These trials are not "traditional" but use fundamental statistical precepts. There was no "replication" but considering the reasons for replication – this statistical design captures the same information and uses it to elucidate additional information. Replications are used for the partitioning of the variability to the replicates but this trial design uses the stress level as a variability factor; thus, the yield variability is captured in that term. There are also usually thousands of yield estimates with this methodology which further increases its power.

Results

In 2006, an analysis of cotton internode distance made by measuring the length of every internode on 10 plants from every combination of treatment and three vigor levels (high, medium and low). The results are presented in Figure 1. In the low vigor area measurements it can be seen that reduction in internode distance begins at node 8. This reduction (or stress) occurs well before flowering and is approximately the same between the Provado and Centric treatments. This indicates that if stress is high enough, Provado will not improve growth over the Centric treatment. In the medium vigor areas, the Provado treatment maintains longer internode lengths at high mainstem node(s). This supports the idea that Provado relieves stress at intermediate stress levels. In the high vigor areas, there is again little difference between treatments. This indicates that stress relieving characteristics of Provado are not evident in area of high cotton vigor.

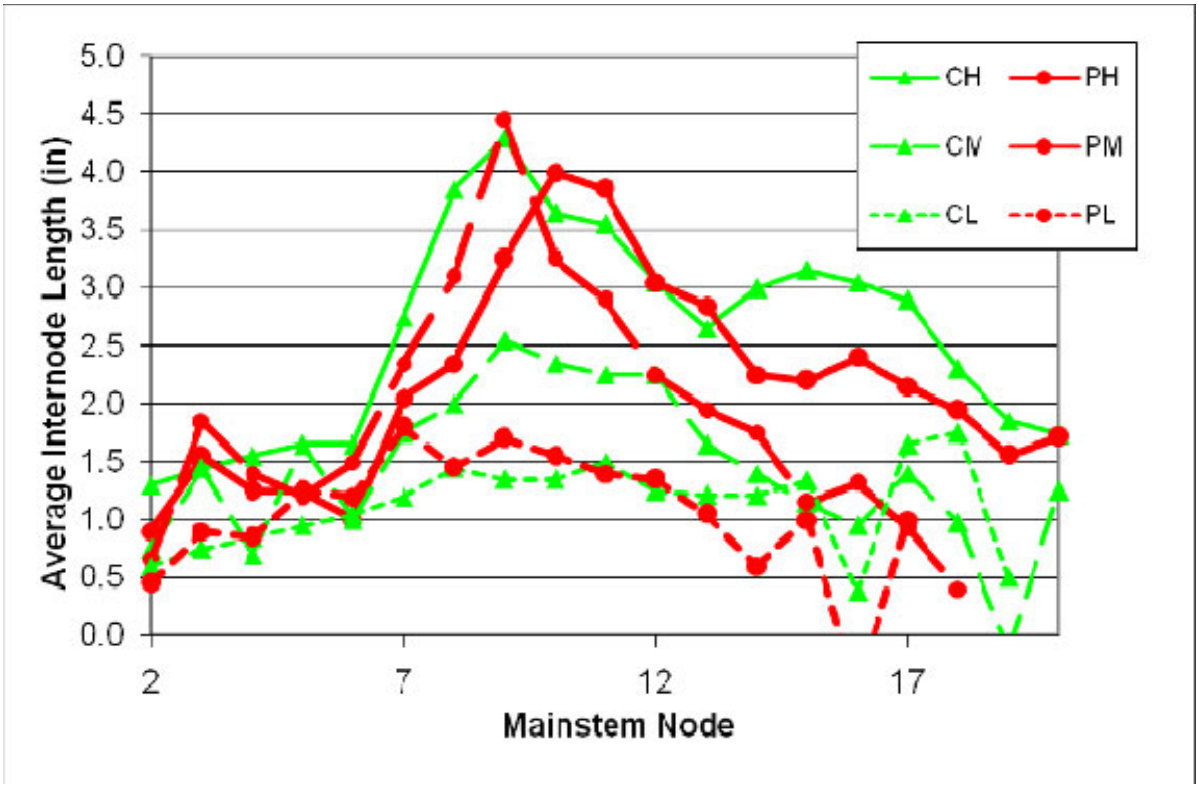


Figure 1. Influence of Centric (C) and Provado (P) on internode length of cotton at three different vigor levels, High (H), Medium (M) and Low (L).

In the AZ06 and AZ07 trials where soil salinity (data not shown) was the major stress inducing factor, the yield response of Provado / Trimax-treated cotton was higher at all vigor levels. These results can be seen in Figures 2 and 3. The analysis of variance and linear regression information is presented in Tables 1 and 2.

In both years and at both locations the main effects (cotton vigor level and neonicitinoid treatment) were both highly significant. In 2006, there was no significant interaction between vigor and treatment, but in 2007 there was. The interaction in 2007 indicated that as vigor level increases, the stress relieving properties of Provado / Trimax were reduced.

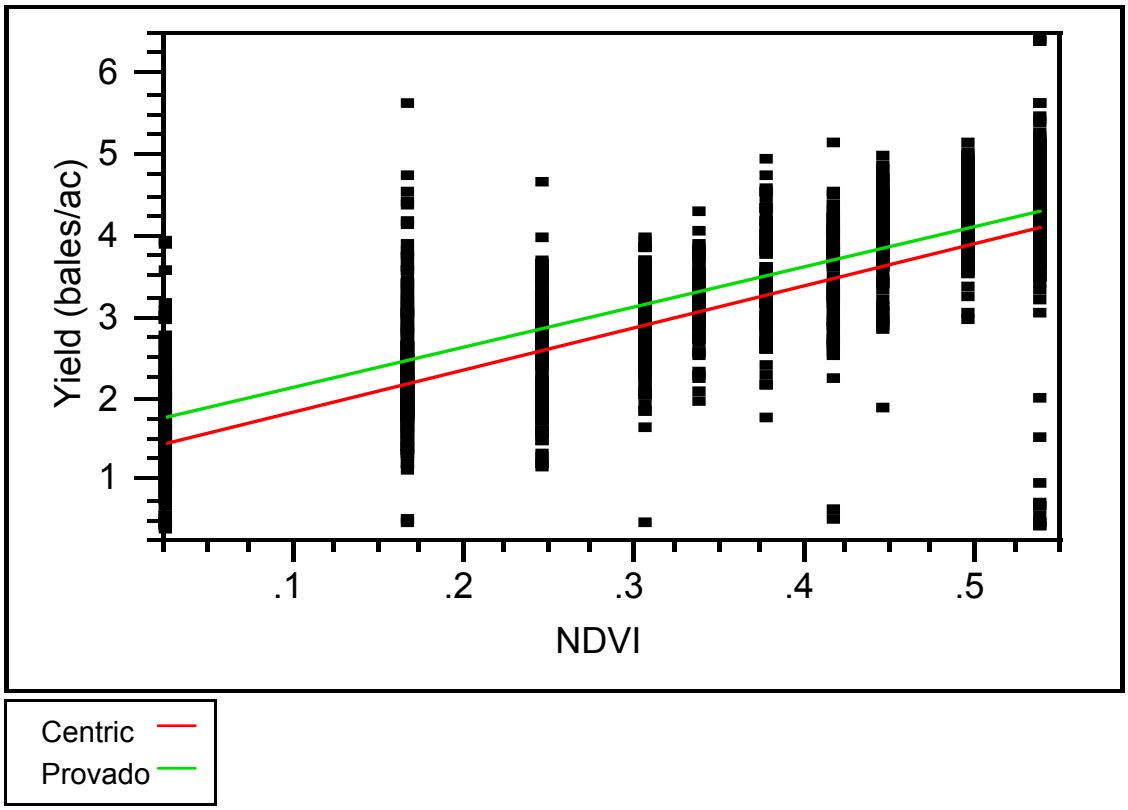


Figure 2 – Cotton lint yield as influenced by vigor levels (NDVI) and neonicitinoid treatment at the AZ06 location

Table 1 – Analysis of variance and combined linear regression data for the AZ06 location

Source	DF	Sum of Squares	F Ratio	Prob > F
NDVI	1	1148	2874	0.0000
MATERIAL	1	15.6	39.1	<.0001
NDVI*MATERIAL	1	0.588	1.47	0.2251
Error	1253	500.5		
Y (Centric) = 1.300 + 5.213 * NDVI R^2 = 0.773 Y(Provado) = 1.625 + 4.982 * NDVI R^2 = 0.652				

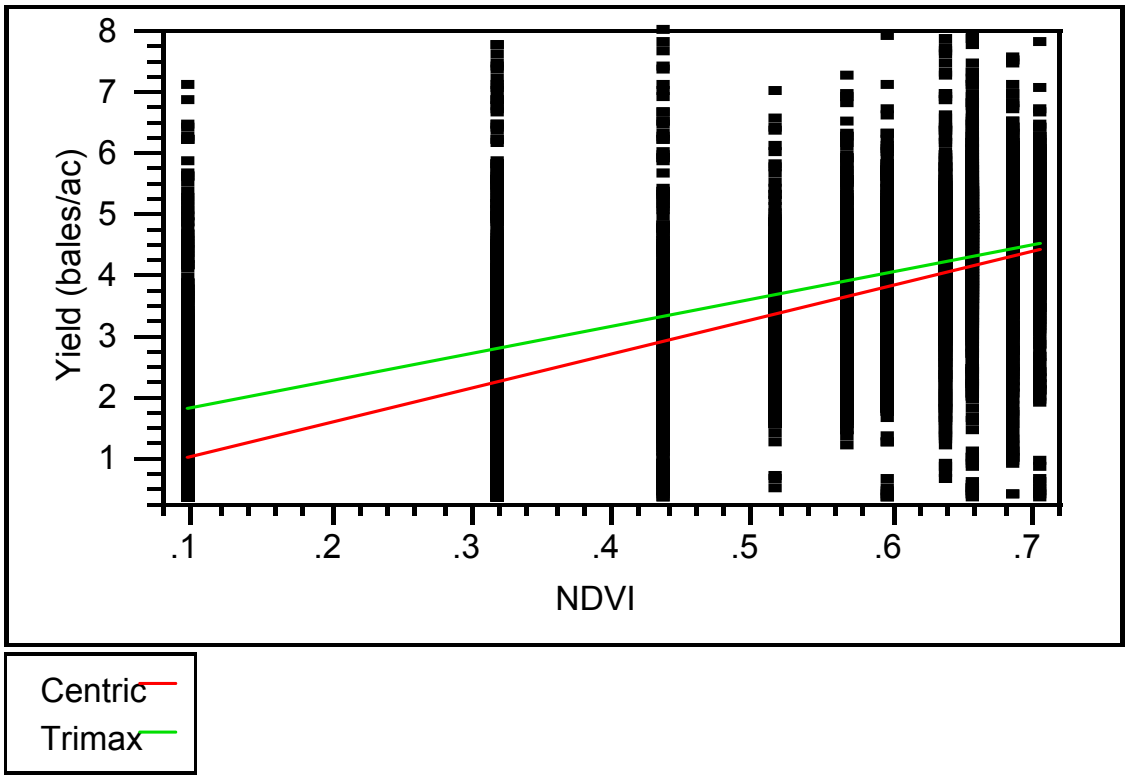
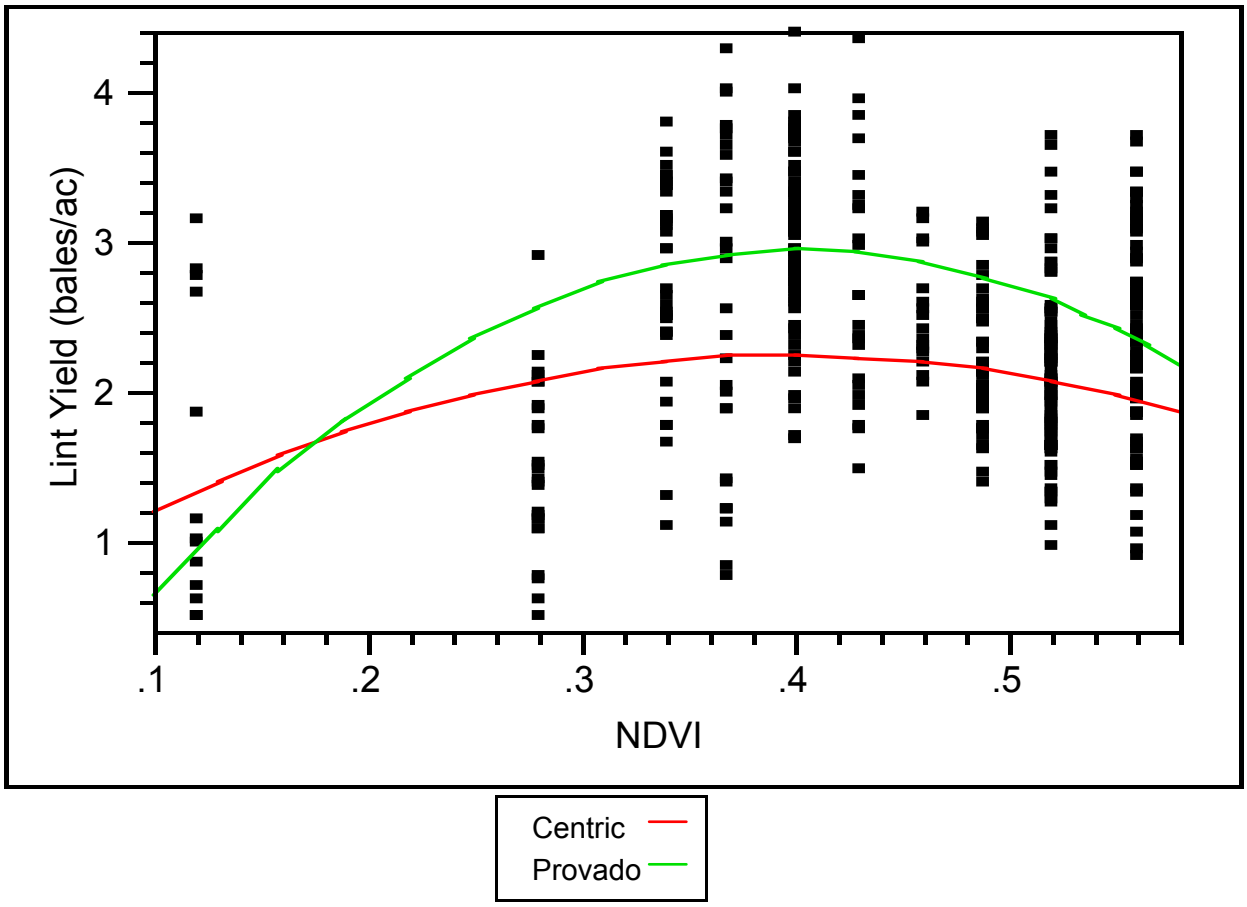


Figure 3 – Cotton lint yield as influenced by vigor levels (NDVI) and neonicotinoid treatment at the AZ07 location

Table 2 – Analysis of variance and combined linear regression data for the AZ07 location

Source	DF	Sum of Squares	F Ratio	Prob > F
MATERIAL	1	119	107	<.0001
NDVI	1	6039	5398	0.0000
MATERIAL*NDVI	1	80.1	71.6	<.0001
Error	8705	9734		
Y(Centric) = 0.492 + 5.568 * NDVI $R^2 = 0.466$ Y(Provado) = 1.379 + 4.418 * NDVI $R^2 = 0.334$				

At the HO06 location, the response to neonicitinoid treatment was better estimated by the use of 2nd order polynomial functions as can be seen in Figure 4. At this location the main stress inducing factor was considered to be hypoxia following irrigations (as noted by the dramatic yellowing of the foliage following an irrigation). Provado increased yields at intermediate vigor levels (NDVI values between 0.2 and 0.55). The fit of the regression equations were highly significant (Prob. < 0.01) even though the R^2 values are not high due to the large number of observations.



Centric: $y = -11.69x^2 + 9.347x + 0.387$ $R^2 = 0.074$
Provado: $y = -24.95x^2 + 20.17x - 1.120$ $R^2 = 0.180$

Figure 4 – Cotton lint yield as influenced by vigor levels (NDVI) and neonicitinoid treatment at the HO06 location

Conclusions

Trimax Pro / Provado gave a consistent, significant yield response when NDVI levels, under hypoxic conditions, were between 0.2 and 0.5, which represent moderate vigor levels. Trimax Pro / Provado increased yields beyond these NDVI values under saline conditions at two locations. This data suggests a superior stress mitigation performance of Trimax Pro / Provado in cotton over competitor neonicotinoid treatments. This statistical design allows users to investigate PGR effects across a range of stress levels quickly and accurately.