Where is the IPM in treating soybeans with a fungicide/insecticide combination in the absence of pests?

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Introduction

Historically, the Kentucky soybean crop is relatively free of serious insect and disease problems. While most of our soybean acres receive herbicide application(s) each year, very few fields are treated with an insecticide or fungicide (Sandell 2003).

Fungicide use was extensively studied in the 1970's and early 1980's by University of Kentucky plant pathologists. Yield results from these tests were inconsistent, primarily due to highly variable disease pressure. The two major conclusions of these studies were 1) fungicide use rarely produced economic benefit in commercial grain operations and 2) fungicides appeared to be best suited for seed producers in very specific situations. As a result, almost no fungicides have been applied to soybeans since early 1980's!

Although large scale outbreaks of soybean insect pests are rare, insecticide applications are justified in some fields virtually every year. Common targets are bean leaf beetle control on emerging seedlings, and mid- to late season applications, especially to late-planted beans against Japanese beetles and grasshoppers (Sandell 2003). There has been no need for scheduling applications of an insecticide and / or fungicide.

The yield boost program

In 2002, Syngenta Crop Protection, Inc. (Syngenta) instituted strip plot trials featuring foliar sprays of two of their products, the stobilurin fungicide Quadris®

(azoxystrobin) at 6.2 fl oz /A and the pyrethroid insecticide Warrior® (lambda-cyhalothrin) at 2.56 fl oz /A. The demonstrations were conducted in numerous grower fields in southern Indiana and Kentucky. The tank mix was applied between soybean plant growth stages (Fehr and Caviness 1977) R3 - beginning pod and R5 - beginning seed. Syngenta reported estimates of excellent yield increases (average 6.8 bu /A) from "strip trials". There were no measures of disease or insect pressure or effects on non-target organisms, and more importantly, the trials were not replicated.

The 2003 cost, based on local product prices and cost of custom application, of this tank mix combination in Kentucky was estimated to be $23.00/A. With this price, a bushel of beans would only have to be worth $3.38 in order to pay for the treatment. During the summer of 2003, soybean (per bushel) prices in western Kentucky varied from the mid- $5.00 range to over $8.00 before falling back to around $7.50 (Riggins 2003). Using the mid-range of these prices ($6.75) and an average yield increase of 6.8 bu /A, the gross value of this application is $45.90. The net profit is calculated at $22.90 per acre after chemical and application expenses are deducted.

Syngenta was so sure of their 2002 results that they initiated a "Guarantee" for 2003. This program offered to pay for product if the treatment did not work and also to pay if there was not a defined "yield boost".

Research-based Recommendations

The use of pesticides to enhance crop yields, even in the absence of obviously damaging pest infestations, is intriguing. It is important to investigate this more carefully because 1) other companies are very likely to implement this calendar-based approach and 2) the non-target impact, especially to beneficial insects and secondary pests has not been evaluated. These questions can and need to be addressed by the unbiased research work of the Cooperative Extension Service (CES).

Year 1 (2003) Methods

In 2003 we evaluated the following data separately in an effort to determine whether or not the suggested effect was "real" and, if so, what was causing the differences. These data came from -

1. Two replicated small plot studies at UK-REC in Princeton, KY.
2. Three replicated strip plots in grower's fields.
3. Observed 6 non-replicated (but paired) strip tests in grower's fields.
4. Summarized yield data from 51 (paired) strip plots in grower's fields.

In all tests, Quadris® (6.2 fl oz/A) and Warrior® (2.56 fl oz/A) in combination or alone, were applied between the R3 and R5 growth stages. All data were analyzed using appropriate statistical methods. The treatments will be abbreviated as follows: Quadris® applied alone = ***Q***; Warrior® applied alone = ***W***; the combination is ***Q+W***; and no application = ***NoA***.

1. UK-REC Replicated Plot Studies. Both studies were carried out on the UK-REC. Both studies were planted as a randomized complete block design (Steel and Tory 1960) with six replications. Also, in both studies pesticide applications were applied with a $C0_2$ powered back pack sprayer delivering 20 gallons per acre at 45 psi. The pesticide

treatments in both cases were ***Q***, ***W***, ***Q+W*** and ***NoA***. Data was collected on pest incidence, defoliation and yield.

UK-REC Test 1 - AG3703 RR soybeans were planted on 14 May 2003. Plots were six, 15" rows by 20' in size. Treatments were applied at growth stages R3, R4 and R5.

UK-REC Test 2 - P94B74 soybeans were planted 16 May 2003. Plots were four, 30" rows by 40' in size. Treatments were applied at R4.

2. Replicated strip plots in grower's fields. In three western Kentucky fields, farmers applied the ***Q+W*** tank mix and ***NoA*** between growth stages R3 - R5. One of these sites was "full season" beans while the other two were "double-crop". Plots were a minimum of 40 acres, and each study contained three replicates. All production practices including the application of pesticides and the measurement of yields, was accomplished by the farmers. The fields were scouted weekly by a scout hired by KY-IPM. Data were analyzed and evaluated by the authors.

3. Non-replicated (but paired) strip tests in grower's fields. Six Fields (2 in Hickman Co., 1 in Fulton Co., 3 in Henderson Co., KY) containing un-replicated, but paired, plots of the ***Q+W*** tank mix and ***NoA*** were monitored. All fields were full-season varieties and all production practices, including the application of pesticides and the measurement of yields, was accomplished by the farmers. The fields were scouted weekly by a scout hired by KY-IPM. Data were analyzed and evaluated by the authors. Because there was no replication in the field, each field (treatment pair) was treated as a replication.

4. Non-replicated but paired strip plots in grower's fields. A general call for data was sent to CES county agents. We received data from 51 fields in eight KY counties including yield, variety, and planting date. All production practices, including the

application of pesticides and the measurement of yields, were accomplished by the farmers. The fields were not scouted or observed by the authors in any fashion. Data were analyzed and evaluated by the authors. Because there was no replication in the field, each field (treatment pair) was treated as a replication.

Year 1 (2003) Results

1. UK-REC Replicated Plot Studies.

   General

   No significant foliar disease developed.

   No significant insect populations developed.

   Yield increases were due to increased 500-seed weight.

   Yield increase due to test weight.

   Yield not increased by seed per pod or pods per plant.

   Phompsis sp. levels were not significantly impacted.

   UK-REC Test-1

   - ***Q*** and ***Q+W***, but not ***W***, delayed maturity by a week, regardless of stage of application (R3-R5).
   - ***Q*** and ***Q+W***, but not ***W***, significantly reduced stem and pod infections (primarily anthracnose).
   - Only significant yield increase was with ***Q+W*** applied at R4.
   - Foliar disease and insects not a factor.

   UK-REC Test – 2

   - ***Q*** and ***Q+W***, but not ***W***, delayed maturity by a week.

- No treatments significantly reduced stem or pod disease.
- ***Q+W***, but not ***Q*** or ***W*** alone, increased yield (3.7 bu /A).
- Foliar disease and insects not a factor

2. Replicated strip plots in grower's fields.

- ***Q+W*** delayed maturity by a week in 2 of 3 tests.
- ***Q+W*** reduced stem disease in 1 of 3 tests.
- ***Q+W*** did not reduce pod disease.
- ***Q+W*** did not significantly increase yields (net economic loss).
- Foliar disease and insects not a factor

3. Non-replicated (but paired) strip tests in grower's fields.

- ***Q+W*** delayed maturity by a week.
- ***Q+W*** reduced stem disease.
- ***Q+W*** did not reduce pod disease.
- ***Q+W*** significantly increased yield (3.42 bu/A)
- Foliar disease and insects not a factor.

4. Non-replicated but paired strip plots in grower's fields.

- ***Q+W*** yields significantly higher than ***NoA***; large range of yields.
- Significantly greater yields in mid maturity varieties compared to early or late maturities.
- Greatest yield/economic response in early maturity varieties.
- Greatest yield and economic gain associated with early plantings.

Year 1 (2003) General Summery

- ***Q*** and ***Q+W*** delayed maturity by about one week.
- ***Q*** and ***Q+W*** tended to reduce stem disease; impact on pod disease “iffy”.
- No obvious insects or foliar diseases played a significant role in 2003.
- Tended towards higher yields where ***Q+W*** applied, but not always so; less response in double crop and late-maturing beans?
- ***Q*** by itself delayed maturity and reduced pod/stem disease, but yields not affected.

Year 1 (2003) “Conclusions”

Data from the 2003 studies provided some evidence of a positive ***Q+W*** affect on soybean yields and some insight as to why. Neither insects nor foliar diseases appeared to be at levels that would account for yield differences. Additionally, there was no evidence in the 2003 information concerning why Warrior® was needed to provide the yield increase when Quadris® alone was enough to provide the measurable difference in defoliation and pod and stem disease control! However, the data did point to fungicide activity on pod and stem disease and that these effects are mitigated by planting date and maturity group.

Year 2 (2004)

In 2004 three small plot experiments were planted on the UK-REC. These experiments were designed to 1.) provide a second year of data on the original treatments; 2.) view any similar effects by another stobilurin fungicide and 3.) explore the effects of soybean maturity and planting date on the plant disease, especially stem and pod disease, and ultimately yield.

To accomplish the first objective, the exact experiments as described in UK-REC Test 1 and 2 were planted in 2004. Only the exact date of planting varied from the 2003 original with UK-REC-1 being planted on 11 May and UK-REC-2 on 06 May 2004 respectively. Objective 2 was accomplished by adding two additional treatments to UK-REC Test 2. Those were the application of a different stobilurin fungicide, Headline® (pyraclostrobin) and Headline® plus Warrior®. Objective 3 was accomplished by designing a new experiment.

In the case of objective three, a randomized complete block experiment with six replications was designed and planted to contain the following treatments: planting date (PD), maturity group (MG)(See Norman 1978), and pesticide application. There were two PD representing early planted "full season" beans (11 May) and late planting "double-crop" beans (21 June). Three similar varieties of Asgrow soybeans, AG3703 RR, AG4403 RR and AG5301 RR, in MG's 3, 4 and 5 respectively, and two pesticide applications ***Q+W*** and ***NoA*** were used. This was a balanced experiment in that plots representing every PD X MG combination, in every replication, received both pesticide applications.

As of this writing, results of these experiments are just becoming available for analysis and, therefore, we are not able to provide them for the proceedings. Hopefully, they will have been enlightened by the time of the conference! In addition, we hope to collect relevant data from other experiments that contain these same treatments.

Where is the IPM in "guaranteed yield enhancement" pesticide applications?

There appears to be no IPM in calendar applications of pesticides to a crop in the absence of any known pests. However, what we know and what we think we know about managing pests, changes over time. The source or impetus for this change can come from a variety of sources. When faced with data indicating trends or responses that lie out of the traditional IPM view, we as scientists, must use sound research approaches to examine the response and possible causes. We can design experiments to explore questions and raise new possibilities. We appreciate the support of the Kentucky Soybean Growers Association and Promotion Board and the Kentucky Integrated Pest Management program in allowing us to start down this path.

In this specific example, pesticide applications are applied to beans without consideration to any recognized pest levels and measured responses cannot be evaluated with standard statistical tests. Also, timing of applications is based on specific plant developmental stages rather than sound "pest load" criteria. This approach is in direct conflict with the spirit and established practice of IPM. Consequently, we would not recommend this without rigorous investigation. While we have found that a calendar approach to pesticide application is probably not justified, there may very well be a biologically-based explanation, such as pod and stem diseases, for the positive results. Additionally, we demonstrated that other production factors, such as planting date and maturity group, will affect these diseases, and also, the efficacy of the treatment.

We are a long way from an understanding of the concepts raised in this study. Nevertheless, a research-based approach to investigating this response has allowed us to identify and investigate some previously unrecognized situations. The "yield enhancement" approach to pesticide use does not follow sound IPM principles and none of the studies addressed impacts to non-target organisms. However, this example has called attention to the impact of some diseases and established a research effort that may reduce losses to them through improved cultural practices. Most importantly, it emphasizes the importance of keeping an open mind and working to establish the biological relevance of observations.

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