INTEGRATED PEST MANAGEMENT IN THE TRANSGENIC ERA

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Abstract

Non-Bt cotton varieties can be protected, produce comparable yields and compete economically with Bt cotton throughout the Cotton Belt. If, however, change dictated that all or most US cotton was non-Bt, would there be sufficient infrastructure to produce it?

Significant change has occurred in integrated pest management in the last 30 years. With the dawning of the transgenic era in 1996, farmers turned a page in how pests are managed. Since 1996 IPM systems have evolved from field-specific (scouting, threshold use, individual field treatment as needed) to preventative approaches. Field-specific grower decisions to use preventative tactics on virtually every field became de-facto area wide IPM approaches. With growers allocating their available resources to increasingly preventative and area wide IPM approaches, resources and demand for field-specific IPM have declined. This has resulted in a decline in the numbers of consultants, aerial applicators and commercial ground applicators.

During the last 30 years, along with the reduction in private sector infrastructure, there has been significant reduction in the numbers of public sector research and extension crop and IPM professionals. Colleges and universities have strongly embraced genetic and molecular approaches to crop production and protection. As a result, our ability to train applied and field-specific agricultural professionals has declined, as well.

In a world in which the human population continues to increase and resources are becoming increasingly scarce, agriculture must be highly efficient. Changes are a certainty. Agriculture will not be able to efficiently adapt to change without the assistance of well-trained private and public sector professionals. Professionals working for corporations are driven by short-term profit motives. Farmer demand drives the numbers of private sector crop consultants and pesticide applicators. Public sector specialists have historically been the key to efficiency and sustainability in crop production and protection on American farms. The ability of American agriculture to nimbly adapt to future change and efficiently contribute to the escalating world need for food and fiber is in doubt unless diminished public sector research and extension capabilities are rebuilt.

Discussion

Across the Cotton Belt there is interest among some growers in the feasibility of growing non-Bt cotton. Some of the questions being asked are: 1. Can non-Bt cotton be grown and successfully protected from worms (since plant bug and stink bug issues are currently the same on both Bt and non-Bt cotton varieties)? 2. Do the available non-Bt cotton varieties yield competitively with Bt varieties? and 3. Can non-Bt varieties be economically competitive with Bt varieties? Research from across the Cotton Belt was consulted to answer these questions.

Can non-Bt varieties be protected from worms?

Several Beltwide Cotton Conference Proceedings articles from the most recent two years were used to answer this question. Two (Edwards et al. 2011, 2012) were compilations of many field studies. They concluded Coragen or Prevathon (rynaxypyr) and Benevia (cyazypyr) were effective against bollworms, but somewhat less effective than 2-gene Bt. However they found, as have other studies, that under high worm pressure oversprays with Prevathon on 2-gene Bt cotton produced yield increases. Eight others studies concluded worms could be successfully controlled on non-Bt cotton (Cattaneo et al. 2011, Colwell et al. 2011, Fortner et al. 2012, Herbert et al. 2012, Jackson et al. 2012, Luttrell et al. 2012, Patman et al. 2012 and Payne and Cochran 2012). Pyrethroids were shown to be effective against bollworms in the Texas High Plains, Mississippi, Georgia and Virginia (Cattaneo et al. 2011, Patman et al. 2012, Jackson et al. 2012, Luttrell et al. 2012, Payne and Cochran 2012, Hebert et al. 2012). Belt (flubendiamide) was effective against bollworms in Arkansas (Colwell et al. 2011, Fortner et al. 2012) but low rates were not effective against either bollworms or fall armyworms in Texas (Cattaneo et al. 2011, Patman et al. 2012). Combined with pyrethroids, however, Belt was highly effective against both bollworms and fall armyworms in Texas (Cattaneo et al. 2011, Patman et al. 2012). Coragen/Prevathon was effective against bollworms in Mississippi, Arkansas and Texas (Jackson et al. 2012, Luttrell et al. 2012, Colwell 2011, Fortner 2012, Patman et al. 2012). It was also effective against fall armyworms in Texas (Patman 2012). Blackhawk (spinosad) was effective against bollworms in Georgia, but it was effective against neither bollworms nor fall armyworms in Texas (Payne and Cochran 2012, Patman 2012). Benevia was effective against bollworms in Arkansas and Texas, but it was not effective against fall armyworms in Texas (Fortner 2012, Patman et al. 2012). Although there were regional differences, the consensus of these studies was, in every area of the Cotton Belt insecticides were available to effectively control the worm pests of cotton.

When worms are controlled, do non-Bt cotton varieties yield competitively with Bt cotton varieties?

The proceeding presentation by Dr. Fromme provided extensive data showing several non-Bt varieties compete very well with Bt varieties in South Texas. Data from three 2011-1012 studies reported at the Beltwide Cotton Conference support Dr. Fromme's conclusions. Under low worm pressure or higher pressure when treated with insecticides, non-Bt cotton yielded competitively with Bt cotton in Mississippi, Virginia and Texas (Jackson et al. 2012, Hebert et al. 2012, Kelly et al. 2012).

Can production of non-Bt cotton compete economically with Bt cotton?

Dr. John Robinson reported on this subject at this symposium at the 2013 Beltwide Cotton Conference. He concluded non-Bt cotton production was economically competitive with Bt cotton. The same conclusion was reached in West Texas, Mississippi and Virginia (Hogan et al. 2011, Jackson et al. 2012, Herbert et al. 2012). Hebert et al. (2012) noted that under higher spray Virginia conditions the higher cost of insecticides and application was offset by the higher seed cost of Bt varieties.

If large acreages of non-Bt cotton were planted would we be able to protect it?

Historically insecticides have been used on cotton for about 10 to 15 years before resistance develops in the target pest species. Bt cotton has been used for 17 years. Non-Bt refuge plantings and stacked Bt genes have been a successful strategy, but it would be naïve to think area wide selection will not drive target pest populations increasingly toward the development of resistance. And, the consensus of reports of symposium at the Beltwide Cotton Conference in 2011 was that under high pressure, insecticide treatment of 2-gene Bt cotton mid-season resulted in increased cotton yields (Green 2011, Jackson et al. 2011, Siebert et al. 2011). This is not an indication that resistance has occurred, but it definitely indicates bollworms are surviving long enough to damage two gene-Bt cotton.

Pest management tactics during the transgenic era - 1996 to present – have increasingly evolved toward the use of preventative tactics used on so many farms that they become de-facto area wide IPM programs. Recent examples are: Bt crops, herbicide tolerant crops, boll weevil eradication, seed treatments (for thrips, nematode, and disease control), use of disease tolerant cultivars, fungicide treatments, nematicide treatments, nematode tolerant varieties, etc. Over time, grower commitment of larger resources to crop protection at the time seed is purchased or planted has competed with and reduced the resources they have been willing to commit to in-season, field-specific IPM. This has resulted in decline in the infrastructure needed to conduct in-season and field-specific IPM.

The author's first recognition that these infrastructure changes may have occurred were his observations, supported by those of Mr. John Norman, Extension Agent Pest Management (retired) and independent crop consultant in the Lower Rio Grande Valley (LRGV) (Norman 2012). The LRGV was a good location for a case study because of its intensive agriculture, it's relatively small (three counties) size and its isolation from other US crop production areas. In 1981 the LRGV had 35-40 chemical or seed Company Fieldmen - in 2012 there were 12. In 1981 there were 18 crop consultants – in 2012 there were five. In 1981 there were 30+ aerial applicators – in 2012 there were five. In 1981 there was a fully staffed USDA ARS Research Center – in 2012 it was closed. In 1981 there was a fully staffed Texas A&M Research and Extension Center – in 2012, grower support through the research and extension center was diminished.

The realization that the infrastructure supporting agriculture in the LRGV had changed begged the question, "Did infrastructure decline only in the LRGV or were changes occurring in other parts of the South as well?" Information on the numbers of crop consultants was obtained though state regulatory agency licensing records and the national CPARD database. Data were available for Louisiana and Arkansas. For Louisiana, records of licensed agricultural consultants were available from 2005 to 2011 (CPARD. 2012). In 2005 there were 282 licensed consultants in Louisiana and by 2011 there were 183 - a 35 percent reduction. In Arkansas, similar records were available from the Arkansas State Plant Board (2012). There were 343 licensed agricultural consultants in Arkansas in 2006, and 248 licensed consultants by 2012 – a reduction of 28 percent. The author conducted a survey of southern state extension entomologists in September of 2012. Twenty-eight surveys were sent and 15 were returned. Forty-seven percent of the respondents indicated that fewer consultants were working in their area or state compared with five years ago while 53 percent said the number of consultants in their area or state had not changed. None of the respondents indicated that the number of consultants had increased. Averaged across respondents, the number of consultants reported had decreased nine percent in the last five years.

The 2012 CPARD database was used to answer the question, "Have the numbers of licensed commercial pesticide applicators changed?" Data were available for Alabama, Arkansas, Florida, Georgia, Louisiana, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, Texas and Virginia for the period 2005-2011. In 2005 there were 14,703 registered commercial applicators operating in those states. By 2011 there were 13,684 – a reduction of 6.9 percent in six years (CPARD 2012). Texas Department of Agriculture (TDA) records provided a comparison over a longer window of time. In 2000 there were 2,482 licensed applicators in the crop protection category. In 2011 there were 1,745 – a 30 percent reduction during eleven years (Texas Department of Agriculture 2012).

Florida, Georgia, Louisiana, South Carolina, Tennessee, Texas and Virginia have separate licensing categories for commercial aerial applicators. There were 1,588 aerial applicators licensed in these states in 2005. By 2011 there were 1,413 – an 11percent reduction in six years (CPARD 2012). TDA records from 2000 to 2011 showed 746 commercial aerial applicators in 2000 and 543 licensed aerial applicators in 2011 – a 27 percent reduction in eleven years (Texas Department of Agriculture 2012). The 2012 extension survey was further indicative of changes in numbers aerial applicators. Forty-seven percent of respondents indicated there were fewer aerial applicators compared with five years ago. Fifty-three percent said the numbers of aerial applicators was unchanged over the last five years. None of the respondents indicated that the number of aerial applicators had increased. The average of survey respondents' estimates indicated an 11 percent reduction in aerial applicators in the last five years.

Extension resources supporting growers are also on the decline. Extension survey respondents unanimously reported that there were fewer Extension personnel working on cotton now compared with five years ago. The average reduction in personnel reported in the 2012 survey was 33 percent over the last five years. In Texas, the number of IPM Agents and Extension Entomologists has decreased 45 percent during the last 20 years (Thomas 2012).

Conclusions

Growers have adopted transgenic and other preventative, area wide IPM tactics. The infrastructure supporting field-specific IPM has been reduced over the last 30 years. In addition, colleges and universities have, in large part, changed their focus. They now emphasize the development genetic and molecular-based technologies. Increasingly, colleges' ability to provide field-specific training is being lost. If cotton growers chose or were forced to adopt field-specific field scouting and spraying on a large scale it would take years to educate enough people to scout their crops. The likely grower response would be to treat on a weekly basis (largely without field scouting information due to shortages of trained field scouts) to protect increasingly scarce and valuable crops.

Change in pests, pest management and agricultural systems are a certainty. Changes will occur and the pace of change may become even more rapid. The lack of experienced consultants, applied research and extension professionals in the future will result in slower and more inefficient grower ability to adapt to change.

Urgent Need to Rebuild Infrastructure

The world population surpassed 7 billion human beings in 2011 (James 2011). Another 4 billion people are expected on earth by 2050 (Kang 2005). In order to feed and clothe these people, agriculture must be very efficient. Historically, changes, problems and breakdowns in pest management systems have been addressed by public sector crop production and crop protection specialists. The reduced numbers of specialists trained to conduct research and aid growers in adopting technologies to deal with change is troubling. Experience has taught us that strong public sector research and extension programs are essential to the ability of farmers to quickly adapt to change. If we fail to rebuild the public sector agricultural infrastructure, agriculture will be unable to efficiently adapt to changes in the future – to our peril.

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