IPM/BMP Practices in Arizona Cotton

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Abstract

Arizona cotton growers were surveyed regarding the importance of Integrated Pest Management (IPM) and Best Management Practices (BMP). Telephone surveys reached 249 individuals over a ten-day period. The survey asked growers to rate the importance of each IPM/BMP tactic on a scale of 1 (not important) to 5 (very important). Of the 14 practices/tactics listed for IPM, eight had significant chi-square values. These included scouting, crop rotation, variety selection, petiole testing for nitrogen, pheromone use, equipment calibration, and stalk destruction. Of the eight practices/tactics listed for BMP, six had significant chi-square values. These included crop rotation, timing and splitting of nitrogen applications, petiole testing, time of planting and variety selection for specific suppression (Bt cotton). In general, whether it was an IPM, weed management, or a BMP practice/tactic, the growers scored a majority of the tactics as important. It could be inferred from the growers' responses that they agree that the practices listed as important were, in fact, important grower practices.

Introduction and Background

As we approach the 21st Century, our society continues to focus on reducing environmental pollutants. Many consumers consider pesticides to be major environmental pollutants because of their potential to contaminate the food and water we consume, and air we breathe. Modern agriculture is expected to use integrated pest management practices (IPM) and best management practices (BMP) to reduce dependency on pesticide use wherever possible and thus reduce environmental pollutants. However, documenting reductions in pesticide use that can be attributed to IPM practices and BMPs is difficult. Therefore, establishing baseline data on management practices and pesticide use is critical in order to document reduced pesticide use through IPM practices and BMP. Documenting wise use of pesticides and other resources is essential to the future of agriculture in Arizona.

The Arizona cotton industry is undergoing rapid changes in pesticide use patterns due to initial successes with new technologies such as insect growth regulators (IGRs) and Bt cotton, a new selective herbicide (Staple), and herbicide resistant cotton varieties (e.g., BXN and Roundup Ready). These new technologies require cautious use and a continuous pursuit of information that will enable us to maintain their viability. However, if the past use of pesticides is an indicator of the future, resistance to new pest control technologies will occur. Therefore, it is important to establish baseline data on current technologies and practices in order to observe and document changes resulting from new technologies.

Materials and Methods

A tactics survey, based in part on a Texas study, was developed to determine the importance of IPM/BMP practices on cotton growing decisions (see Appendix A). Cotton growers were either asked to rate the importance of each IPM/BMP tactic on a scale of 1 (*Not Important*) to 5 (*Very Important*), or asked questions that required *Yes* or *No,* or short answers.

A random sample of cotton growers was obtained from the Arizona Agricultural Statistics Service (AASS). Criteria for selecting respondents were based on records of producers who grew cotton within the last three years. Telephone enumerators were given specific training on terminology, and basic principles of IPM/BMP prior to data collection. Telephone surveys were conducted both during day and evening hours to maximize the number of possible contacts. We were able to complete interviews for 249 individuals over a ten day period.

Results and Discussion

The survey was segmented into five parts (see Appendix A). The enumerators initially asked general questions about farm operation (Part 1), followed by questions rating the importance of selected IPM tactics (Part 2). Next, they asked questions specific to the use of herbicides and IPM practices (Part 3), then questions regarding BMP tactics (Part 4), finishing with general questions about producer age, education and experience. Results are presented in Tables 1- 4.

We pooled the Arizona counties into three regions: East, Central and West. The East region included Cochise, Graham and Greenlee counties; the Central region included Pima, Pinal and Maricopa counties; and the West region included La Paz, Mohave and Yuma counties. This approach was used because nine of the 15 counties in Arizona grow cotton, but several counties grow less than 1000 acres. In addition, we were unsure that we obtained a valid sample size for small cotton acreages.

Survey respondents reported growing a total of 139,697 acres of cotton in Arizona in 1995 (Table 1). This acreage represents 33.9 percent of the total acres grown in the state as estimated by the Arizona Agricultural Statistical Services. Of the nearly 140,000 acres reported, over 70 percent were grown in the Central region; and, of the two types of cotton grown—"upland" or "pima"— the Eastern counties reported the highest mean acreage of Pima cotton (average 300 acres/grower). Growers in the Central region had the highest statewide average upland cotton acreage at 582.6 acres/grower. Grower responses indicated that organic cotton was produced on 13.0, 7.3 and 4.9 percent of the reported cotton acreage in the East, Central and West regions, respectively. We suspect that these percentages are overestimates that reflect various definitions, some quite liberal, of organic cotton production. Unfortunately, the survey did not define organic cotton production.

In the first part of the survey, we asked growers if they agreed (*Yes* or *No*) with our definition of IPM. A statewide average of 98 percent agreed with the following definition used in the survey:

> "A sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks."

The Integrated Pest Management practices portion of the survey asked growers to rate the importance of each IPM tactic on a scale of 1 (*Not Important*) to 5 (*Very Important*), (see Table 2). They were also asked to indicate the "most important tactic" using the same 1 to 5 scale. Responses for each tactic were summed by region and statewide. Chi-Square tests at 0.05 level of probability with 2 d.f. showed significant differences between regions for specific questions. Of the 14 practices/tactics listed, eight had significant Chi-Square values. These included scouting, crop rotation, variety selection, petiole testing for nitrogen, pheromone use, equipment calibration, and stalk destruction. In general, the Eastern counties rated the importance of IPM tactics lower than their counterparts in the rest of the state. For example, under the categories *scouting, pheromone use*, and *stalk destruction*, growers in the East region rated these practices as less important than growers in either the Central or Western regions. Conceivably, this could be due to a smaller sample size for the East region, or, more likely, that growers did not perceive these particular IPM tactics as that important. This could be due to lower insect pressures in the East region compared to other regions in the state. In general, only two category scores—*petiole testing* and *modeling*—were rated below 3 (*Important*) in the statewide average. This could be because these are two of the newest technologies that are available. Statewide, of the 192 responses, growers identified scouting as the "most important tactic."

Grower attitudes regarding IPM practices related specifically to weed management are presented in Table 3. Growers were asked a series of *Yes* or *No* questions regarding the following topics: hand weeding, pre- and post-emergence herbicide applications, banding of herbicides, cultivation practices, the rotation of pesticide chemistry, and the cleaning of equipment to reduce weed seed transport between fields (see Appendix A, Questions 10-19). The table tabulates growers' favorable responses (a "*yes*" answer to the question). For example, to the question "*Do you use postemergence herbicides?*," 47.8 percent of the Eastern region growers responded "*Yes.*" Chi-Square tests (0.05 probability level, 2 d.f) indicated significant differences between regions (East, West and Central) compared to the statewide average for questions regarding the use of pre- and postemergence herbicides and the use of "in-row weeders." Growers were also asked how much they spent on hand weeding. The average statewide cost for hand weeding was reported as $27.87 per acre in addition to other weed control costs.

Grower responses provide a description of weed control practices used in the 1995 Arizona cotton crop and how these practices varied in different regions of the state. Statewide, most growers use both preemergence herbicides before or at planting (tactic 2), and postemergence herbicides (tactic 1). As indicated by tactic 5, most of these applications were broadcast applications. The practice of banding postemergence herbicides will no doubt increase with increasing use of the postemergence herbicides Staple, Roundup Ultra (on Roundup Ready cotton), and Buctril (BXN cotton). Significantly less preemergence and postemergence herbicides were used in the East region compared to the Central and West regions. Statewide, few growers band preemergence herbicides or use electro-mechanical hydraulic quick hitch guidance systems in their farming operations despite the fact that these practices can reduce production costs. Another tactic that can reduce costs, though not widely used, is the use of in-row weeding implements during cultivation (tactic 7). Interestingly, in-row weeding is more widely used in the East region (where less herbicide is used) than in the Central or West regions. Hopefully, hand weeding costs and other weed control costs can be reduced as Extension education programs focus on banding or eliminating pre-plant preemergence herbicide applications and using precision cultivation and in-row weeding techniques.

Chi-square tests (0.05 probability level, 2 d.f.) indicated that, for seven IPM tactics associated with weed control, the East, Central, and West regions did not differ significantly from the total statewide responses. Grower responses were mixed both within and between regions with no consistent patterns. Due to confusion on the part of both enumerators and growers, the depth of plowing (question 14c) was eliminated from consideration. We also noted that growers were asked if they used water to clean equipment (tactic 9) and pickers (tactic 10) between fields (tactics that reduce the spread of weeds from field to field). Because equipment can be cleaned in other ways, the responses may underestimate the use of these tactics. The responses to tactic 8 indicate that many growers believe they rotate herbicide chemistry, although in reality, few alternatives existed in 1995, making the practice difficult to accomplish. The responses most likely reflect the rotation of brand names and herbicides in the same chemical class (e.g., Prowl and Treflan, or Caparol and Prometryn, or Direx, karmex, and diuron).

Grower responses to questions about Best Management Practices are presented in Table 4. Growers were asked to rate BMP tactics on a scale of 1 to 5. Chi-Square tests (0.05 probability level, 2 d.f). showed significant differences in responses between regions for specific questions. Eight categories had significant differences. Only pre-irrigation and clean ditch banks were not significantly different between regions. In general, only one category—*petiole testing*—rated below 3 (*Important*) in the statewide average. The results suggest that growers recognize the importance of the surveyed practices and that educational programs are having an impact. This *Low Importance* was consistent with the *Low Importance* response we obtained in the IPM portion. The "*most important tactic*" identified by the respondents was split between *Time of Planting* and *Varieties Used*, at 43 votes each.

In the last part of the survey, we asked a variety of general informational questions, such as the age and educational level of the respondents. The average age of a respondent was 49 years. Most respondents had taken some college courses. The percentages of respondents who identified themselves as commercial applicators, private applicators, or those employing a Pest Control Advisor, were 12.4 percent, 66.4 percent and 83.7 percent, respectively. The typical commercial applicator had been in business for an average of 9.6 years. The average time in business for private applicators was 11.1 years.

Summary

We were able to survey nearly 34 percent of the cotton growers statewide, with over 70 percent of the acreage surveyed being located in the Central counties. In general, whether it was an IPM, weed management, or a BMP tactic/practice, the growers scored a majority of the tactics as important. It could be inferred from the growers' responses that they agree that the practices listed as important were, in fact, important grower practices. In addition, the respondents recognized the need for a professional opinion by employing PCAs to make pest control recommendations.

The IPM/BMP survey responses, combined with the 1080 data (see related article by authors in this Cotton Report, *Survey of Cotton Weeds and Weed Control Practices in Arizona Upland Cotton Fields*) describe typical weed control practices in Arizona cotton production systems. Most growers use both pre-emergence and post-emergence herbicides during the season; however, pre-emergence herbicides applied before or at planting, and later in the season at layby, account for the vast majority of herbicide active ingredient applied to cotton fields in 1995. Since pre-emergence herbicides are typically applied before listing (i.e., bed formation), it is not surprising that applications were broadcast applications rather than band applications. Band applications were used in some situations, but herbicides (MSMA, fluazifop, clethodim, sethoxydim and others) account for only a small portion of the cotton acres treated. A 1996 survey of 76 growers found that all used field cultivation for weed control; however, the 1995 survey found that almost none utilized a precision guided system in combination with in-row weeding in place of standard cultivation techniques (1996 Survey H report).

In general, this survey provides a baseline data set that characterizes pesticide (and specifically herbicide) use prior to the adoption of new technologies represented by transgenic cotton varieties (Roundup Ready, BXN), selective over-the-top herbicides Staple, Roundup Ultra (used only as RRC varieties), Buctril (used only on BXN varieties), and precision guided in-row weeding techniques. We expect that widespread adoption of these technologies will be reflected in future surveys and will be associated with reduced reliance on preemergence herbicides, increased importance of band applications, and reduced herbicide load on the environment.

Date_____ Numerator_____

AZ Cotton IPM/BMP Tactics Survey

County_____ Respondent (Principle Owner/Manager)_____

Zip Code_____ (2nd Location)_____

1. How many acres of cotton do you grow? _____
   If zero, the survey is complete. Thank you.
2. What is the total acreage on the farm? _____
3. Do you consider yourself to be an organic cotton grower? _____Yes _____No
4. Did you use IPM on your cotton for 1996? _____Yes _____No
5. Do you agree or disagree with this definition of IPM:
   "A sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools is a way that minimizes economic, health, and environmental risks."

   _____Agree _____Do Not Agree

6. On a scale of 1 to 5 (5 being highest), please rate the importance of the following IPM tactics to cotton IPM in your area by placing an X in the appropriate box. Consider insects, weeds, and diseases as pests. Only tactics that are very important in managing major pests should be marked highly important. Thanks for your participation.

IPM Management Tactic	1	2	3	4	5
Scouting for insects, weeds, or diseases					
Crop rotation to reduce insects, weeds, or diseases					
Economic thresholds (action thresholds) to determine when to apply insecticide					
Select varieties that reduce or avoid pests					
Recommended planting dates					
Recommended plant population					
Petiole tissue testing to determine crop nitrogen status					
Computer models to assist in management decisions					

Appendix A

IPM Management Tactic	1	2	3	4	5
Consider natural enemies when making treatment decisions					
Pheromones to monitor or control pests					
Calibrate pesticide application equipment at least annually					
Destroy stalks to reduce pests					
Cultivate or hoe for weed control					
Band pesticides to reduce amount used or conserve beneficials					

7. Of the foregoing IPM practices, which is the *most* important tactic? _____

8. Other IPM Management Practices specifically related to herbicides:

Did you use hand weeding? ____Yes ____No

If so, what was the estimated cost per acre? $_____

Did you use a postemergence herbicide, such as Bladex, Butril, Goal, Prometryn, Roundup Ultra? ____Yes ____No

Did you use any of the following preemergence herbicides before or at planting: Bladex, Karmex (diuron), or Prometryn? ____Yes ____No

This past year, did you:

Band your preemergence herbicide applications? ____Yes ____No

Band your postemergence herbicide applications? ____Yes ____No

Broadcast your herbicide applications? ____Yes ____No

This past growing season, did you use:

"Precision Guidance System" in conjunction with cultivation? ____Yes ____No

An "in-row" weeder (e.g., a torsion rod weeder or spring hoe)? ____Yes ____No

A deep plow (e.g., Kevernaland) to invert the top foot of soil profile? ____Yes ____No

Appendix A

Did you rotate your pesticide chemistry:

Herbicides? _____Yes _____No

Insecticides? _____Yes _____No

Did you clean (i.e., wash off with water) your equipment when moving from field to field? _____Yes _____No

Did you clean (i.e., wash off with water) your picker between fields? _____Yes _____No

9. On a scale of 1 to 5 (5 being highest), please rate the importance of the following BMP tactics to cotton in your area by placing an X in the appropriate box. Consider insects, weeds, and diseases as pests. Only tactics that are very important in managing major pests should be marked highly important.

BMP Management Tactic	1	2	3	4	5
Pre-irrigation					
Clean ditch banks					
Crop rotation					
Time of nitrogen applications					
Split applications of N					
Petiole tissue testing					
Time of planting					
Variety selection for specific suppression (i.e., BT Cotton, BXN Cotton)					

10. Of the foregoing BMP practices, which is the *most* important tactic? _____

11. Your Age_____

Number of Years of Education Completed:

H.S. Grad____ Highest College Degree Earned_____

12. Are you a Commercial Certified Applicator? _____Yes _____No

If yes, how long? _____

If no,

Appendix A

Are you a Private Applicator? _____Yes _____No

If yes, how long? _____

If you are *not* a Commercial or Private Applicator, do you employ a PCA?

_____Yes _____No

If yes, how long have you employed the PCA? _____

Appendix A

Table 1. Grower Response to Total Reported Survey Crop Acres and Cotton Acres by Regions in Arizona for 1995.

Region	Number of Surveys	Total Acres Operated	Cotton Acres	No. Reported Pima Cotton	Average Pima Acres	No. Reported Upland Cotton	Average Upland Acres
East	46	25,799	14,759.0	27	300.1	37	179.8
Central	162	214,150	103,554.0	48	191.1	162	582.6
West	41	53,984	21,384.0	6	198.2	41	492.6
State	249	293,933	139,697.2	81	229.8	240	505.1

Table 2. Regional Differences in Grower Responses Regarding the Importance of IPM Practices in Arizona Cotton in 1995

Integrated Pest Management Practices
Response Differences by Region

	IPM Practices/Tactics[1]	East $\bar{x}$	Central $\bar{x}$	West $\bar{x}$	State $\bar{x}$	Difference *	Chi-Square 0.05, 2 d.f.	Significant Difference	Sum of Most Important Tactic
1	Scouting for insects, weeds, diseases	4.52	4.92	4.88	4.77	9.190	5.99	**	100
2	Rotating crops to reduce insects, weeds, diseases	4.11	4.10	4.53	4.24	6.342	5.99	**	15
3	Using economic thresholds to determine when to apply	4.20	4.41	4.24	4.28	1.091	5.99		15
4	Selecting varieties that reduce or avoid pests	3.70	4.26	3.95	3.97	10.922	5.99	**	21
5	Following recommended planting dates	3.89	3.86	4.34	4.03	4.802	5.99		5
6	Following recommended plant populations	3.26	3.78	3.71	3.58	5.647	5.99		1
7	Petiole tissue testing to determine nitrogen status	2.07	2.97	2.98	2.67	16.263	5.99	**	0
8	Using computer models in management decisions	1.89	2.24	2.20	2.11	3.684	5.99		0
9	Considering natural enemies in making treatment decisions	4.17	4.08	4.07	4.10	4.972	5.99		13
10	Using pheromones to monitor or control insects	2.84	3.58	3.40	3.27	9.917	5.99	**	0
11	Calibrating pesticide application equipment at least annually	4.33	4.67	4.88	4.62	6.838	5.99	**	7
12	Destroying stalks to reduce pests	4.20	4.45	4.73	4.46	8.051	5.99	**	2
13	Cultivating or hoeing for weed control	4.63	4.61	4.66	4.63	0.771	5.99	**	12
14	Banding pesticides to reduce amount used	3.57	3.85	3.80	3.74	1. 547	5.99		1

*Kruskal and Wallis test of nonparametric statistics
See: Principles and Procedures of Statistics
Robert G. D. Steel and James H. Torrie
McGraw-Hill, 1960, p. 406

1. On a scale of 1 to 5 (*Not Important* to *Very Important*).

Table 3. Regional Differences in Positive Grower Responses to IPM Herbicide Practices on Arizona Cotton in 1995

	IPM Tactics with Herbicides	East %	Central %	West %	State %	Difference	Chi-Square 0.05, 2df	Significant Difference
1	Used post-emergence herbicide	47.8	78.6	75.6	72.4	12.995	5.99	**
2	Used pre-emergence herbicide before or at planting	67.4	89.3	73.2	82.5	16.417	5.99	**
3	Banded pre-emergent herbicide applications	21.7	32.3	24.4	28.9	4.342	5.99	
4	Banded post-emergent herbicide applications	32.6	49.0	51.2	46.3	4.940	5.99	
5	Broadcasted herbicide applications	58.7	74.4	68.3	70.4	5.317	5.99	
6	Used a "Precision Guidance System" in conjunction with cultivation	6.5	8.9	9.8	8.6	0.145	5.99	
7	Used an "in-row" weeder	52.2	34.2	22.0	35.5	9.003	5.99	**
8	Rotated herbicide chemistry (1)	37.0	47.5	46.3	45.3	2.493	5.99	
9	Cleaned equipment when moving from field to field	34.8	34.4	32.5	34.2	0.243	5.99	
10	Cleaned picker between fields (wash with water)	43.2	55.6	59.0	53.8	4.236	5.99	

1/ Note there are no herbicide chemistry to rotate to

Table 4. Regional Differences in Positive Grower Responses to BMP Practices in Arizona Cotton in 1995

Best Management Practices
Response Differences by Region

	BMP Practice[1]	East $\bar{x}$	Central $\bar{x}$	West $\bar{x}$	State $\bar{x}$	Difference *	Chi-Square 0.05, 2 d.f.	Significant Difference	Sum of Most Important Tactic
1	Pre-Irrigation	4.28	3.79	4.24	4.10	5.715	5.99		35
2	Clean ditch banks	4.30	4.16	4.41	4.29	3.266	5.99		2
3	Crop rotation	4.02	4.33	4.56	4.30	9.467	5.99	**	35
4	Time of nitrogen application	4.22	4.54	4.55	4.43	7.894	5.99	**	9
5	Split application of nitrogen	3.57	4.20	4.20	3.99	8.148	5.99	**	21
6	Petiole tissue testing	2.02	2.83	2.83	2.56	11.901	5.99	**	3
7	Time of planting	4.67	4.30	4.63	4.53	8.957	5.99	**	43
8	Variety selection for specific suppression (BT cotton)	3.26	4.18	3.65	3.69	15.350	5.99	**	43

* Kruskal and Wallis test of nonparametric statistics
See: Principles and Procedures of Statistics
Robert G. D. Steel and James H. Torrie
McGraw-Hill, 1960, p. 406

1. On a scale of 1 to 5 (*Not Important* to *Very Important*)