ARIZONA COTTON PESTICIDE USE DATA: OPPORTUNITIES AND PITFALLS

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Abstract

Pesticide use reporting systems are becoming more widespread. The data gathered by these systems has enormous potential for a wide range of applied research. Arizona's pesticide use reporting system illustrates both the opportunities and pitfalls that will arise with the increased use of reporting systems. The data available provides a detailed and extensive picture of pesticide use in major Arizona crops like cotton. With improvements it could be the cornerstone of research that benefits producers and the environment. As it stands, however, the Arizona pesticide reporting system lacks fundamental information essential to make it a useful data source. Summaries illustrate both the strengths and weaknesses of the Arizona reporting system. Preliminary research results provide an example of the potential power of the dataset.

Introduction

Pesticide Use reporting is not going to go away. California has required full agricultural pesticide use reporting since 1990 (http:// www.cdpr.ca.gov/docs/pur/purmain.htm). Arizona has required full reporting for all commercial agricultural applicators since 1991(http://www.sosaz.com/public_services/Title_03/3-03.htm). New York State passed a bill in 1996 and started a program in 1997 to quantify pesticide use (http://pmep.cce.cornell.edu/ regulation/psur). Presently Oregon is developing a reporting system and Wisconsin recently passed a bill mandating development of a pesticide reporting system in the near future. Moreover, state mandated reporting systems are only part of the story. In Arizona an estimated 50% of vegetable producers participate voluntarily in a private pesticide use reporting program to provide processors with exact information on potential residues on produce (Janzen 1999). All of these reporting systems exist as a result of combined pressures from consumer and environmental groups, state regulatory bodies and food processors. All of these use reporting systems are separate from the National Agricultural Statistics (NAS) surveys which provide overall pesticide use statistics based on statistical samples primarily for regulatory purposes. There is no reason to believe these pressures will diminish in the near term.

Arizona's pesticide use reporting system is unique. It combines the detailed usage information of the California system with accessibility and ease of use. While the system covers more than just commercial applications for the whole state, it is easily manipulated with desktop database software. This has facilitated the development of useful applications for this kind of extensive data and consequently stimulated discussion of just how this data can be optimally used and collected.

Cotton is Arizona's most widely planted and most valuable field crop. Combined with the relatively intensive nature of cotton pest management, cotton pesticide use is disproportionately represented in the Arizona pesticide use database. Furthermore, much of the present and planned research that takes advantage of this data is focussed on cotton. This paper has multiple purposes: Discussing pesticide use reporting in general; Summarizing recent trends in Arizona cotton pesticide use; Illustrating the power of Arizona's pesticide use database; and using our experience of working with this database as a vantage point from which to consider the options available to future pesticide use reporting systems.

Methods

Use Reporting: The Basics

General summaries of pesticide use are confounded by the diversity of pesticide products. Products are usually categorized by active ingredient (AI) for general summaries. This allows for some aggregation of the numerous pesticide products used in agriculture. Liquid and dry formulations of differing strength can all be grouped together. Within a single crop and AI there is relatively little variation in application rates compared to the variation across crops within an AI or across AIs. With a pesticide product database with conversion factors it is quite simple to summarize pesticide use by AI.

By Pounds of AI

While it is natural to want a single measure that describes all agricultural pesticide use, summing pounds of pesticide use across AIs is not a useful proposal. Recommended label rates vary from .01 pounds per acre for some pyrethroid products (ie. Karate) to over 100 pounds per acre for some nematicides (Telone II). Combining usage statistics from applications of these two products would effectively lose the information on the pyrethroid while overstating the importance of the heavier nematicide. This practice becomes particularly misleading when observing trends over time. Marked increases or decreases in an overall usage measure could be the result of swings in a single product. Conversely, major increases or

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decreases in the use of the pyrethroids could easily be masked.

Treated Acres

Measures of treated acres is another approach to summarizing pesticide use. NAS has traditionally reported the percentage of fields treated and the average number of treatments per field. This kind of information has become particularly important in the last three years with the passing of the Food Quality Protection Act (FQPA). In the FQPA regulatory process, in the absence of actual usage data, regulators use 100% of acres at maximum label applications.

Reporting acres treated is a relatively simple process for the producer and is information that is easily stored in a database. It is more difficult to design and implement a system that determines *which* acres are being treated so as to determine multiple treatments. Ideally each field would have an ID number that would allow for identification of the field through the season. California has attempted to include this in its reporting system. In Arizona, no attempt has been made to track fields. With multiple crops and changing field size and location year to year field tracking increases the complexity of use reporting substantially.

This seemingly small detail is actually a major limitation in the Arizona reporting system and a potential weak link in any system. Without field identification it is impossible to know which acres have been treated how many times.

Application Intensity

An alternative measure is an intensity measure which determines how many applications would have been made if every acre had been treated equally. This is simply the ratio of treated acres to planted acres. While this statistic gives a rough idea of usage, it masks any variation within the area considered. For instance, at the state level in 1998, Arizona had an application intensity for insecticides of approximately five implying all fields were sprayed, on average, five times. At the county level, however, intensities range from .22 to 6.22. Clearly usage patterns vary across the state. If the area considered was pared down to the field, which would necessitate field tracking, then the result would be the number of treatments on each field

In the Arizona 1080 reports, fields are identified by range, township and section, which generally limits the potential cotton acreage to 640 acres. Within the section there is no way, however, to know how many acres are actually planted in cotton. Reports of five ten acre applications could be one field receiving five applications or five fields receiving one application or any combination in between. For research discussed later in this paper, we have been able to obtain section level cotton acreage from an Arizona growers group which allows for section level intensity measures. While variation is unquestionably being lost within the section level data, without field tracking this is the only way that section level data can be made useful for statistical analysis.

Only a true intensity measure allows for comparisons of usage across large areas and across time. Ultimately, different areas must be compared in terms of percent of acres treated. Under the present system this can only be done at the county level or where other measures of cotton acreage are available. Over time, percentages are necessary to control for changes in planted acres. Any overall gross measure of Arizona pesticide use in cotton over the last five years would show usage falling precipitously. This statistic would reflect the steep decline in acres planted to cotton in the state. The "intensity" measure that normalizes treated acres treated with planted acres provides a reasonable way of comparing across years.

Application Rates

Despite the lack of field tracking, the Arizona use data provides a means of knowing actual application rates for pesticide products in the field. Pesticide labels only provide a range of recommended rates for a certain product. The same product might have a quite wide range of recommended rates for different target pests. As mentioned before, in the absence of better data the default assumption for regulatory purposes has been full label rates.

Actual pesticide use rates only necessitate a measure of acres treated by a particular tank of pesticides. Arizona's reporting system requires reporting of both pounds of product to be applied and acres on which that pesticide will be applied. A simple conversion from pounds of product to pounds of AI allows for comparison of application rates within an AI.

Mixed Applications

Finally, usage rates are further complicated by the possibility of mixed applications of two or more AIs. Pesticides are widely used in combination and yet little information about this practice is available. While in general the practice of tankmixing products may be more common with herbicides, it has also been a common practice with insecticides in Arizona in recent years. In 1995, the worst year of a whitefly infestation, 488 combinations of up to five different AIs were recorded. These multiple AI tankmixes complicate both the application rate and applied acres measures.

Data

Pesticide use reporting is not complete in Arizona. Much like California's system prior to instituting full reporting, Arizona requires the reporting of only certain kinds of applications. In addition to the omission of field-tracking, this is clearly a weakness of the database. Recognizing these weaknesses, it is still possible to make good use of the data that is available.

Arizona mandates reporting of pesticide applications by commercial applicators, the applications of pesticides registered under section 18 registrations and certain applications of pesticides included on the Arizona Department of Environmental Quality (DEQ) Groundwater Protection List (GWPL). Anecdotal evidence indicates that there is also voluntary reporting of unregulated pesticide applications

Commercial applicators have a strong incentive to comply with reporting regulations. They can lose their state license if they do not follow proper procedures. In Arizona, commercial applicators play a major role in pesticide application because of the importance of aerial applications of pesticide, all of which are done by commercial operations.

Section 18 registrations have been important for tracking new chemistries as they enter into cotton production. The insect growth regulators (IGRs) (Knack and Applaud) are the most recent examples of section 18 registrations that should have full reporting in the database. Once again, the incentive for producers to report is relatively high because continued registration of the product is dependent on full reporting. On the other hand, the potential penalty for an individual producer is small relative to the commercial applicator and unfamiliarity with he reporting system may lessen compliance.

Finally, the reporting of GWPL applications, which should be complete for those AIs on the list, is actually difficult to quantify. The lack of a visible regulatory presence for the GWPL and relative lack of producer incentives make this aspect of the Arizona use reporting system potentially unreliable. Because the GWPL applies only to soil-applied applications this uncertainty affects reports of herbicides and nematicides more than insecticides and defoliants.

Results

Using the Arizona Pesticide Database

The limitations of the Arizona reporting system determine where the data can be most useful. At a minimum, reported applications provide a lower bound for actual applications in the state. They also provide hard evidence of the range of practices being used by producers across the state. Furthermore, the reporting system has been in place without serious structural changes since 1993 when the GWPL was included. Thus trends over time should reflect actual trends within the group reporting applications.

In the scenarios where reporting can reasonably be assumed to be full, or almost full, more involved hypotheses can be made. The reporting of applications of IGRs should be relatively complete and thus summaries of their use should represent their actual use in the state. In general, the use of aerial applications of insecticides in cotton leads us to believe that a high percentage of insecticide applications in mid and late season cotton are included in the dataset.

In 1998, there were 2.1 million application-acres on 265,900 acres of Arizona cotton. Figure 1 shows that application-acres have declined to less than half of the level of the early 1990s. Maricopa and Pinal counties represent the majority of the treatment acres. Figure 2 shows application intensity -- application-acres normalized by the acres planted in cotton for both the state and the individual counties. At the state level, even controlling for the steady decrease in acres planted to cotton, the number of pesticide applications has declined. This is also true for the major production counties of Pinal and Maricopa.

1995 represents the high point in application intensity for both the state, at 14.9 applications per acre, and the major producing counties. This was the year before IGRs were available and whitefly infestation was high. Where infestations occurred, a high number of insecticide applications were made to avoid potential yield loss and reduced lint quality. This was also a period of heavy use of tankmixes which, because application-acres are included for each separate active ingredient, will inflate the intensity measure.

Figures 3 and 4 show the reported application-acres and application intensity broken down into type of pesticide. It is easy to see that insecticides dominate the database. This result is not unexpected as the number of applications of insecticides will commonly dwarf the number of applications of any other single category.

It is also important, however, to recognize how the limitations of the database might manifest themselves in these numbers. Herbicides are clearly severely undercounted in the pesticide use reports. Producers frequently apply their own herbicides at or before planting and at layby. Thus the only non-voluntary incentive to report would come from the GWPL. The sharp rise of reports in 1993 with a decline thereafter is consistent with the publicized onset of the new regulatory program and the subsequent decrease in awareness thereafter. In fact anecdotal evidence indicates that herbicide use in general is on the increase.

Defoliant usage, which is probably well represented, as it is frequently aerially applied, appears to be steady. Plant growth regulator usage (Pix), at 65% of the acreage in 1998, is 50% higher than any previous year.

Figure 5 shows insecticide intensity by Arizona counties. As expected Maricopa and Pinal counties are near the top in terms of application intensity. During 1995 these counties experienced widespread whitefly infestation. Interesting in this graph is the disparity between La Paz, Yuma and Mohave counties. All in western Arizona along the Colorado river, these three counties appear to have very different usage patterns through the 1990s. Application intensities in Mohave county for all kinds of pesticides are consistently lower than other counties. This might indicate a generally lower reporting rate rather than a lower level of usage.

Figure 6 shows herbicide intensity in Arizona counties. As mentioned before, herbicide reporting is likely to be low. Other than a few aberrations this graph still illustrates a general decline in herbicide use reporting after highs in 93 and 94.

Figure 7 shows defoliant intensity in Arizona counties. Relatively low intensities in the eastern counties of Cochise and Graham are not a surprise both because cooler fall weather assists the defoliation process and reporting is likely to be lower from these areas. Once again, Mohave county's relative low reported intensity appears to be an anomaly.

Figure 8 shows the plant growth regulator intensity in Arizona counties. There is considerable variation at the county level from year to year, perhaps as a result of the weather dependant nature of plant growth regulator use. The overall intensity measure indicates the general increase in plant growth regulator usage.

Figures 9 and 10 track the useage of the top ten insecticides used in Arizona between 1991 and 1998. The general reduction in insecticide use is reflected as is the whitefly infestation in the middle part of the decade. Fepropathrin (Danitol) is a dramatic example of an AI, heavily promoted for whitefly tankmixes, that has seen reduced usage with the registration of IGRs.

Tables 1, 2 and 3 provide 1998 use statistics by pesticide type, with preliminary 1999 use statistics collected through September 1st. Preliminary 1999 numbers indicate that pest pressure was low. The increased use of Roundup Ready cotton is indicated in a 100% increase in glyphosate usage. Continued use of Bt. cotton explains the continued low usage of gossyplure, a pink bollworm pheromone that has been heavily used in Arizona.

An Application: Adoption of IGRs

A research project was developed to explore the potential power of the Arizona pesticide use data. The limitations of the Arizona use reporting system were taken into consideration. A study of the adoption of IGRs and the subsequent effect on pesticide applications takes full advantage of the strengths of the use database while sidestepping the acknowledged limitations.

The IGRs pyriproxyfen (Knack) and buprofezin (Applaud) were granted section 18 status beginning in the 1996 growing season for the purpose of combating whiteflies. Producers were limited to one application of each product and reporting was mandatory. Thus, it is reasonable to assume that IGR reporting in 1996 was complete within the limits of regulatory compliance.

In 1995, prior to the registration of IGRs, in problem areas producers treated as many as 12 times to minimize whitefly damage (Dennehy and Williams, III, 1997).The database should include the majority of the whitefly applications because whitefly pressure primarily occurs after the cotton canopy has closed over the rows, necessitating commercial aerial application of whitefly-targeted insecticides. Discussions with producers and extension agents indicate that specialized equipment needed to treat later season cotton from the ground is the exception and that in many areas, heavy irrigation schedules would make use of this equipment impossible.

It is important to identify applications specifically targeting whiteflies. This can be accomplished by focussing on certain tankmix combinations. As a result of grower experience with, and extension research on, the whitefly infestation in Arizona, by 1995 the efficacy of pyrethroid-organophosphate combinations was already widely recognized in 1995 (Dennehy et al. 1995). Explicit insect resistance management (IRM) guidelines were developed recommending that non-pyrethroids be employed against other pests to maintain efficacy of pyrethroids singly and pyrethroids synergized by an organophosphate or endosulfan (Ellsworth and Diehl, 1995).

This study utilizes acreage data on the IGRs, a variety of tankmix combinations that include combinations of active ingredients indicated in extension publications (Ellsworth et al, 1994, Ellsworth et al, 1996) and an overall tankmix aggregate. The most commonly used whitefly tankmix in 1995 is an acephate-fenpropathrin (Orthene-Danitol) combination The aggregate tankmix acreage was considered because so many different permutions of potential whitefly active ingredients were used in 1995. There were 488 different tankmix combinations including up to five active ingredients. 280 of these combinations were included in the aggregate tankmix variable as likely whitefly applications. Table 4 shows the most common whitefly tankmix combinations. In the tankmix variable, all combinations include at least one pyrethroid and a non-pyrethroid. We removed combinations including the pink bollworm pheromone gossyplure, whitefly-specific imidicloprid and all non-cross-family mixes (ie. two organophosphates, chlorpyrifos and acephate (lorsban and orthene) not a combination deemed effective against whiteflies).

For this analysis, the Arizona Cotton Research and Protection Council (ACRPC) provided data on cotton acres at the section level. As discussed earlier, an acreage measurement is necessary to normalize application-acres into a meaningful measure of application intensity. This measure of mean applications per section masks variation within a section but makes it possible to use the unusually disaggregate section level data. A section is 640 acres, while a third of Arizona cotton farms are 500 acres or more (USDA, 1999). These farms accounted for three-quarters of Arizona's cotton acreage in 1997. In this way, each section of the state where cotton is grown becomes an observational unit. It makes it possible to construct a large, geocoded database on pesticide use intensity with between 1634 and 2157 observations per year between 1995 and 1998. This study makes use of a section-level database to examine (a) factors explaining IGR adoption and (b) how adopters of IGRs altered their overall insecticide use to control whiteflies.

Preliminary findings indicate that IGR adoption can be explained to a large extent by location effects. Adoption was also more likely on sections where an index measuring whitefly susceptibility to synergized pyrethroids was low and where whitefly applications were larger the previous year. Adoption was inversely related to local population density. On sections where growers adopted IGRs, expenditures on synergized pyrethroid and other tank mix applications fell by \$62.52 per acre. On sections with no IGR adoption, tank mix expenditures fell less, by \$44.37 per acre. On adopting sections, net costs of controlling whiteflies fell by \$29.62 per acre, or by over \$11,000 per farm. (See **Adoption of Insect Growth Regulators in Arizona Cotton: Determinants and Economic Implications,** in the 2000 Beltwide proceedings)

Discussion

With the historically limited available information on pesticide usage the focus of research has always been on relatively simple characterizations of use patterns. With a use reporting system like the Arizona L1080 form the possibilities expand substantially. The forms include the date of application, whether the application was made by ground or air and starting this year, the target pest. All of this data coupled with the power of spatial analysis/GIS mapping and statistics offers endless opportunities for research directly useful to the cotton producer.

Work is under way by entomologists to utilize this data to better understand the ecology of pest populations. Pest Control advisors will soon use this information to improve IPM decision-making and resistance management. Plant pathologists have already taken advantage of GIS mapping of pesticide use patterns to better understand nematodes in cotton. This kind of research is still in its infancy and hold great promise for production agriculture right down to the field level with precision agriculture.

Another obvious application for this data is further support of the regulatory system so as to assist producers. When special, localized problems arise which call for a section 18 or SLN registration, the information necessary to determine the extent and severity of the problem will be available. Resistance issues can be substantiated with actual use data, along with insect counts and susceptibility measures. In another regulatory arena, pesticide use data is providing fact-based alternatives to exaggerated default assumptions being used in re-registration decisions and risk assessment as a result of the Food Quality Protection Act.

Summary

With the increased interest in pesticide use reporting systems there is an opportunity for researchers to gain valuable data for applied agricultural research. As an established use reporting system, the Arizona pesticide use data represents the opportunities and pitfalls of these systems. In its present form, the Arizona pesticide use reporting systems provides useful data for detailed summaries of Arizona pesticide use and limited statistical research. Results show a general decrease in the use of insecticides in Arizona cotton and a substantial economic impact of IGRs. With the addition of complete coverage, field tracking and secondary farm and producer data, the pesticide use data would be an even better dataset providing a wealth of data for wide range of research agendas.

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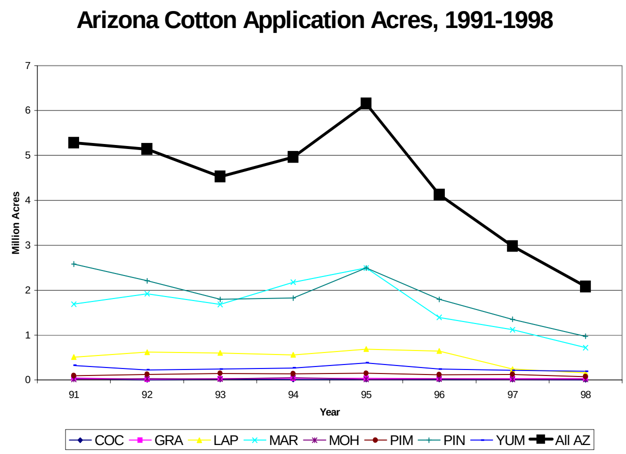

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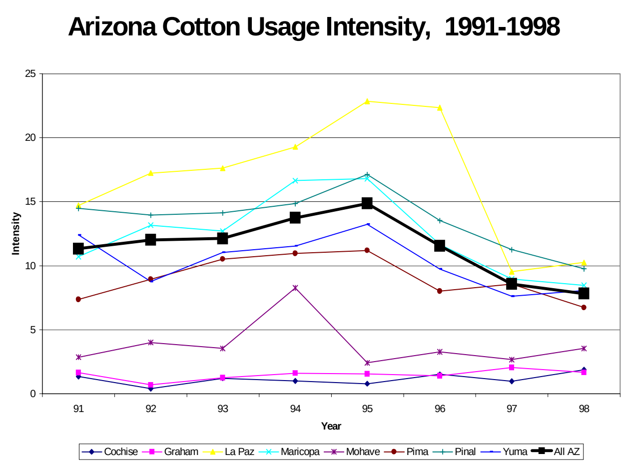

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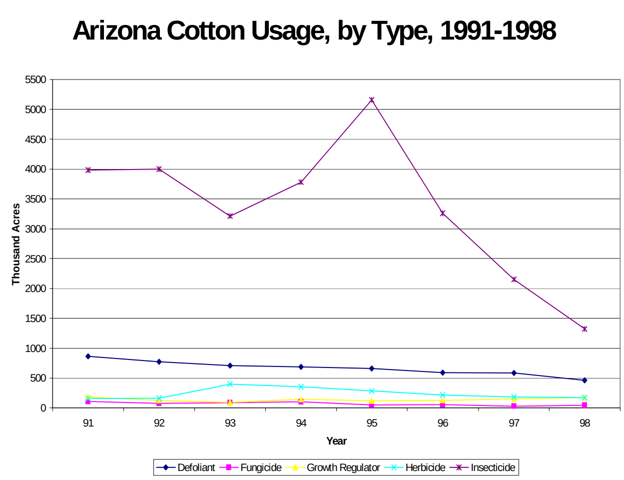

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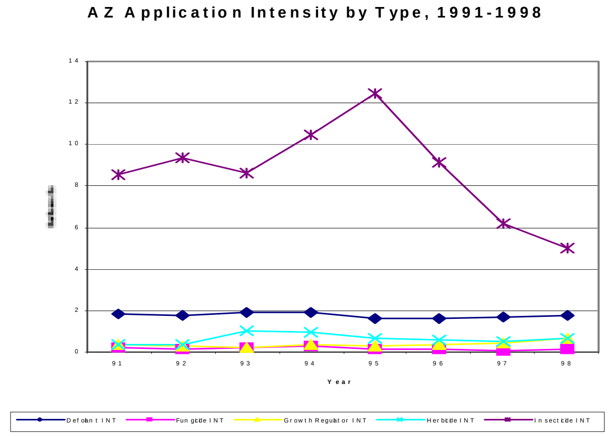

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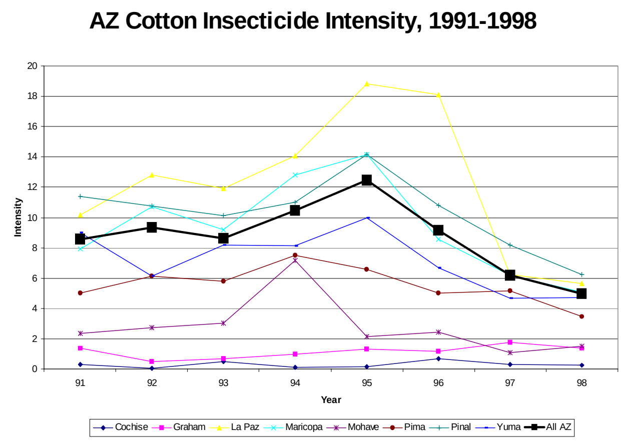

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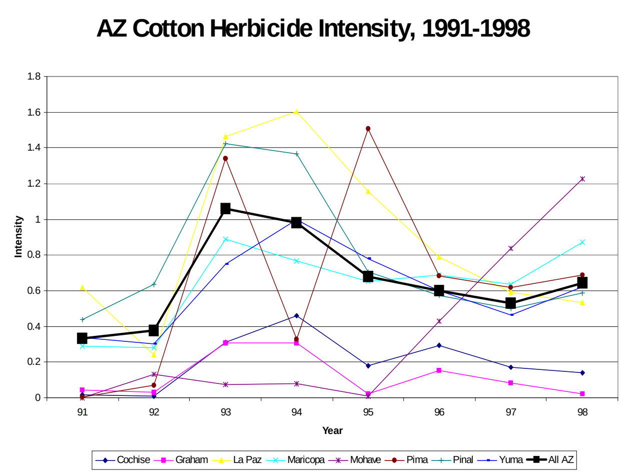

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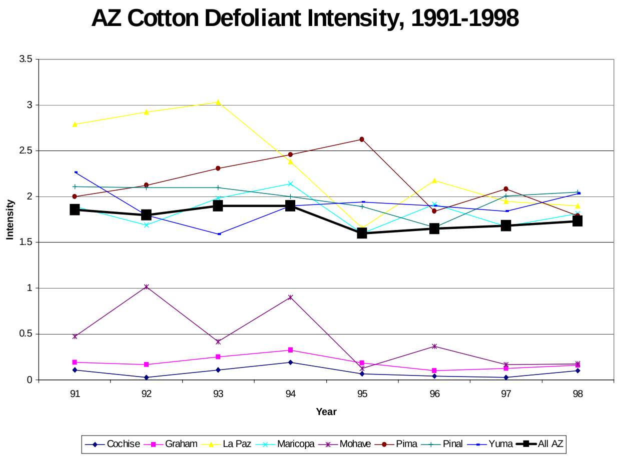

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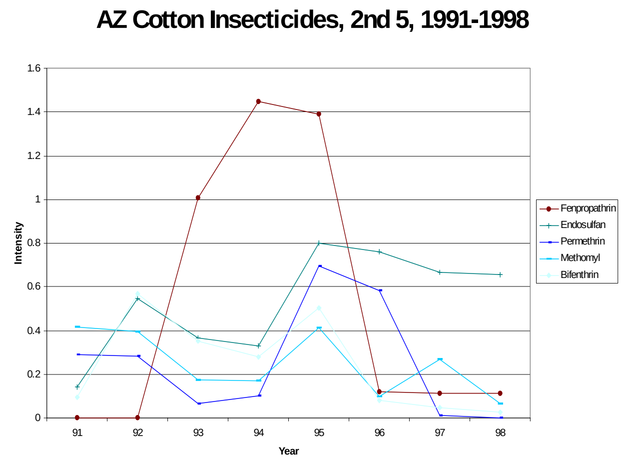

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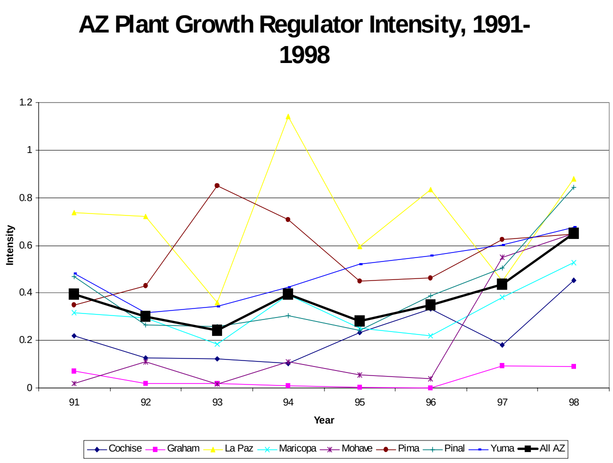

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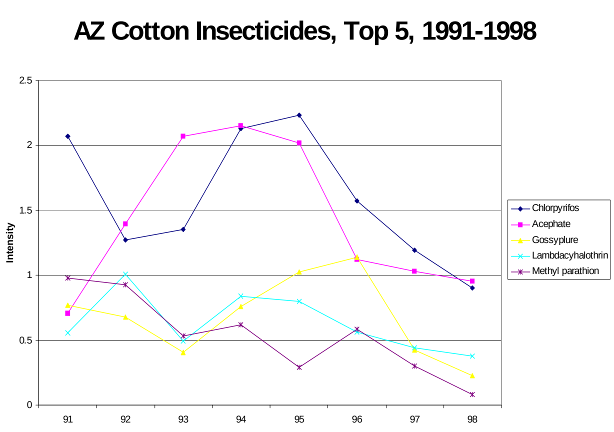

Figure 9.

Table 1. Arizona L1080 Insecticide Usage, 1998 and 1999.

Active Ingredient	1999 (Thru 9-1-1999) App. Acres	Mean Rate	% of Plt Acres	1998 App. Acres	Mean Rate	% of Plt Acres
Acephate	204611	0.80	81.5%	253544	0.79	95.4%
Aldicarb	3172	1.02	1.3%	22267	1.05	8.4%
Amitraz	2269	0.17	0.9%	6319	0.21	2.4%
Azinphos-methyl	877	0.57	0.3%	3420	0.43	1.3%
Bifenthrin	12051	0.05	4.8%	7142	0.06	2.7%
Bt	135	0.15	0.1%	35		0.0%
Buprofezin	10445	0.35	4.2%	33864	0.35	12.7%
Carbaryl	111	0.90	0.0%	275	0.60	0.1%
Chlorpyrifos	127708	0.71	50.8%	240522	0.70	90.5%
Cyfluthrin	13993	0.04	5.6%	13611	0.04	5.1%
Cypermethrin	19511	0.07	7.8%	18860	0.05	7.1%
Deltamethrin	1581	0.03	0.6%	7141	0.03	2.7%
Diazinon				321	0.22	0.1%
Dicofol	1856	0.61	0.7%	5614	1.08	2.1%
Dimethoate	21186	0.35	8.4%	52130	0.46	19.6%
Disulfoton				2152	0.68	0.8%
Endosulfan	151174	1.15	60.2%	174273	1.02	65.5%
Esfenvalerate	6292	0.04	2.5%	4422	0.04	1.7%
Fenoxycarb				150	0.50	0.1%
Fenpropathrin	13746	0.19	5.5%	29527	0.20	11.1%
Gossyplure	46360	0.01	18.5%	59312	0.02	22.3%
Imidacloprid				1888	0.11	0.7%
Lambda-cyhalothrin	84910	0.03	33.8%	100016	0.03	37.6%
Malathion	4125	1.14	1.6%	5097	1.32	1.9%
Methami-dophos	1620	0.79	0.6%	9213	0.81	3.5%
Methidathion	176	0.64	0.1%	2175	0.59	0.8%
Methomyl	26011	0.36	10.4%	16940	0.43	6.4%
Methyl parathion	11661	0.73	4.6%	21763	0.88	8.2%
Naled	73	0.21	0.0%	625	0.07	0.2%
Neem Oil				126	0.13	0.0%
Oxamyl	32891	0.77	13.1%	62914	0.79	23.7%
Oxydemeton-methyl	436	0.10	0.2%	4208	0.29	1.6%
Permethrin	302	0.11	0.1%	227	0.16	0.1%
Phorate	2825	1.48	1.1%	4903	1.12	1.8%
Piperonyl butoxide				991	0.12	0.4%
Profenofos	5113	0.85	2.0%	17261	0.93	6.5%
Propargite	201	1.10	0.1%	4519	1.41	1.7%
Pyriproxyfen	27302	0.05	10.9%	114180	0.05	42.9%
Sulprofos	84	0.14	0.0%			0.0%
Thiodicarb	2161	0.67	0.9%	623	0.38	0.2%
Tralomethrin	560	0.02	0.2%	45	0.15	0.0%
Zeta-cypermethrin	10156	0.04	4.0%	21478	0.04	8.1%

Table 2. Arizona L1080 Herbicide Usage, 1998 and 1999.

Active Ingredient	1999 (Thru 9-1-1999) App. Acres	Mean Rate	% of Plt Acres	1998 App. Acres	Mean Rate	% of Plt Acres
Bromoxynil	1977	0.43	0.8%	3904	0.32	1.5%
Clethodim	1332	0.17	0.5%	536	0.20	0.2%
Cyanazine	11918	0.89	4.7%	16364	1.00	6.2%
Diuron	8392	0.86	3.3%	9391	0.70	3.5%
Fluazifop-P-butyl	1952	0.29	0.8%	2572	0.30	1.0%
Fluometuron	118	0.65	0.0%	1166	0.52	0.4%
Glyphosate	19576	0.69	7.8%	10371	0.61	3.9%
MSMA	1753	1.46	0.7%	2872	1.35	1.1%
Norflurazon				949	0.38	0.4%
Oxyfluorfen	909	0.40	0.4%	1378	0.47	0.5%
Pendimethalin	50851	0.90	20.2%	41341	0.92	15.5%
Prometryn	31277	0.90	12.5%	39114	0.93	14.7%
Pyrithiobac-sodium	6212	0.04	2.5%	5928	0.07	2.2%
Sethoxydim	1132	0.33	0.5%	807	0.34	0.3%
Trifluralin	20542	0.63	8.2%	31753	0.63	11.9%

Table 3. Arizona L1080 Fungicide, Growth Regulator and Defoliant Usage, 1998 and 1999.

Active Ingredient	1999 (Thru 9-1-1999) App. Acres	Mean Rate	% of Plt Acres	1998 App. Acres	Mean Rate	% of Plt Acres
Fungicides						
Dichloro-propene	10579	41.20	4.2%	11148	48.13	4.2%
Mancozeb	2977	0.99	1.2%	4055	1.14	1.5%
PCNB	1426	1.49	0.6%	5571	0.69	2.1%
Sulfur	8584	3.64	3.4%	21816	3.99	8.2%
Growth Reg.						
Cytokinins	1349	0.00	0.5%	5499	0.00	2.1%
Ethephon	546	0.62	0.2%	27748	0.86	10.4%
Gibberellic acid	1873	0.00	0.7%	1486	0.00	0.6%
IBA	2747	0.00	1.1%	3215	0.00	1.2%
Mepiquat chloride	140675	0.03	56.0%	134778	0.04	50.7%
Defoliants						
Cacodylic acid				18610	0.64	7.0%
Diuron Def.				95857	0.04	36.1%
Endothall				26018	0.07	9.8%
Paraquat				46449	0.25	17.5%
Sodium chlorate				103418	4.20	38.9%
Thidiazuron				123974	0.08	46.6%
Tribufos				47187	1.05	17.7%

Table 4. Most Common Tankmix Combinations.

Tankmix Ais	Product names	Reports
Acephate-Fenpropathrin	Orthene-Danitol	1286
Acephate-Lambdacyhalothrin	Orthene-Karate	505
Chlorpyrifos-Fenpropathrin	Lorsban-Danitol	413
Acephate-Bifenthrin	Orthene-Capture	285
Bifenthrin-Endosulfan	Capture-Thiodan	228
Acephate-Zeta-cypermethrin	Orthene-Mustang	214
Fenpropathrin-Profenofos	Danitol-Curacron	184
Chlorpyrifos-Lambdacyhalothrin	Lorsban-Karate	182
Acephate-Chlorpyrifos-Lambdacyhalothrin	Orthene-Lorsban-Karate	159
Acephate-Chlorpyrifos-Fenpropathrin	Orthene-Lorsban-Danitol	126
Endosulfan-Zeta-cypermethrin	Thiodan-Mustang	112
Bifenthrin-Chlorpyrifos	Capture-Lorsban	107
Chlorpyrifos-Oxamyl	Lorsban-Vydate	101