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COTTON PESTICIDE USE DATA BASED ON ARIZONA'S ADA 1080 FORMS FOR 2002

Louis Carlo
Pesticide Information and Training Office
University of Arizona
Paul Baker
Department of Entomology
University of Arizona

Abstract

In Arizona, environmental and public health policies protecting Arizona's groundwater have generated statewide pesticide use reporting systems, thus offering opportunities for pesticide use research. The goal of this paper is to assist cotton growers and pest control applicators by providing meaningful pesticide use information. To do so out of the expanse of pesticide data that is generated, we have isolated the main pesticide products used in Arizona for the production of cotton, those being: Defoliants - Sodium Chlorate; Fungicides - Aflatoxin; and Insecticides - Acephate. In keeping with the purposes of this paper, we identify these pesticides and discuss their five-year trends with respect to regional pest control management.

Introduction

The University of Arizona College of Agriculture and Life Sciences offers an array of technology tools to assist cotton growers. Our goal is to provide growers reliable information on cotton pest management and pesticide use in Arizona. Cotton growers and regional experts can then collaborate, evaluate options, and develop strategies based upon balanced and reasonable information. Arizona cotton growers face many challenges. Among these challenges, are pest management issues amidst constantly changing pest population's pressures and pesticide registrations.

Environmental and public health concerns regarding the protection of Arizona's groundwater has lead to an improved statewide Arizona Department of Agriculture (ADA) 1080 pesticide use report form, and thus offers opportunities for pesticide research. Since 1996, Arizona Agricultural Statistics Service (AASS), under cooperative agreement with ADA's Environmental Services Division (ESD), has provided raw pesticide use data to the University of Arizona's Pesticide Information and Training Office. This office is in support of research aimed at understanding agricultural pesticide use to assist Arizona regulators, growers, researchers and interested stakeholders.

Arizona's ADA 1080 pesticide use reporting form continues to be revised. Since initiation, subsequent modifications have incorporated data on aerial applications, licensing, and materials registered under Section 18's. Later, reporting requirements were expanded to include more pesticide applications. In 1993, pesticides on the Arizona Department of Environmental Quality (ADEQ) Groundwater Protection List (GPL) were incorporated into the reporting process. At present, pesticides subject to ADA monitoring include all commercial agricultural applications and soil applied pesticides that are on the ADEQ Groundwater Protection List.

The report compiled by Ken Agnew titled *Crop Profile For Cotton in Arizona* contains detailed information on cotton production methods and pests common to Arizona (Agnew, 1999). In 2001, a total of 33,377 target pest reports were generated for all the ADA 1080's form all the crops in Arizona. Target pest reports on cotton were separated into Insect/Non-insect groupings, and categorized by pest species. Of target pests on cotton, approximately 60% were reported as Insect pests, while the other 40% were reported as Non-Insect pests. *Lygus* was the most frequently reported target pest on all Arizona crops in 2001. On reports submitted for cotton, results showed 3,124 listings for the pest *Lygus* out of 15,774 (19.8%) from the total pesticide application reports. This was followed by the sweet potato whitefly with 2,711 (17.2%), and pink bollworm with 1,218 (7.7%). The remaining 26% of cotton pest frequencies were distributed across categories of aphid, (3.5%), budworm/bollworm (3.5%), silverleaf whitefly (3.4%), armyworm (2.6%), thrip (0.9%), and cotton leaf perforator (0.9%) (Shanley and Baker, 2002).

The availability of ADA 1080 data on agricultural pesticides affords numerous enhancements to research endeavors, linking growers, regulators, and stakeholders toward common pest management solutions. The quality and utility of this data continue to improve and increase in value. The long-term goal is to help growers by providing meaningful pesticide use information in "real time". This means that the information would be available via a website that would be only weeks old. This information will hopefully allows regulators, researchers, stakeholders and other interested parties to take part in a variety of pesticide related issues. It is in our societies' cumulative interest to strengthen local pest management initiatives and also to provide a regional, long-term perspective.

Materials and Methods

At The University of Arizona Pesticide Information and Training Office, ongoing efforts to improve and enhance the database have culminated in a comprehensive information system, representing agricultural pesticides on crops grown in Arizona. This work is done in collaboration with Arizona Agricultural Statistics Service (USDA-NASS). Pesticides subject to ADA monitoring include custom applications, soil applied pesticides on the ADEQ Groundwater Protection List (GPL), and Section 18 use (A.R.S. §§ 3-341 et seq. and 3-3101 et. seq.). The data fields that are collected include active ingredient (AI), EPA registration number, quantity, crop, acres treated, harvest date, re-entry intervals, wind velocity, aerial and ground applications, equipment codes, and license/permit ID numbers for regulated sellers, applicators, and growers.

In 1996, collaborative agreements were formed with USDA-NASS in Arizona. Arizona Agricultural Statistics Service (USDA-NASS) re-configured the database structure as a relational database in Standard Query Language (SQL) to execute in Microsoft FoxPro™. From the expanse of Arizona's pesticide use data, the information for cotton was retrieved and isolated for further quantitative analysis focusing on the quantity and type of pesticides that were used. We then developed relational queries leading to the cotton sub-set of ADA 1080 data that are presented in this paper.

This data is initially entered as a direct transcript of the applicators handwriting. Therefore as one can imagine, due to this transcription process there are minor inconsistencies with the names of the products and the way they are input into the database. Therefore, considerable time is spent validating each data entry. When applicable, certain brand name corrections and active ingredient determinations have been corrected for by using the information found on product labels. Though, this validated ADA 1080 data is considered a relatively good indicator of commercial applications, it should be noted that the ADA 1080 data does not comprise the total amounts applied for all pesticide in a given year. In fact, not all applications are required to be reported to the ADA, this is because growers are not required to submit use reports of private pesticide applications, nor foliar applications of the pesticides that are on the groundwater protection list. Federal law requires that records be kept of these uses yet ADA request them only on site visits or for other regulatory reasons.

Results and Discussion

It is not our intention to endorse individual products or to warranty the effectiveness of the products presented in the ADA 1080 pesticide use data. The results of the pesticides used on cotton grown in Arizona during 2002 are presented in Figures 1-5. The unit of measure reported here is dictated by the pesticide formulations themselves, for example, "solid" formation materials such as dusts, powders, and granules are measured by weight in pounds and pesticides purchased as either quarts or gallons are reported as "liquids". In 2002 a total of 533,441 of pesticides were applied to cotton (Table 1). From that total, 297,446 pounds and 235,995 gallons of pesticides were applied.

From this overall amount we have separated out the main types of products and active ingredients that were used. To do so, a data query was run for the top 40 pesticides used in Arizona cotton production during 2002. The results of this query are presented and discussed in the following section. These pesticides cumulatively represent 90.9% of the overall data reported for cotton on the ADA 1080 reporting form for the year 2002. In Appendix 1 we have provided a detailed list of the individual products that comprise the summary figures found in Table 2. A summary of the types of pesticides is presented in Table 2.

The majority of pesticide products used for cotton production in 2002 can be found in the defoliants, insecticides, and fungicides. These types of pest management products comprise the majority of pesticide inputs into the cotton farming system in Arizona. A closer look at the actual defoliants, fungicides, and insecticides are provided in Tables 3, 4, and 5, respectively.

Results demonstrate that the over 98% of defoliants used were liquid formulations. The most widely used defoliant was sodium chlorate, at 78,906 gallons or 81.7% of the defoliant applied for cotton production during 2002, based on ADA 1080 data.

The fungicides used on cotton in 2002 as reported on the ADA 1080 forms were all solid formulations (Table 4). The most widely used fungicide active ingredient was Aspergillums Flavus AF36 (aflatoxin), at 118,536 pounds or 98% of the fungicide applied for cotton production during 2002, based on ADA 1080.

Table 5 shows that of the 21 insecticide products, 13 were solid formulations and 8 were liquid formulations. In the year 2002, the most widely used active ingredient was acephate, at 150,311 pounds or 88.6% of the total insecticide applied for cotton production during 2002, based on ADA 1080 data.

By combining the data in Tables 3, 4, and 5, it can be determined that during 2002 the main types of pesticides and active ingredients used for cotton production in Arizona were: Sodium Chlorate (defoliant - liquid gal.); Aflatoxin (fungicide - solid lb.); and Acephate (insecticide - solid lb.). In keeping with the purposes of this paper we will discuss these major pesticides. However, in Appendix 2 we have provided a detailed listing of products for readers who are interested in some of the lesser-

applied products based on the dataset. Figure 1, outlines the 5-year trend of the use of sodium chlorate, aflatoxin, and acephate from 1998 to 2002.

For the defoliant Sodium Chlorate (liquid gal.), the five-year trend shows a sharp decline (Fig.1). University of Arizona studies indicate that the success of the product Ginstar with the active ingredient thidiazuron may account for some of the drop off seen in sodium chlorate products (Dittmar et.al.1999; Clark and Carpenter, 2002). This alone however does not completely explain the downward trend, because in addition to the success of Ginstar has been the progressive inclusion of defoliant additives such as Accelerate with the active ingredient endothall and CottonQuick with the mixed active ingredients of sulfate and phosphonic acid. Therefore, it seems as though there has been a regional cut back in sodium chlorate products as they are either replaced by other products or mixed with additives. Since sodium chloride use increased in 2002 it looks as though the rebound may be associated with costs or efficacy.

The fungicide Aspergillus flavus AF36 with Aflatoxin (solid lb.) shows a sharp increase from 1998 through 2001, with a decline in 2002. This upward trend is indicative of general wide spread use of this product. There are diverse naturally occurring strains of *Aspergillus flavus* that can be measured at the soils surface, the magnitude of these fungi have been found to vary from one location to another. Although once established, some communities such those around Yuma have persisted (Orum et.al. 1998). Any physical damage or lesions on a cotton plant can render that plant susceptible to this fungus, causing reduced yields and discoloration:

> "Infection results in damage to cotton lint by staining and weakening the fibers, and when the fungus penetrates the seed, viability is lost since seed germination is inhibited." (Knowles, et.al.1998).

The fungicide Aspergillus flavus AF36 combats this process in the following manner:

> "… Aspergillus flavus AF36, is proposed for application to cotton to reduce the incidence of aflatoxin producing strains of *Aspergillus flavus* and thereby reduce aflatoxin contamination of cottonseed. When applied just prior to flowering, Aspergillus flavus AF36 which does not produce aflatoxin, competitively excludes aflatoxin producing *Aspergillus flavus* strains without increasing *Aspergillus flavus* in the environment in the long term." (EPA, 2003)

Future ADA 1080 pesticide use data needs to be analyzed to help determine the significance of the 2002 curtailing use of Aspergillus flavus AF36. One again this data may be showing the balancing out of product use with pest damage thresholds. Also, careful attention to the length of the summer growing season and over irrigation as proposed by cooperative extension research (Knowles et.al. 1998) may also be contributing to the 2002 decrease in its use.

The ADA 1080 pesticide use data five-year trend for acephate shows that indeed, the use of acephate has remained high. Though acephate use dropped in 2000 and 2002, the general trend appears to be cyclical in nature, dropping and raising, yet still remaining high relative to the other products used. This could be due to applicators responding to pests as crop damage thresholds are reached. The persistence of the Lygus insect has necessitated the greatest insecticide input into Cotton farming in Arizona. University of Arizona Department of Entomology researchers recommend the use of acephate products which have been described as having positive results that were "surprisingly uniform across years and across sites." (Ellsworth and Diehl, 1998). Pesticide mixes have not been found to be particularly more effective (Ellsworth et.al. 1998). Hence, it is expected that we see acephate products widely used for cotton production in Arizona.

A Pesticide Life Cycle

As we continue to evaluate products over more than 5 years, a pattern starts to emerge. It is not an unexpected pattern but a pattern of a life expectance of a pesticide. Inherent in the regional five-year pesticide use data, the life of a pesticide product can be outlined. It appears once a product is adopted by growers, or even recommended by experts, its use increases. Most of the time the growth in its use is substantial and the product seems to flood the market. When a product hits its peak, sometimes it may be used for a couple of years or sometimes just a year, and then there is a corresponding reduction in the use of the product. This product reduction is most likely caused by efficacy, competition or safety issues because the pest problems are not eliminated. The ADA 1080 database gives us a unique opportunity to look over the life cycle of pesticides and thus in the future be able to investigate theses trends.

In the future, we will continue to illuminate long-term trends and regional pesticide use patterns derived from the ADA 1080 data. It is imperative that this data continue to be collected and analyzed. This ADA 1080 data has an eminent role in determining statewide pest management decision-making. In order to prepare a system of regional Integrated Pest Management that can respond to pest problems as they arise and change, pesticide use data becomes a critical component for success. On a societal scale our level of communication has increased to the point that now we see whole regions responding to pest problems with a greater awareness. Cooperative extension research and education is the foundation on which farmers, applicators, legislators, and business meet and communicate their pest management ideas. Thus, funding and strengthening scientific

based cooperative extension research provides methods of community interaction, which becomes the corner stone of sustainable pest management over large regions and over the long term of agricultural production.

Summary

From a large pool of over 100,000 pesticide use records covering more than 20 crops and 5 years, we identified and isolated the pesticide use data for cotton grown in Arizona during the year of 2002. In this report, the University of Arizona Pesticide Information and Training Office presented yearly quantities of solid and liquid formulated pesticides that were reported to be applied by commercial pesticide applicators in Arizona. The goal of this report is to assist cotton growers and pest control applicators by providing meaningful pesticide use information.

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Table 1. Total quantities of cotton pesticides applied to Arizona cotton as reported in 1080L data for 2002.

2002 Arizona 1080-Form Pesticide Use Data for Cotton, Solid Formulations:	
Total Pounds	297,446
2002 Arizona 1080-Form Pesticide Use Data for Cotton, Liquid Formulations:	
Total Gallons	235,995

Source: NASS 2003 1080 Form Database.

Table 2. The main types of pesticides used on cotton production in Arizona, 2002.

Type	Gallons	Pounds
Defoliant	96,585	1,503
Fungicide	120,666	0
Herbicide	14,324	599
IGR	3,309	5,891
Insecticide	51,016	163,729
Miticide	1,890	0
Plant Regulator	5,045	0
Soil Fumigant	24,425	0

Table 3. Defoliants use on cotton production in Arizona, 2002.

Brand Name	Active Ingredient	Liquid Gallons	Solid Pounds
FreeFall	Thidiazuron		1,503
Ginstar EC		4,976	
2 lb. Chlorate Defoliant - Dessicant	Sodium Chlorate	64,449	
Leafex 3		14,457	
Def 6	Tribufos	3,297	
Accelerate	Endothall	2,893	
CottonQuick	Sulfate & Phosphonic Acid	6,513	
	TOTALS	96,585	1,503

Table 4. Fungicides reported used on cotton in Arizona, 2002.

Brand Name	Active Ingredient	Liquid Gallons	Solid Pounds
Aspergillus Flavus AF36	Aflatoxin		118,536
Penncozeb 75DF	Mancozeb		2,130
	TOTAL		120,666

Table 5. Insecticides used on cotton in Arizona, 2002.

Brand Name	Active Ingredient	Liquid Gallons	Solid Pounds
Orthene 90 S	Acephate		115,967
Orthene 75 WSP			33,491
Orthene TT&O			451
Address 75S			402
Thimet 20G	Phorate		4,505
Temik 15G	Aldicarb		2,885
Intruder	Acetamiprid		2,185
Centric 40WG	Thiamethoxam		2,053
DipelPro DF	Bacillus Thuringiensis		875
Lannate 90WSP	Methomyl		464
Sevin 5	Carbaryl		450
Applaud R 70WP	Buprofezin		5,891
Knack	Pyriproxyfen	3,309	
Lorsban 4E-HF	Chlorpyrifos	21,563	
Lock-On		2,762	
Thionex 3EC	Endosulfan	9,985	
Phaser 3EC		5,515	
Drexel 3EC		4,784	
Thiodan 3EC		2,698	
Vydate C-LV	Oxamyl	3,710	
	TOTALS	54,325	169,620

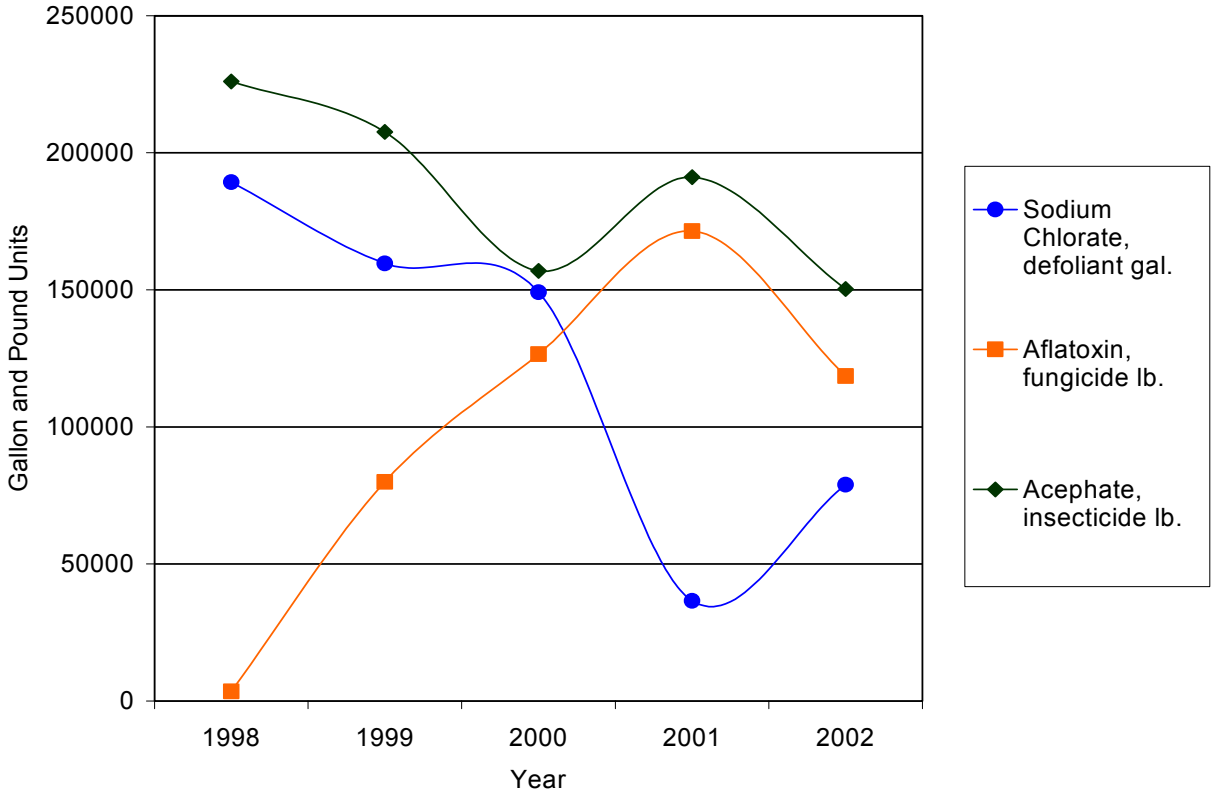

Figure 1. Five year trends of the pesticides sodium chlorate, aflatoxin, and acephate used in Arizona's cotton production as reported on the ADA 1080 form.

APPENDIX 1

Validated ADA 1080 Data of the Main Types Pesticides Used for Cotton Production in Arizona, 2002.

Type	Brand Name	Active Ingredient	Liquid Gallons	Solid Pounds
Defoliant	FreeFall	Thidiazuron		1,503
Defoliant	2 lb. Chlorate Defoliant-Dessicant	Sodium Chlorate	64,449	
Defoliant	Leafex 3	Sodium Chlorate	14,457	
Defoliant	Ginstar EC	Thidiazuron	4,976	
Defoliant	Def 6	Tribufos	3,297	
Defoliant (additive)	CottonQuick	Sulphate	6,513	
Defoliant (additive)	Accelerate	Endothall	2,893	
Fungicide	Aspergillus Flavus AF36	Aflatoxin		118,536
Fungicide	Penncozeb 75DF	Mancozeb		2,130
Herbicide	Trilin 10G	Trifluralin		599
Herbicide	Prowl 3.3 EC	Pendimethalin	6,986	
Herbicide	Roundup Ultra Max	Glyphosate	4,348	
Herbicide	Cotton-Pro 4E	Prometryn	2,990	
IGR	Applaud R 70WP	Buprofezin		5,891
IGR	Knack	Pyriproxyfen	3,309	
Insecticide	Orthene 90 S	Acephate		95,291
Insecticide	Thimet 20G	Phorate		4,505
Insecticide	Temik 15G	Aldicarb		2,885
Insecticide	Intruder	Acetamiprid		2,185
Insecticide	Centric 40WG	Thiamethoxam		2,053
Insecticide	Dipel Pro DF	Bacillus thuringiensis		875
Insecticide	Lannate 90WSP	Methomyl		464
Insecticide	Sevin 5	Carbaryl		450
Insecticide	Orthene 75 WSP	Acephate		33,491
Insecticide	Acephate 90 SP	Acephate		20,676
Insecticide	Orthene TT&O	Acephate		451
Insecticide	Address 75S	Acephate		402
Insecticide	Lorsban 4E-HF	Chlorpyrifos	21,563	
Insecticide	Lock-On	Chlorpyrifos	2,762	
Insecticide	Thionex 3EC	Endosulfan	9,985	
Insecticide	Phaser 3EC	Endosulfan	5,515	
Insecticide	Drexel 3EC	Endosulfan	4,784	
Insecticide	Thiodan 3EC	Endosulfan	2,698	
Insecticide	Vydate C-LV	Oxamyl	3,710	
Miticide	Microthiol Disperss	Sulfur		1,890
Plant Regulator	Pix Plus	Mepiquat Chloride	5,045	
Soil Fumigant	Telone II	Dichloropropene	24,425	

Source: NASS, ADA 1080 pesticide use form. This table reflects the validated results of top 40 queries that represent 90.9% of the overall cotton data for 2002.

APPENDIX 2

Validated ADA 1080 Data of the Active Ingredients Used for Cotton Production in Arizona, 2002.

Active Ingredient	Brand Name	Type	Pound
Acephate	Orthene 90 S	Insecticide	95,291
Acephate	Orthene 75 WSP	Insecticide	33,491
Acephate	Acephate 90 SP	Insecticide	20,676
Acephate	Orthene TT&O	Insecticide	451
Acephate	Address 75S	Insecticide	402
Acetamiprid	Intruder	Insecticide	2,185
Aflatoxin	Aspergillus Flavus AF36	Fungicide	118,536
Aldicarb	Temik 15G	Insecticide	2,885
Bacillus thuringiensis	Dipel Pro DF	Insecticide	875
Buprofezin	Applaud R 70WP	IGR	5,891
Carbaryl	Sevin 5	Insecticide	450
Chlorpyrifos	Lorsban 4E-HF	Insecticide	21,563
Chlorpyrifos	Lock-On	Insecticide	2,762
Dichloropropene	Telone II	Soil Fumigant	24,425
Endosulfan	Thionex 3EC	Insecticide	9,985
Endosulfan	Phaser 3EC INSECTICIDE	Insecticide	5,515
Endosulfan	DREXEL 3EC	Insecticide	4,784
Endosulfan	Thiodan 3EC	Insecticide	2,698
Endothall	Accelerate	Defoliant (additive)	2,893
Glyphosate	Roundup Ultra Max	Herbicide	4,348
Kinetin	Geen Sol 70	Fertilizer	1,077
Mancozeb	Penncozeb 75DF	Fungicide	2,130
Mepiquat chloride	Pix Plus	Plant Regulator	5,045
Methomyl	Lannate 90WSP	Insecticide	464
Oxamyl	Vydate C-LV	Insecticide	3,710
Pendimethalin	Prowl 3.3 EC	Herbicide	6,986
Phorate	Thimet 20G	Insecticide	4,505
Prometryn	Cotton-Pro 4E	Herbicide	2,990
Pyriproxyfen	Knack	IGR	3,309
Sodium Chlorate	2 lb. Chlorate Defoliant - Dessicant	Defoliant	35,640
Sodium Chlorate	Leafex 3	Defoliant	14,457
Sodium Chlorate	2 lb. Chlorate Defoliant - Dessicant 5905-87	Defoliant	28,809
Sulfur	Microthiol Disperss	Miticide	1,890
Sulfate & Phosphonic Acid	CottonQuick	Defoliant	6,513
Thiamethoxam	Centric 40WG	Insecticide	2,053
Thidiazuron	FreeFall	Defoliant	1,503
Thidiazuron	Ginstar EC	Defoliant	4,976
Tribufos	Def 6	Defoliant	3,297
Trifluralin	Trilin 10G	Herbicide	599

Source: NASS, ADA 1080 pesticide use form. This table reflects the validated results of top 40 queries that represent 90.9% of the overall cotton data for 2002.