UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

December 15, 2021

MEMORANDUM

SUBJECT: Status of Over-the-Top Dicamba: Summary of 2021 Usage, Incidents and Consequences of Off-Target Movement, and Impacts of Stakeholder-Suggested Mitigations (DP # 464173: PC Code 128931)

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Product Review Panel Date: November 23, 2021

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1. SUMMARY

This document summarizes incident reports and other information provided to the Agency related to off-target movement of dicamba during the 2021 growing season. This document does not contain any regulatory or policy decisions related to dicamba.

For cotton and soybean growers facing multiple-herbicide-resistant broadleaf weed populations, like Palmer amaranth and waterhemp, only three herbicides belonging to two modes of action classes are available to provide weed control after crops emerge from the ground (post-emergence). Over-the-top dicamba (OTT dicamba) is one of only two synthetic auxins available for over-the-top (OTT) use with herbicide tolerant crops. Since the original registration in 2016, cotton and soybean growers have rapidly adopted dicamba-tolerant (DT) seed and OTT dicamba products for the post-emergence control of problematic multiple-herbicide resistant weeds. Simultaneously, there have been reports of off-field movement of dicamba, leading to damage in various crops and residential and natural landscapes.

Nationally, about three-quarters of the cotton acreage and about two-thirds of the soybean acreage are planted with DT seed. Based on market research data and aggregated sales data, about half of DT cotton and DT soybean were treated one or more times with an OTT dicamba product in 2020 (2021 data are not yet available). The significant adoption of dicamba tolerant technology is demonstrative of the need to control herbicide resistant weeds that can reduce yields and hamper production in these crops. The acres of DT cotton and soybean planted but not treated with OTT dicamba products may indicate that growers selected the seed variety not for

the herbicide trait, but instead based on genetics/yield potential, or as a defense against off-target movement of OTT dicamba used on neighboring fields.

Based on pesticide usage survey data from 2020, misuse of dicamba products not registered for OTT use may have occurred on a small percent of DT soybean and cotton acres. Non-OTT dicamba usage on cotton and soybean have increased significantly since the registration of the OTT dicamba products. This may be due to misuse or to increased use of dicamba preemergence application.

Weed scientists have confirmed dicamba resistance in Palmer amaranth and waterhemp, and that resistance is spreading. As resistance to dicamba increases, benefits of the DT crop systems will decrease.

In 2021, EPA continued to receive reports of off-target movement of dicamba. EPA received nearly 3,500 reports alleging effects from off-target movement of dicamba onto various non-target vegetation, including cotton and soybean varieties that are not dicamba-tolerant, ornamental plants, other crops (sugarbeet, rice, sweet potato, peanut, grapes, cucurbits, vegetables, fruit trees, caneberries) and natural areas. Incidents in food crops reportedly occurred in Arkansas, Illinois, Kansas, Missouri, North Dakota, Nebraska, Ohio, South Dakota, Tennessee, and Texas. Incidents were also reported for non-crop areas in Arkansas such as state parks and wildlife refuges.

Generally, pesticide incidents are underreported. Based on conclusions from previous BEAD assessments and current feedback from stakeholders and 6(a)(2) reports in 2021, EPA expects that OTT dicamba related incidents continue to be under-observed and underreported. The number of reported incidents vary depending on the state. EPA received few incident reports from states such as Georgia, Louisiana, and Mississippi, where OTT dicamba is widely used. In other states, such as Arkansas, Illinois, and Minnesota, reported incidents are numerous and widespread. Reported effects vary in severity and include landscape level damage and reductions in crop quality and yield. Additionally, the reports indicate some growers' crops (or non-croplands) have experienced multiple years of exposure to dicamba and subsequent damage.

There have also been more than 290 incidents reported in counties where additional restrictions were implemented to prevent off-field exposures to endangered species and critical habitat. The Agency is not aware of any "take" where an endangered species or critical habitat has been harmed. However, these incidents suggest the possibility that a "take" could occur.

The impact of incidents associated with the use of OTT dicamba extend beyond damage to sensitive vegetation. Damage resulting from off-target movement of dicamba has caused social conflicts in agricultural communities since DT seed was first commercialized, including strained relationships with neighbors, vandalism, and violent altercations, as well as a fatal shooting. In 2021, EPA has continued to receive reports of social conflicts caused by dicamba.

The exact circumstances of various off-target incidents are not always known and often difficult to determine. Off-target movement of dicamba may occur when there is unintentional noncompliance with label parameters due to product usability, intentional noncompliance with label parameters (e.g., applying after a cutoff date), unlawful use of non-OTT dicamba that is not

registered for OTT use on dicamba-tolerant crops, legal applications of non-OTT dicamba on other crops such as corn, and/or volatility. According to some stakeholders, off-target movement can occur even when there is complete compliance with label parameters of OTT dicamba products. Officials from numerous states posit that secondary movement, or volatility, is the cause of the majority of off-target incidents. In addition, while some small number of reported dicamba-like incidents may be the result of environmental stress or exposure to other pesticides, the Agency considers the preponderance of incidents to be the result of dicamba exposure.

Stakeholder-suggested mitigations to decrease dicamba misuse and incidents may reduce off-target movement, but EPA has not, at this time, conducted a full assessment of further potential mitigations. Furthermore, the stakeholder suggested mitigations may severely restrict a user's ability to use dicamba for OTT weed control, effectively resulting in cancellation. Other suggested mitigations are not feasible to be implemented in the near term.

Stakeholders also suggested cancellation scenarios of some or all OTT dicamba products. If the use of OTT dicamba was no longer permitted the Agency expects that growers currently using an OTT dicamba system in cotton and soybean would switch to using the OTT 2,4-D system. Like dicamba, 2,4-D is a synthetic auxin and certain products are registered for use with herbicide-tolerant cotton and soybean. It is similarly effective against problematic weeds with a similar potential for resistance to develop. However, dicamba users and seed companies may not be able to quickly adjust to the loss of dicamba, given available supplies of alternative herbicides and tolerant seed, especially since growers make seed choices months in advance of the growing season.

If the Agency restricted use of OTT dicamba in soybean production but not cotton, states that have substantial acreage of both soybean and cotton may experience increased incidents as growers would be forced to plant highly sensitive non-DT soybean in close proximity to DT cotton. A state-level or geographic cancellation, instead of a crop-specific cancellation, would allow growers who plant both soybean and cotton to grow both crops with the same herbicide-tolerance traits, reducing incidents in soybean and cotton and limiting potential impacts for growers.

2. INTRODUCTION

This document has been prepared to provide transparency about incident reports and other information provided to the Agency pertaining to off-target movement of dicamba in the 2021 growing season and to inform growers, state legislatures, and state pesticide regulators as they make decisions about the 2022 growing season. This document reviews information received by the Agency on dicamba since the 2020 registration of four Over-the-Top (OTT) dicamba products. Changes in cotton and soybean acreage, adoption of the DT trait, and dicamba usage are described. Incidents reported to the Agency are summarized and impacts to non-DT cotton and soybean growers, and others, are described. Mitigation measures proposed in letters to the Agency are summarized and the impacts of these measures are qualitatively assessed.

In 2020, the 9th Circuit court vacated the 2018 registrations of three OTT dicamba products[1] (9th Cir. 2020), and shortly after, the EPA issued a cancellation order. After review of new information, on October 27, 2020, EPA approved new five-year registrations/extended registrations for OTT dicamba products[2]. The 2020 OTT registrations include more restrictive use requirements than the vacated 2018 registrations[3] (USEPA, 2020a). Additional requirements were also placed on use in counties with endangered species that might be at risk from exposure to dicamba. The growing season of 2021 is the first year OTT dicamba products were used with the new more restrictive measures. Additional background on the regulatory history of OTT dicamba is available at: https://www.epa.gov/ingredients-used-pesticide-products/registration-dicamba-use-dicamba-tolerant-crops.

Despite these 2020 changes to the label, in early July 2021 the Agency began receiving reports via email, calls, and popular press articles describing dicamba damage to plants off the treated field. As a result, on September 9, 2021, the Agency issued letters to the registrants reminding them of their obligations to report adverse effects data under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 6(a)(2), and to identify specific information EPA expected to receive (USEPA, 2021a). The Office of Pesticide Programs staff also had several meetings with various stakeholders including the following, during which the 2021 field season was discussed:

- Association of American Pesticide Control Officials (AAPCO), September 2, 2021
- BASF, September 30, 2021
- Bayer, September 22, 2021.
- North and South Dakota (Dakotas), August 4, 2021
- EPA Region 7, September 9, 2021
- Arkansas State Plant Board (and EPA personnel from Region 6), July 30, 2021
- Illinois Department of Agriculture (and EPA personnel from Region 5), August 19, 2021
- Weed science researchers and extension specialists, scheduled through Weed Science Society of America (WSSA), August 30, 2021. This meeting is referenced throughout as Academics (2021) or meeting with Academics (2021).

To provide context for the situation in which the 2021 incidents occurred, EPA first provides summaries of the most recent assessments of the benefits of dicamba and assessment of off-

[1] M1768 Herbicide (Alternate Brand Name: XtendiMax With VaporGrip Technology; EPA Reg. 524-617), Engenia Herbicide (EPA Reg. 7969-345, and DuPont FeXapan Herbicide (EPA Reg. 352-91]). Note that in April of 2019, EPA registered another OTT product, a premixed product of dicamba plus s-metolachlor, A21472 Plus VaporGrip Technology (Alternate Brand Name: Tavium Plus VaporGrip Technology; EPA Reg. 100-1623). The registration of Tavium was not vacated/cancelled.

[2] The Agency approved registrations for XtendiMax with VaporGrip Technology (EPA Reg. 264-1210) and Engenia Herbicide (EPA Reg. 7969-472) and extended the registration of Tavium (EPA Reg. 100-1623). Note: The Agency registered FeXapan Plus VaporGrip Technology (EPA Reg. 352-938) on Feb 24, 2021; however, Corteva did not commercially market this registration (Corteva, 2021b).

[3] Restrictions for these OTT dicamba products include: requiring volatility-reducing agents, larger buffer distances, and application cutoff dates to address off-target movement. For applications to dicamba-tolerant soybean, the cutoff date is June 30th and for applications to dicamba-tolerant cotton the cutoff date is July 30th. Additionally, all non-DT crop uses were removed from the label.

target dicamba incidents, both conducted in 2020. EPA then summarizes relevant information about the 2021 growing season, including cotton and soybean production information, dicamba usage and dicamba sales, and new information about dicamba resistance.

In order to understand the frequency and distribution of off-target movement of dicamba in 2021, EPA summarizes incident reports and other reports of off-target movement received by the Agency by November 17, 2021. EPA also summarizes information shared about whether reported incidents may underestimate the actual number of incidents. EPA describes the consequences of off-target movement to growers, researchers, landowners, and agricultural communities, as well as to state agencies.

Off-target movement of dicamba can occur due to accidental or intentional failure to follow the use directions. Because the regulatory response to alleged OTT dicamba-related incidents depends on the circumstances that influence off-target movement, EPA evaluates conditions identified in incident reports.

Along with the incident reports and other reports, the Agency also received comments and feedback on different regulatory options the Agency could consider, including options to improve the label. In this memo, EPA provides some initial considerations of the impacts from these "stakeholder suggestions". Stakeholder suggestions include cancellation of dicamba, regional and crop restrictions on dicamba, and label changes.

The following abbreviations are used throughout this document.

AAPCO	Association of American Pesticide Control Officials
BEAD	Biological and Economic Analysis Division
DT	Dicamba tolerant
ESA	Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
Non-OTT	Dicamba products that are not registered for dicamba tolerant crops
OPP	Office of Pesticide Programs
OTT	Over-the-Top application or Over-the-Top dicamba products
USDA	United States Department of Agriculture
WSSA	Weed Science Society of America

3. SUMMARY OF 2020 ASSESSMENT FOR OTT DICAMBA PRODUCT REGISTRATION

3.1 2020 Benefits Assessments

In 2020, BEAD reviewed the benefits of dicamba in cotton and in soybean (Orlowski and Kells, 2020a and 2020b). Between 2017 and 2018, dicamba products for use in dicamba tolerant (DT) crops were used on 43% of all U.S. cotton acres and on 21% of all U.S. soybean acres; the majority of usage was after crop emergence. Postemergence dicamba in cotton production was primarily used to target herbicide-resistant Palmer amaranth and redroot pigweed. In soybean,

postemergence dicamba was primarily used to target herbicide-resistant Palmer amaranth, waterhemp, kochia, ragweed, and marestail.

BEAD found that for growers facing weed populations with resistance to glyphosate (Weed Science Society of America [WSSA] Group 9 herbicide), ALS acetolactate synthase (ALS) inhibitor herbicides (WSSA Group 2,) and protoporphyrinogen oxidase (PPO) inhibitor herbicides (WSSA Group 14), the registration of dicamba in DT cotton or soybean would give growers an effective herbicide to control these weeds. For areas that do not yet have resistance to one or more of these herbicides, OTT dicamba provides additional flexibility in rotating and/or mixing herbicides for managing weed populations, thereby reducing selection pressure on individual herbicides and prolonging the effectiveness of currently available control options for herbicide-resistant weed species.

However, the development of localized dicamba-resistant weed populations has the possibility to reduce the benefits growers obtain from this technology in some areas. In fields with dicamba-resistant weeds the benefits are lower because of reduced efficacy in controlling those problematic weed biotypes.

BEAD concluded that the registration of dicamba for postemergence use in DT crops gives many growers increased flexibility in their choice of herbicide resistance and integrated weed management programs. It allows growers the ability to apply an additional effective mode of action for control of problematic weed species, like Palmer amaranth, as the WSSA recommends applying at least two effective modes of action to control a weed species. Growers using DT seed have the option to use dicamba as a cost-effective way to control problematic herbicide-resistant broadleaf weed species, and as an additional tool to delay the further development of herbicide resistance. BEAD found that growers have alternative herbicides available to provide postemergence control of problematic multiple-herbicide-resistant broadleaf weeds, including OTT 2,4-D and glufosinate.

For more information, see *Assessment of the Benefits of Dicamba Use in Genetically Modified, Dicamba Tolerant Cotton Production* and *Assessment of the Benefits of Dicamba Use in Genetically Modified, Dicamba Tolerant Soybean Production* (Orlowski and Kells, 2020a and 2020b) in the docket.

3.2 2020 Incidents and Impacts Assessment

In 2020, BEAD reviewed information on dicamba incidents. Concomitant with the registration and grower adoption of the OTT dicamba products, large numbers of incidents of damage from offsite movement have been reported. Based on incidents reported to the EPA and on data from USDA's Agricultural Resource Management Survey (ARMS), BEAD concluded that incidents were being underreported to the EPA by approximately 25-fold. Based on the ARMS survey, BEAD also concluded that dicamba products not intended for use on DT crops were being illegally used on DT crops after planting. BEAD found that, relative to not registering OTT dicamba, the registration of OTT dicamba might reduce misuse of dicamba products not intended for DT crops.

BEAD concluded that offsite movement of OTT dicamba could have substantial impacts to non-users. These impacts include crop yield and quality losses, loss of organic certifications, damage to research and crop breeding programs, residential and landscape damage, increased costs to state lead agencies, and conflicts between neighbors.

BEAD considered a number of control measures and restrictions intended to reduce drift. BEAD found that these control measures may increase applicator or grower control costs and could make use of OTT dicamba products more difficult. BEAD concluded that the control measures should benefit non-users by addressing offsite movement but would not completely eliminate impacts to non-users if misuse occurs.

For more information, see *Dicamba Use on Genetically Modified Dicamba-Tolerant (DT) Cotton and Soybean: Incidents and Impacts to Users and Non-Users from Proposed Registrations* (Chism et al., 2020) in the docket.

4. CURRENT SITUATION

4.1 Cotton and Soybean Acreage and Dicamba Usage

The national planted acreage of cotton declined in both 2020 and 2021 (Table A-1). From 2019 to 2021, cotton acreage declined from 13.7 million acres to 11.2 million acres (-18 percent). State-level declines were especially notable in states like Louisiana where the number of acres planted was more than halved from 2019 to 2021 (USDA/NASS 2021).

Conversely, the national total planted soybean acreage has increased in both 2020 and 2021, resulting in a two-year increase of 13 percent (Table A-2). States with the greatest percent increases between 2019 and 2021 include South Dakota, Georgia, New York, Texas and Mississippi (USDA, 2021).

Multiple other data sources are used in this document as no one source includes all information about acreage, adoption of DT seed, and dicamba usage. Table B-1 in Appendix B compares acreage estimates across different data sources. Overall, there is high agreement between the sources (greater than 92%) on number of acres planted/grown. The discrepancies between sources may be due to slightly different survey methodologies.

Pesticide usage data for cotton and soybean for 2020 are available by seed trait (DT or Non-DT), by type of dicamba products (OTT or non-OTT) and by application timing (Kynetec, 2021). Data for 2021 are not yet available from the data provider. These data are proprietary and are contractually non-releasable to the public. Detailed usage data are provided in a confidential attachment (Attachment B, Tables B-2 to B-9). Summary data for cotton (Table 1) and for soybean (Table 2) are included below, but these tables must be redacted prior to release outside of the Agency.

After accounting for the yearly acreage variability, the percent of cotton and soybean acreage planted with DT seed was relatively stable between 2019 and 2020. In 2020 about three-quarters percent of the cotton acreage used DT seed (Table B-2) and about two-thirds percent of the

soybean acreage used DT seed (Table B-3). Data for the 2021 growing season are not yet available.

About two-thirds of DT cotton was treated one or more times with a dicamba product. Less than 20 percent of the acres were treated with non-OTT dicamba products and roughly 60 percent were treated with OTT dicamba products (Table B-4), with some acres treated with both types of products.

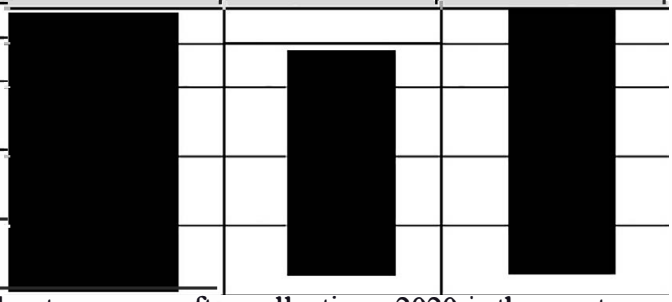
About 60 percent of DT soybean was treated one or more times with a dicamba product. Ten to 15 percent of the DT soybean acreage was treated with non-OTT dicamba products and around half were treated with OTT dicamba products (Table B-5); less than ten percent of DT soybeans were treated with both types of products.

The permitted timing of dicamba applications differs between the four OTT products and all other dicamba products. Only the four OTT dicamba products are permitted to be used after the crop has been planted. Recent usage data (2021 data not yet available) indicate that less than one percent of DT cotton acres planted were treated post-emergence with a non-OTT dicamba product (Table B-6).

For soybean, the most recent pesticide usage survey data indicate that non-OTT dicamba products may have been misused on about five percent of DT soybean acreage (Table B-7). The Agency also observed similar misuse of dicamba products from a 2018 survey on DT soybean based on a survey conducted by USDA (USDA/ERS, 2020; Chism et al., 2020).

Table 1. Summary of Cotton Acreages and Dicamba Usage. THIS TABLE CONTAINS PROPRIETARY USAGE DATA AND MUST BE REDACTED PRIOR TO PUBLIC RELEASE.

2020 Cotton*	Acres	Percent of DT Acres Grown	Percent of US Cotton Crop
Acres Surveyed for Herbicide Usage			
DT Acres Surveyed			
DT Acres Treated One or More Times with any Dicamba Product			
DT Acres Treated One or More Times with an OTT Dicamba Product			
DT Acres Treated Post with a non-OTT Product			



* Pesticide usage survey data are available about one year after collection. 2020 is the most recent data available

The usage of non-OTT dicamba products has greatly increased over time (Kynetec, 2021). Table B-8 reports the number of cotton acres treated with non-OTT dicamba products by year and, between 2015 and 2020, usage more than doubled. Table B-9 reports the use of non-OTT dicamba on soybean acres over time. Between 2015 and 2020 usage of non-OTT dicamba has increased five-fold. Several potential explanations for the large increases may include misuse or increased use of dicamba as a preemergent treatment.

Table 2. Summary of Soybean Acreages and Dicamba Usage. THIS TABLE CONTAINS PROPRIETARY USAGE DATA AND MUST BE REDACTED PRIOR TO PUBLIC RELEASE.

2020 Soybean*	Acres	Percent of DT Acres Grown	Percent of US Soybean Crop
Acres Surveyed for Herbicide Usage	[redacted]		[redacted]
DT Acres Surveyed		[redacted]	
DT Acres Treated One or More Times with any Dicamba Product			
DT Acres Treated One or More Times with an OTT Dicamba Product			
DT Acres Treated Postemergence with a non-OTT Product			

* Pesticide usage survey data are available about one year after collection. 2020 is the most recent data available

The Agency reviewed the annual sales data for OTT dicamba products that each registrant submitted as part of the 6(a)(2) letters. These data are not crop specific but crops in some states may be inferred based on the location of crop production. Table B-10 shows the total amount of dicamba from the four OTT products sold by state and the percent of sales attributable to each of the four registrants. Notably, OTT dicamba sales leaders changed in about 70 percent of the States between 2020 and 2021. Because each registrant typically only investigates incidents related their own products, and the sales leader changes in most states, claims by any single registrant of incident reduction is not likely to be meaningful.

The registrant submitted sales data, measured in pounds of dicamba sold, may be used to estimate the number of acres treated in each state. The label rate of 0.5 pounds of dicamba acid equivalent (a.e.) per acre is presumed. Table B-11 compares DT cotton and soybean acres with the acres potentially treated once or twice with an OTT dicamba product. Nationally, about 61 percent of the DT cotton and soybean acres could be treated with the amount of OTT dicamba sold, assuming one application. That is more DT acres are planted than can be treated with OTT dicamba sold may be due to defensive planting to protect against off-target movement, selection of the variety based on genetics/yield potential and not for the herbicide trait, or illegal use of dicamba products not registered for use on DT crops (non-OTT dicamba products).

4.2 Development of Dicamba Resistant Weeds

In the 2020 impact assessment (Chism et al., 2020), the Agency concluded that as resistance to dicamba spreads, the DT/OTT dicamba technology will be become less useful to growers with herbicide-resistant weeds.

As has been observed for other herbicides, including glyphosate (Group 9) and the ALS inhibitor herbicides (WSSA Group 2), widespread and repeated use of dicamba has led to dicamba-resistance in problematic broadleaf weed species, like Palmer amaranth and waterhemp, and this resistance appears to be spreading. The first incidents of dicamba resistance in Palmer amaranth

were reported (Steckel and Perkins, 2020) and subsequently confirmed during the 2020 growing season in Tennessee by University of Tennessee Extension Weed Scientists (Steckel, 2020). The Tennessee scientists confirmed that the labeled rate only provided 40 to 60% control of Palmer amaranth and that follow-up applications only marginally improved control in some replicated trials. The Tennessee scientists also reported that resistance to dicamba in the populations of Palmer amaranth that they evaluated also conferred resistance to 2,4-D, a similar synthetic auxin herbicide (WSSA Group 4 like dicamba) used for over-the-top control of broadleaf weeds in soybean and cotton. State Extension weed scientists in Arkansas reported Palmer amaranth populations in Arkansas displaying decreased sensitivity to dicamba, as well as other key herbicides including 2,4-D and glufosinate (Barber, 2020) and state Extension weed scientists in Georgia also reported decreased sensitivity of Palmer amaranth to dicamba in 2020 (Culpepper, 2020). While cross-resistance between 2,4-D and dicamba is not guaranteed, it occurs with enough frequency that the reduced effectiveness of 2,4-D should also be considered as a potential impact of resistance to dicamba.

While the initial reports of reduced sensitivity or resistance to dicamba occurred in 2020, the 2021 growing season provided confirmation that resistance to dicamba is becoming much more widespread. Dicamba resistant Palmer amaranth is common across Tennessee where state Extension weed scientists no longer consider dicamba an effective herbicide control option for Palmer amaranth in many parts of the state (Arkansas, 2021; Unglesbee, 2021f; Steckel et al., 2021). Dicamba-resistant Palmer amaranth has also been confirmed in Arkansas (Arkansas, 2021; McGeeney, 2021) and a screening effort is being conducted to confirm resistance to dicamba in waterhemp populations exhibiting decreased sensitivity to dicamba across seven states including Missouri, Illinois, Indiana, Louisiana, Nebraska, Ohio, and Tennessee (Winans et al., 2021). In two of these states, Illinois and Tennessee, state Extension weed scientists have confirmed resistance in multiple populations of waterhemp resistant to dicamba (Unglesbee, 2021d). Given the widespread use of over-the-top dicamba herbicide products on soybean and cotton in the U.S., the Agency expects more instances of dicamba resistance to be confirmed and resistance to dicamba in problematic broadleaf weeds like Palmer amaranth and waterhemp to continue to spread.

Two registrants submitted records for "suspected resistance" as part of the 6(a)(2) reporting requirements, and there have been a substantial number of cases reported as suspected resistance (see Attachment C-1). There have only been a limited number of cases that have required additional testing by registrants, and only one company has confirmed resistance that has also been confirmed by state agricultural extension agencies (Steckel and Foster, 2021; Unglesbee, 2021d). While registrants identified only one confirmed case of resistance, this does not demonstrate a low frequency of resistance. The number of suspected cases tested was low, which prevents determining the frequency of resistance. Registrants claim that most of the efficacy "failures" were attributed to environmental factors or misapplication (e.g., weeds emerged after application, weed not labeled for control, weeds too big, mis-spray / mechanical failure, inadequate spray coverage). Efforts to control weeds that were not killed following a dicamba application included respraying with OTT dicamba products or applying other herbicide products or cultivation. However, extension weed scientists are reporting and confirming resistance

beyond what the registrants have reported. As resistance increases, benefits of the DT technology will decrease (Chism et al., 2020).

Given that some registrants report that growers are making a second application of dicamba to remediate the initial failure (see Attachment C-1), the Agency is concerned that growers are not implementing robust herbicide resistance management plans, specifically using two effective modes of action. Therefore, the agency questions whether or not registrants are implementing effective herbicide resistance management plans (e.g., providing sufficient recommendations that encourage the use of a different mode of action or other method of control following a failure of dicamba) as required under the terms and conditions.

In 2019, Dr. Johnson, a weed scientist in Indiana, indicated there were several fields where waterhemp survived dicamba application and stated that the situation resembled the way fields looked when the first glyphosate-resistant waterhemp populations were found (Unglesbee, 2019). Dr. Steckel (2020), a weed scientist in Tennessee, echoed similar sentiments regarding Palmer amaranth escapes following dicamba applications. Given that two extension weed scientists compared the early onset of glyphosate-resistance with two different weed species with recent dicamba escapes, the Agency looked at the trajectory of glyphosate resistance.[4] The Agency is concerned that dicamba resistance is increasing and is not being effectively managed by current resistance management training materials provided as part of the terms and conditions of registration. If weed resistance to dicamba were to follow the same trajectory as glyphosate, the value of dicamba for OTT uses and for other registered dicamba uses would be effectively lost, severely jeopardizing the ability of soybean and cotton producers to control problematic broadleaf weeds.

4.3 Public Letters Received

In September of 2021, the Deputy Press Secretary of EPA told DTN that the Agency was concerned with incidents and assessing the new information to determine if any new regulatory action would be needed (Unglesbee, 2021h). After that announcement, the Agency received dozens of letters concerning the pending dicamba registrations for use with DT cotton and soybean. Information from the submitted letters is incorporated, as appropriate, in this memorandum. While this memorandum takes into consideration all comments known to have been received, because there was not a formal comment period, it is possible that comments received close to the date of this memorandum are not included.

Several letters indicated that growers need as many tools as possible and that OTT dicamba for use in DT cotton and soybean is important to combat troublesome weeds (Palmer amaranth) and allows farmers to continue using no till and conservation tillage practices. Letters provided information indicating that the high adoption rate of this technology is a sign of importance to

[4] Before 1998, there were no reports of glyphosate-resistant weeds (Heap, 2021). Between 1998 and 2003 in the United States, there were only 14 reports of two weeds resistant to glyphosate in nine states. In 2004, there was a cumulative total of 18 reports involving 5 species 14 states; in 2005, was a cumulative total of 29 reports involving 7 species in 18 states, and between 2006 and 2016 there was reporting in the double digits of new cases of glyphosate-resistant weed populations. As of 2020, there are 172 reports involving 17 weed species in 40 states.

growers; urging EPA to extend the soybean cutoff date (currently June 30) to be equal to that of cotton (currently July 30); seeking greater flexibility with Section 24(c) so states can extend applications beyond the federal cutoff date to accommodate weather or double cropped soybean systems; explaining that further regulation could prevent farmers from having the ability to control weeds which in turn could reduce yields; requesting a timely decision to help inform seed purchases for the 2021 growing season; and/or indicating that incidents are down or not occurring in their state. Alabama Soybean and Corn Association et al. (2021) informed the Agency of potential impacts to farmers if changes were made due to the supply chain issues with agricultural pesticides. As of November 17, 2021, examples of letters received include those from *agricultural coalitions* from the states of: Kansas Coalition of Agriculture (2021), Nebraska Agri-Business Association (2021); *farm bureaus*: Tennessee Farm Bureau Federation (2021), Arizona Farm Bureau (2021), Louisiana Farm Bureau Federation (2021), Georgia Farm Bureau (2021), New Mexico Farm and Livestock Bureau (2021), Ohio Farm Bureau (2021); *seed dealers/Co-Ops*: Minnesota Crop Production Retailers (2021); c*ommodity groups***:** American Soybean Association (ASA, 2021), Illinois Soybean Growers (2021), Delta Council (2021), North Carolina Producers Association (2021), North Dakota Soybean Growers Association (2021), Ohio Soybean Association (2021), South Dakota Soybean Association (2021), Tennessee Corn Growers Association (2021), Tennessee Corn Growers Association (2021), Nebraska Soybean Association; Iowa Soybean Association (2021); *academics*: Li, 2021; Nolte, 2021; *individual growers*: Meyer (2021), Maurath (2021), Rezac (2021), Robbins (2021); *governmental entities*: Alabama Department of Agriculture and Industries (2021), Kansas Department of Agriculture (2021), Louisiana Department of Agriculture (2021), Texas Department of Agriculture (2021), Missouri Department of Agriculture (2021), Nebraska Department of Agriculture (2021), New Mexico Department of Agriculture (2021), Oklahoma Department of Agriculture (2021).

Another set of letters from stakeholders provided varying levels of details describing incidents and views on underreporting of incidents. These letters describe damage to non-DT soybean, and numerous species of trees and other broadleaf herbaceous plants. These incidents were documented on farms, research/breeding plots of seed companies, residential areas, public lands (e.g., parks, natural areas, wildlife refuges), industrial landscapes (e.g., cemeteries, business store fronts) and roadsides. Some letters offer suggestions on potential label changes (e.g., earlier application cutoff dates, increased enforcement, cancellation). Additionally, the Environmental Protection Network (2021) suggested that the Agency should pursue non-label options by convening a Scientific Advisory Panel (SAP) to develop an understanding of dicamba volatility, working with states to take vigorous enforcement actions, requiring registrants to establish a compensation fund through terms and conditions of registration, and/or working with USDA Animal and Plant Health Inspection Service's (APHIS's) Biotechnology Regulatory Service (BRS) to coordinate the deregulation of new herbicide-tolerant crops and the registration of herbicide for use on the crops. As of November 17, 2021, examples of letters received from *non-dicamba-tolerant soybean growers/private citizens* include*:* Nelms (2021), Chincoine (2021), Maginel (2021) Sowers (2021); *crop consultant*: Baldwin (2021); *non-governmental organizations*: Audubon Arkansas (2021), Environmental Protection Network (2021); *seed*

companies/independent seed dealers: Stine Seed (Stine, 2021), Merschman Seed (2021), Ball (2021) and *lawyer representing farmers in Arkansas*: Mays (2021).

5. INCIDENTS REPORTED TO THE AGENCY

A pesticide incident is any exposure or effect from a pesticide's use that is not expected or intended (USEPA, 2021b). Incident reports help EPA determine if the pesticide's application directions need to be changed, if the uses of the pesticide should be restricted, or if additional protective safety equipment should be required. EPA uses information related to pesticide incidents from a variety of sources such as required reporting information from pesticide manufacturers, information submitted directly to EPA, and voluntary reporting by the public through various methods. Observations of visual symptomology and/or plant damage consistent with exposure to dicamba form the majority of dicamba related incidents reported to EPA. In the case of dicamba, sensitive plant species exhibit characteristic visual injury in the form of deformed leaves/cupping (epinasty) after exposure to low concentrations of dicamba. While the Agency is concerned with the overall impacts of incidents, the severity in any particular case is dependent on many factors (e.g., the level of sensitivity of a species, the frequency in which a plant is exposed, the growth stage in which a plant is exposed, the dose received).

Dicamba-tolerant (DT) seed was deregulated by USDA in 2015 (Firko, 2015a and 2015b). DT cotton was first grown commercially in 2015, and DT soybean in 2016. Dicamba herbicide products for OTT use on DT crops were registered by EPA in the fall of 2016 for use in the 2017 growing season. Dicamba-related incidents have been reported to EPA since dicamba-tolerant seed (cotton seed) was released in 2015, two growing seasons prior to a registration of OTT dicamba herbicides (Carey, 2016; BASF, 2021d). Once the OTT dicamba herbicides were registered, the acres of cotton and soybeans in the United States treated with dicamba increased exponentially (USEPA, 2018; Unglesbee, 2021b), and applications of dicamba occur later in the season on these use sites, more frequently, and at higher rates than before the dicamba-tolerant technology was on the market (USEPA, 2018; Unglesbee, 2021b). Incidents have been reported every year since the deregulation of DT crop seeds and there were continued reports of incidents in 2021 despite the additional restrictions added in the 2020 registration decision.

Chism et al. (2020) summarized the history of dicamba related incidents catalogued in the Agency's Incident Data System (IDS) and found incidents went from zero reported in 2014 through 2016 to a total of approximately 1,400 in 2017, 3,000 in 2018, and 3,300 in 2019. A summary was not available for the 2020 season at that time.

The Agency compiled incidents reports for 2021 from the registrants (Corteva, 2021c-e; Syngenta, 2021b; Bayer, 2021b-e; BASF, 2021b and 2021c), the States (Dunbar, 2021a-b; AAPCO, 2021; Ende, 2021; King, 2021; Gere, 2021b; Creger, 2021; Verhougstraete, 2021; Beaver, 2021; Hubbard, 2021; Scott, 2021a; Region 7, 2021) and other sources that provided quantifiable information (Stine, 2021; Audubon Arkansas, 2021) (see Attachment C.2 for the breakout of data by source providing data). The Agency considers each report as a unique incident but acknowledges in some cases an incident may have been double counted as in most cases it is not possible to cross reference an incident from a registrant with those reported by

state or other sources. Additionally, it is worth noting that most reports only provide a total number of incidents reported; therefore, a cumulative timeline of incidents is not able to be determined. This memo attempts to take into consideration all incidents reported to the Agency as of 17 November 2021. Some States indicated that they were not finished with their investigations for the 2021 season, so this summary may change when all States finalize their cases and complete their reports.

In 2021 there were 3,461 incidents on varying species (information on species injured by dicamba will be described in the "Non-cropland" section below) (Table 3). This represents a slight increase from 2019. Incidents affected more than 1 million acres of non-DT soybean and at least 160,000-acre of vegetation in a wildlife refuge in 2021 (Table 3). In later sections, this memo will attempt to provide more context on what these numbers mean given the potential for underreporting and landscape level effects that were seen in many states during the 2021 growing season. There were 290 incidents that occurred in counties that have concerns with endangered species and/or critical habitat (see the section: *Incidents Occurring in Counties with Endangered Species or Critical Habitat* for more details).

Incidents were reported in 29 of the 34 states where use of dicamba on DT crops is authorized. There were nine states that had more than 100 incidents (Arkansas, Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, and South Dakota); six states that had more than 10 but less than 100 incidents (Kentucky, North Dakota, Ohio, Tennessee, Texas, Wisconsin); 14 states that had less than 10 incidents (Delaware, Florida, Georgia, Louisiana, Maryland, Michigan, Mississippi, New Jersey, New York, North and South Carolina, Oklahoma, Pennsylvania, Virginia); and five states that either had no incidents or did not report to the Agency (Alabama, Arizona, West Virginia, New Mexico, and Colorado). There is disagreement among state regulators who see this technology causing widespread, landscape level damage compared to states that have low incidents and want to preserve, and potentially expand, use of OTT dicamba.

Table 3. Summary of Incidents Reported by State, Not Crop Specific*, to the Agency through the States, general public, non-governmental organizations, and FIFRA Section 6(a)(2) Reporting for 2021, as of 17 Nov 2021.

State	Total Number (No.) of Incidents[1]	Total Acreage Affected[1]	Total Number of Counties with Endangered Species Concerns [ESA Counties] within a State[2]	No. of ESA Counties with Incidents (No. of Incidents within ESA Counties)[1]	Acres Planted[3]	
					Cotton	Soybean
Arkansas	509	758,449[4]	3	1 (14)	475,000	3,050,000
Delaware[5]	4	70	0	-	0	155,000
Georgia[5]	1	-	9	-	1,170,000	140,000
Illinois	336	66,140	18	9 (43)	0	10,600,000
Indiana	134	9,495	6	1 (2)	0	5,700,000
Iowa	528	101,026	12	10 (69)	0	10,100,000
Kansas	244	11,448	0	-	110,000	4,850,000
Kentucky	35	2,400	12	2 (8)	0	1,800,000
Louisiana[5]	4	27	2	-	110,000	1,080,000
Maryland	1	30	0	-	0	490,000
Michigan	2	-	18	-	0	2,150,000
Minnesota	711	36,593	10	9 (34)	0	7,700,000
Mississippi[5]	3	2,000	4	-	445,000	2,230,000
Missouri	111	19,729	10	2 (22)	315,000	5,700,000
Nebraska	323	20,211	7	6 (44)	0	5,600,000
New Jersey[5]	1	5	1	1 (1)	0	100,000
New York[5]	1	58	3	-	0	325,000
North Carolina	4	474	45	1 (2)	370,000	1,650,000
North Dakota	45	30,735	7	3 (6)	0	7,300,000
Ohio	34	2,207	3	2 (3)	0	4,850,000
Oklahoma	9	364	1	-	485,000	575,000
Pennsylvania[5]	2	17	0	-	0	580,000
South Dakota	290	30,437	10	7 (30)	0	5,500,000
Tennessee	30	1,092	15	2 (2)	275,000	1,500,000
Texas	76	-	18	1 (2)[6]	6,367,000	110,000
Virginia[5]	5	460	2	-	74,000	600,000
Wisconsin	15	683	26	7 (8)	0	2,100,000
Not Reported	3	-	-	-	-	-
Total	**3,461**	**1,094,150[4]**	**242**	**63 (290)[6]**	**10,196,000**	**86,535,000**

* Aside from non-dicamba-tolerant soybean, there were six large acreage crops (cotton, peanut, potato, rice, sugarbeet, sweet potato) and at least 10 specialty crops (cucumber, vineyards, melon, peas, peppers, pumpkin, squash, tomatoes, tree and shrub nurseries, and timber) mentioned in incident reports.

1 Corteva, 2021c-e; Syngenta, 2021b; Bayer, 2021b; Stine, 2021; Bayer, 2021c; 2021d; 2021e; BASF, 2021b-c; AAPCO, 2021; Ende, 2021; King, 2021; Gere, 2021b; Creger, 2021; Verhougstraete, 2021; Dunbar, 2021a-b; Audubon Arkansas, 2021; Hubbard, 2021; Scott, 2021a; Beaver, 2021; Region 7, 2021. Incidents have primarily been reported on soybean, but there have been more than 80 plants that have been reported as being injured by dicamba.

2 USEPA, 2020b

3 Acres of cotton and soybean grown nationally, regardless of herbicide tolerance technology (USDA-NASS, 2021).

4 Dunbar (2021b) provided reports, does not include 160,000 A wildlife refuge with dicamba injury.

5 Indicates a state for which the Agency previously had no reported incidents or very few reports of dicamba symptomology

6 BASF (2021c) reports damage in Harris County, which is the Houston area. It is uncertain if the business is incorporated in the county or if there are grapevines in the county that were injured. The 2017 USDA Census of Agriculture reports 9 acres of grapes were grown in Harris County.

5.1 Non-Soybean Crops

5.1.1 Reported by States

While the majority of incidents have centered around non-DT soybean, there have been several reports of other crops that have been injured by dicamba. There were six large acreage crops and more than 10 specialty crops mentioned in reports by states to EPA (Table 4). Many of the reports from states were without quantification of the number of calls received or acres damaged. However, occasionally more details were provided. Arkansas (Dunbar, 2021a), Tennessee (AAPCO, 2021), and Nebraska (Creger, 2022) reported damage to tree/shrub nurseries; the nursery in Nebraska was 50 acres. North Dakota reported damage to four or five potato fields (Academics, 2021) and a "couple" sugarbeet fields (AAPCO, 2021). Nebraska reported five incidents associated with vineyards (Creger, 2021), and Arkansas reported three incidents to peas (Dunbar, 2021a). Minnesota reported approximately 31,000 acres of sugarbeet had been injured and believes that may be an underestimate (AAPCO, 2021). Campbell (2021) indicated that approximately 1,050 acres of sweet potatoes were damaged in Arkansas and that sweet potato growers have been experiencing crop damage for four years. Ohio reported that some growers of pepper, pumpkin, squash and tomato have received herbicide damage and some of these growers have had damage since 2017 (Academics, 2021).

5.1.2 Non-Soybean Crops from Academics

Wasacz et al. (2021) determined that snap beans were approximately 1.5 – 3.2 times more sensitive than soybean when looking at the ID_{50} which represents the dose of dicamba that causes a 50% leaf deformation. This study looks solely at leaf deformation and not yield losses. The Agency is currently evaluating this information to determine if this study would impact the endpoints for risk assessments given that the Agency currently considers soybeans as the most sensitive species is its risk assessment.

Table 4. States Reporting Dicamba Damage to Non-Soybean Crops in 2021.

Non-Soybean Crops with Reported Damage	**State Reporting Incidents**	**References**
Large Acreage Crops		
Cotton	AR, MO	Dunbar, 2021a; AAPCO, 2021
Peanut	AR	Arkansas, 2022
Potato	ND	Academics, 2021
Rice	AR	Dunbar, 2021a
Sugarbeet	MN, ND	AAPCO, 2021
Sweet potato	AR	Arkansas, 2021; Campbell, 2021
Specialty Crops		
Cucumber	AR	Dunbar, 2021a
Grape/vineyards	OH, NE, TN, MN, TX, MO	Academics, 2021; Creger, 2021, AAPCO
Large scale commercial vegetables	TN	AAPCO, 2021
Melon	AR	Dunbar, 2021a
Peas	AR	Dunbar, 2021a
Pepper	OH	Academics, 2021
Pumpkin	OH	Academics, 2021
Squash	OH	Academics, 2021
Tomato	OH, AR	Academics, 2021; Dunbar, 2021a
Tree/Shrub Nurseries	TN, AR, NE	Academics, 2021; Dunbar, 2021a; Creger, 2021
Timber	AR	Dunbar, 2021a

5.1.3 Non-Soybean Crops from Registrants and 6(a)(2) Letters

Additionally, registrants submitted new incident information to the Agency pertaining to ongoing/pending litigation. Many of these cases pertain to specialty crops and a description of this information is in Attachment C-3.

5.1.4 Conclusion of Incidents from Non-Soybean Crops

The majority of incidents were to non-DT soybean. However, many states reported damage to crops other than non-DT soybean. This indicates there are various other crops and plants within the landscapes, where OTT dicamba is being used, that are being injured by dicamba. Additionally, the Agency became aware of a species that may be more sensitive to dicamba than soybean.

5.2 Non-DT Soybeans

Some states reported that damage was regional within their state, meaning that some areas of a state had little to no damage or isolated damage and other areas in the state had widespread

damage (Illinois, 2021; Region 7, 2021). Other states reported fewer incidents than in previous years (e.g., North Dakota, South Dakota; Illinois); however, in some cases, state officials suggested that incidents may be underreported (e.g., North Dakota, South Dakota, Minnesota, Illinois) (Dakotas, 2021; AAPCO, 2021). Other states report similar levels of injury as in previous years (e.g., New York, Florida, North and South Carolina, Virginia, Delaware, Texas, Oklahoma), and these states had relatively low numbers of reports compared to other states (AAPCO, 2021). Consequently, these low reporting states do not consider dicamba to be a problem (AAPCO, 2021; Li, 2021). Conversely, Arkansas, Minnesota and Nebraska, have reported a similar or greater number of incidents compared to previous years, (Arkansas, 2021; AAPCO, 2021). States absent/not providing feedback at the AAPCO meeting include: New Jersey, Alabama, Georgia, Mississippi, Maryland, Pennsylvania, West Virginia, Louisiana, New Mexico, and Colorado.

State agents in Arkansas reported that in previous years, when individuals reported incidents, callers were reporting one or two fields being damaged. This year, a caller reported seven to 15 fields with damage, and these incidents occurred despite the additional state restrictions in place (Arkansas, 2021). Some states, such as South Dakota, have documented, though investigations, that incidents have been reported in locations1-2 miles from the nearest dicamba applications (Gere, 2021a) to 20 miles from the nearest dicamba applications (Arkansas, 2021). Several states reported landscape level/ “fence row to fence row” damage (e.g., Arkansas, North Dakota) (Arkansas, 2021; Dakotas, 2021; AAPCO, 2021; Steed, 2021a) despite applicators doing their best to follow the labels.

An academic from Texas indicated that the few incidents that have occurred with dicamba have been the result of drift (Academics, 2021). However, the majority of states report that while some incidents may be due to spray drift (e.g., Nebraska), the majority are likely due to volatility (e.g., Nebraska, North Dakota, Missouri, Arkansas) (AAPCO, 2021; Hardy, 2021). States say that many of the incident reports coming in were from people who have made reports in previous growing seasons since the registration of OTT dicamba (AAPCO, 2021; Nelms, 2021; Unglesbee, 2021c; Maginel, 2021; Green, 2021b).

5.2.1 Conclusions of non-DT soybean

Some states indicate they have significant problems with dicamba incidents and other states have limited reported incidents (potential reasons for this discrepancy are discussed in a later section, see section *Factors Influencing Incidents*). While states indicate that incidents may occur due to drift, several states reported landscape level injury, which indicates dicamba volatility, was widespread. In the process of investigating potential dicamba incidents some states reported that the nearest known source of dicamba was more than a mile away from the injured crop. Additionally, state agents in states with many incidents suggest people are being impacted for multiple years.

5.3 Research/Breeding/Seed Production Plots

BEAD’s 2020 impacts memo (Chism et al., 2020) described the significance of research breeding programs throughout the country and suggested that the continual loss of university

soybean breeding research could jeopardize the long-term viability of a university's breeding program.

The 2021 season yielded more damage to university research plots. An academic from North Dakota indicated that there was dicamba damage symptomology present on all breeding plots in the eastern third of North Dakota as well as some research plots (Academics, 2021). Iowa had 44 research trials (in 10% of state counties) affected by off-target movement of dicamba in the past two years (Academics, 2021). Despite the State of Arkansas adding more restrictive buffers for dicamba applications near research fields (i.e., 1-mile buffer from research) (Arkansas, 2021; Unglesbee, 2021a), academics still had damage at all research stations in Eastern Arkansas.

In addition to damage to university research plots, Gullickson (2021a) suggested that almost all companies with soybean research programs have had plots damaged by dicamba. Stine Seed Company sent the Agency data indicating at least 36 research locations were damaged out of an undisclosed number of locations in nine states (Stine, 2021). Stine (2021) indicated the company plants more than a million research plots a year and they had damage to hundreds of thousands of plots. Furthermore, Stine Seed Company has experienced this type of damage for five years.

Information provided by registrants in response to the 6(a)(2) letters suggest they too had damage to research, breeding and/or seed production plots. Three of the four registrants provided data about damage to their companies' research, breeding and/or seed production plots (See Attachment C-4).

5.4 Non-Cropland

There were also reports of incidents involving vegetation around homes and natural areas including: ornamental plants, home gardens, non-fruit trees, and native plant species (Arkansas, 2021; Audubon Arkansas 2021; Nelms, 2021; Steed, 2021b; Brantley, 2021; Brian, 2021) in both residential and public areas (e.g., parks, wildlife refuges).

5.4.1 Landscape, gardens, etc.

There were more than 25 plants/trees species specifically mentioned in reports to states (Table 5). Many of the reports from states were a list of plants without quantification of the number of calls received or number of plants/trees damaged. Nebraska reported 14 incidents involving dicamba damage to vegetation around residential settings (Creger, 2021), and Arkansas had 41 reports of residential incidents (Dunbar, 2021a). In Arkansas (Dunbar, 2021a), there may have been one to three plant species mentioned in the report. Academics from Illinois indicated they have heard 30 or more species have been damaged (Academics, 2021).

Table 5. States Reporting Dicamba Damage to Various Types of Vegetation in Residential Settings in 2021.

Vegetation Damaged in Residential Settings	**State Reporting Incidents**	**References**
Gardens *(tomatoes, potatoes, peas, herbs, peppers, okra, blackberry, spinach, squash, pole beans, garden beans)*	SD, TN, TX, KS, IL, AR, NE	Dakotas, 2021; AAPCO, 2021; Sowers, 2021; Dunbar, 2021a; Creger, 2021; Nelms, 2021; Brantley, 2021
Native vegetation *(prairie forbs, black-eyed susan)*	IL	Academics, 2021; Illinois, 2021; Nelms, 2021
Ornamentals *(azalea, vinca, roses, hibiscus, salvia)*	TX, SD, AR, NE	Dakotas, 2021; AAPCO, 2021; Sowers, 2021; Dunbar, 2021a; Creger, 2021
Trees *(ornamentals, sycamore, fruit trees, pecan, oak, elm, maple, hackberry)*	IL, KS, MO, IA, AR, NE	Academics, 2021; Illinois, 2021; AAPCO, 2021; Hartzler, 2021; Dunbar, 2021a; Creger, 2021; Nelms, 2021; Brian, 2021; Brantley, 2021

5.4.2 Public Lands (Wildlife Refuges, Parks, etc.)

In 2020, the Agency (Chism et al., 2020) summarized many incidents of dicamba symptomology at the landscape level. Newly available data indicate that these incidents are more extensive than had been described and are continuing into 2021.

Audubon Arkansas (2021) hypothesized that in a landscape full of genetically modified organism (GMO) crops, the atmospheric loading of volatile dicamba could be enough to cause landscape scale damage. To test this hypothesis and to document the geographic extent of the effects, Audubon Arkansas led a community science monitoring project during the growing seasons of 2019, 2020, and 2021.

Audubon Arkansas developed a web-based reporting application and trained volunteers to search for signs of dicamba symptoms on native and ornamental plants and document these signs with reports and photographs. Volunteers were trained to identify symptoms associated with a plant growth regulator (PGR) herbicide, such as leaf cupping, epinasty, and chlorosis. Further the volunteers were trained to look for more than one symptom on a plant, uniform symptomology across a plant, and to identify areas where multiple plants and species displayed symptoms.

Table 6. Results from Audubon Arkansas Community Science Project (Audubon Arkansas, 2021).

Year	Records / Photos Submitted	Records / Photos consistent with Damage from PGR Herbicide
2019	243 records, 728 photos	178 probable; 65 possible
2020	123 records, 737 photos	116 probable; 4 possible
2021	21 records, 191 photos	21 probable

Table 6 summarizes results from this three-year project. Participants and resources varied from year to year, so these data cannot be used to document trends. However, eleven 2019 sites with documented symptoms were revisited in 2020 and once again showed symptoms. These sites and others revisited in 2021 showed symptoms. Audubon Arkansas (2021) also included results of plant tissue samples that tested positive for dicamba from the Arkansas Plant Board (all 2020 and 2021 samples not yet analyzed).

Species displaying probable or possible symptoms include over 20 species of trees and shrubs (e.g., elms, magnolias, maples, oaks, sweetgum, sycamore) and many other annual and perennial plant species (e.g., peppervine, pokeweed, sunflowers, grapes, Virginia creeper) (Audubon Arkansas, 2021). Sycamore was the most frequently reported species showing probable symptoms and was documented at 96 locations.

Observations were made across 20 Arkansas counties and symptoms were documented on diverse properties including university research farms (4), cemeteries (37), churchyards (22), Arkansas Game & Fish Commission properties (8), state natural areas (6), city parks (4), national wildlife refuges (2), state parks (2), several public spaces, and many county and state roads.

Steed (2021b) describes dicamba symptomology on several tree species, most notably sycamore, throughout the Dale Bumpers White River National Wildlife Refuge, Arkansas. This refuge ranges from a quarter mile to 10 miles wide and stretches for about 60 miles along the White River until it empties into the Mississippi River. Brantley (2021) also described widespread reports of damage to trees and shrubs (sycamore, cypress, pines, white oak) and state parks and wildlife refuges in Arkansas.

5.4.3 Conclusions of Non-Crop Incidents

Numerous plant species were reported to have dicamba symptomology. These reports demonstrate that off-field movement of dicamba is occurring in non-crop areas leading to widespread damage to additional plant species. Several reports indicated that vegetation around natural areas and residential landscapes have had multiple years of exposure to dicamba.

5.5 Incidents Occurring in Counties with Endangered Species or Critical Habitat

In 2021, incidents have occurred in counties with endangered species or critical habitat (referred to as "ESA counties") (Table 3). While incidents have been reported in ESA counties, the

Agency is not aware of any "take" where an endangered species or critical habitat has been harmed. However, these incidents suggest the possibility that a "take" could occur.

As mentioned above, because the sources of reports were from multiple entities, the Agency was not able to ensure that an individual incident was not counted more than once but made sure not to double-count a county that was reported by more than one source. Table 3 provides a summary of incidents in ESA counties. For example, in Iowa, 10 of 12 ESA counties had at least one reported incident and there were 67 different incidents within ESA counties in Iowa (Table 3). Overall, there were 63 ESA counties with at least one reported dicamba incident and total of 290 reported incidents in ESA counties during 2021 (Table 3).

A large portion of incidents in ESA counties occur in states where the only DT crop is soybean. However, cotton is also cultivated in five of the states with incidents in ESA counties (Arkansas, Texas, Missouri, Tennessee, and North Carolina) (Table 3). Because the majority of incidents were in states that only produce soybean, the Agency wanted to explore the possible role that use in cotton may contribute to incidents in ESA counties. To do this, the Agency used Southeast Missouri, which has two ESA counties, as an example. The Agency looked at the cotton and soybean acres (based on acres harvested [USDA, 2017]) in and around the ESA counties in Missouri (Figure 1). Both Dunklin and Cape Girardeau are the ESA counties. Only soybean is grown in Cape Girardeau, but it has two adjacent counties that grow cotton. Both cotton and soybean are grown in Dunklin County, and the acreage is split with ~45% cotton and ~55% soybean.

In Cape Girardeau, where cotton is not grown, use in cotton may not be likely to contribute incidents. However, some stakeholders suggest that volatilized dicamba can move more than a mile (Arkansas, 2021; Gere, 2021), so an application to cotton in one county could affect non-target vegetation in an adjacent county. In Dunklin County, acreage in the two crops is similar; therefore, it is not possible to exclude applications to cotton as a possible source for incidents in an ESA county. Further, the Agency does not have data indicating that applications made to cotton would be less likely to result in off-target movement and/or incidents than an application to soybean under the same conditions. However, since applications to cotton are often made later in the season, when temperatures are warmer, volatilization may be more likely with use in cotton.

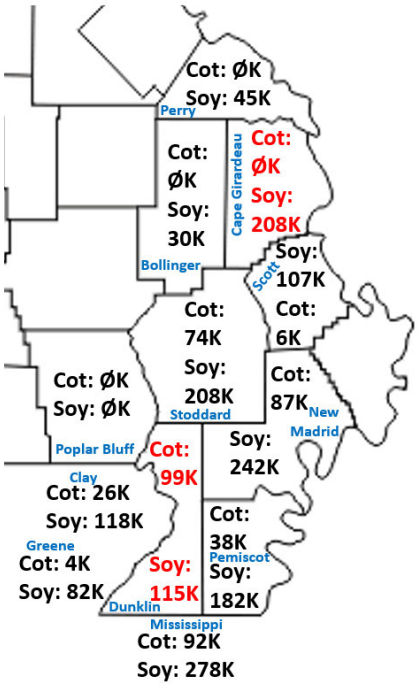


Figure 1. Map and associated cotton and soybean acres (in thousands) harvested in ESA counties (red) and surrounding counties (black) in Southeast Missouri in 2017. (USDA, 2017).

5.6 Impacts to Growers of Non-DT Crops

The impacts to non-DT growers from offsite movement of dicamba from OTT applications can be substantial (Chism et al., 2020). High value crops may suffer yield and quality losses, organic growers could lose organic certification, and research and crop breeding programs could be disrupted. Losses may be more pronounced when a plant had multiple exposures to dicamba versus a single exposure or if exposure occurs when the plant is in a reproductive growth stage versus a vegetative growth stage.

5.6.1 Specialty Crops

Doohan (2021) provided survey data of financial losses of specialty crop growers who experienced losses from herbicide drift. As indicated earlier, respondents considered dicamba, 2,4-D or glyphosate as the most likely herbicides causing damage. Therefore, the findings associated with losses from specialty crop growers (described below) are attributed to the aforementioned herbicides and not dicamba specifically. Approximately 35% of respondents said they had no financial losses in 2019-2020 and about 50% had losses less than $10,000 per grower, not per acre (Doohan, 2021). This is likely due to growers having a small acreage (<5 acres) and either having direct sales to people or contracts with local restaurants (Academics, 2021). In addition, approximately 15% of the reporting specialty crop growers in the mid-west

had financial losses of $10,000 or greater and 1% had losses greater than $500,000 (Doohan, 2021).

5.6.2 Grapes/Vineyards

Timmons et al. (2021) is a recent court case where plaintiffs claim multi-year exposure effects on grape plants, causing losses every year since 2015 through 2021. While the Agency's information on this case is limited, the Agency recognizes long-term effects of multiple exposures events per year to perennial species, especially when they occur in sequential years. The Agency is not aware of research that examines the impacts of multi-year exposure of dicamba to a perennial species, but the Agency assumes that a single-year exposure would be less impactful than multiple years of exposure and that the more years a plant is exposed to dicamba the greater the impact.

5.6.3 Sweet Potato

Campbell (2021) reported that sweet potato farmers have received injury for four to five years and never know what the yield penalties are until harvest. Batts et al. (2020) conducted research on dicamba injury by applying OTT dicamba products at reduced rates modeling spray drift and found that dicamba exposure 30 days after transplant of sweet potato slips tended to have greater yield losses than exposure 10 days after transplant, and that losses may differ between the two salts of the OTT formulations (i.e., BAPMA [sodium methyl amine] salt vs. DGA [diglycolamine] salt). Batts et al. (2020) found a quadratic decrease in yield, of all grades of sweet potatoes, as the rate of dicamba increased when exposure occurred 30 days after transplant. Depending on the grade of sweet potato, yield losses ranged from 53% to 92% with the highest rate of BAPMA salt (1/10X rate). However, applications with the DGA salt had yield losses at rates ≥1/500X or higher leading to yield losses ranging from 7% to 42%.

5.6.4 Tree Nurseries

Creger (2021), Dunbar (2021a), and Academics (2021) reported incidents to tree and shrub nurseries. Impacts to tree nurseries can be considered substantial given that aesthetics, not yield, is the indicator of financial loss. Trees that are too severely damaged by dicamba cannot be sold and are therefore considered a total loss. Depending on the size of the tree, it may be able to be held for another year in hopes that the tree grows out of the injury and is not damaged the following year.

5.6.5 Research/Breeding/Seed Production Plots

EPA's 2020 impacts memo (Chism et al., 2020) described the significance of research breeding programs throughout the country and suggested that the continual loss of university soybean breeding research could jeopardize the long-term viability of a university's breeding program. Additionally, there were many instances of dicamba damage to seed companies and registrants who produce non-DT seed for sale. The Agency assumes similar impacts as a university breeding program but possibly at a larger scale given that a university program is contained within a state, but industry plots are nationwide.

5.6.6 Conclusions of Impacts to Growers of Non-DT Crops

Growers of specialty crops, grapes/vineyards, research/breeding/seed production plots and sweet potatoes report damage multiple years, some since DT cotton was commercialized. Losses may be more pronounced when a plant had multiple exposures to dicamba versus a single exposure or if exposure occurs when the plant is in a particular growth stage.

5.7 Impacts to Non-Cropland

Newly available data indicate that dicamba related incidents on public lands (e.g., parks, wildlife refuges) are more extensive than had been described previously (Chism et al., 2020). In 2021, the Agency received many reports (Arkansas, 2021; AAPCO, 2021; Audubon Arkansas 2021; Brantley, 2021; Brian, 2021; Creger, 2021; Dunbar, 2021a; Hartzler, 2021; Illinois, 2021; Nelms, 2021; Steed, 2021b; Academics, 2021). These reports demonstrate that off-field movement of dicamba is occurring and causing widespread damage to plants on public lands and natural areas across the Midwest and the South. Dozens of different plant species have been damaged. Of particular concern are the long-term effects of multiple exposures events per year to perennial species, especially when they occur in sequential years.

5.8 Social Impacts

Because use of OTT dicamba can result in off-target damage to non-DT crops and landscapes, the use of OTT dicamba can result in conflicts between growers using dicamba and community members with crops and vegetation sensitive to dicamba. In an extreme case, in 2016, a man was murdered in a dispute over dicamba drift (McCune, 2017; Capital Journal, 2017). Though dicamba use requirements have changed since 2016, the tension in rural areas around dicamba drift and volatility has remained. Stakeholders have expressed frustration, impatience, and even made references of violence in conversation with Extension specialists and state regulators (Charles, 2021; AAPCO, 2021; Illinois, 2021). State regulators recounted physical harm and retribution threatened against applicators, neighbors, and even family members and spoke of farmers having lost friends due to differences in decisions about using dicamba (Region 7, 2021). Some retailers are choosing to not sell OTT dicamba products because they do not want to deal with complaints related to dicamba (Illinois, 2021). The Agency has received multiple emails from growers and neighbors impacted by dicamba drift and volatility; the authors of these emails express frustration about a lack of recourse for dicamba damage and write that the use of dicamba is damaging the social fabric of rural communities (Ball, 2021; Peterson, 2021; Brian, 2021).

5.9 Impacts to State Agencies

State agencies have been impacted by the 2020 decision to register OTT dicamba. State agencies manage certification and licensing for pesticide applicators, investigations of pesticide incidents, and pesticide product registrations within the state, including provisions under FIFRA subsections 24(a) and 24(c).

5.9.1 Enforcement

State lead agencies, through AAPCO, have reported budget shortfalls and other resource constraints due to the number of dicamba-related incidents requiring them to divert or reallocate resources to investigate dicamba complaints (Chism et al., 2020). In states that have been heavily impacted with dicamba incidents, state officials feel as if farmers have given up on them because they are not able to enforce the label and incidents have not improved over time (Region 7, 2021).

Some states (e.g., Minnesota and Iowa) have changed their reporting process to accommodate the handling of incidents by creating different categories of incidents (Unglesbee 2021c). One category initiates a formal investigation that may result in a determination of the cause of damage. The second category is akin to a notification to let the authorities know that damage occurred without a request for a formal investigation.

Arkansas (2021) reported that they have 30 investigators, and all have undergone herbicide symptomology training. The state indicated it was challenging to conduct an incident report on a 160,000-acre incident and they are still closing out cases from 2017 through 2019. State officials also spend time working on litigation.

5.9.2 State Authority to Regulate Dicamba Products

The 2020 decision memo (USEPA, 2020) included a clarification regarding state authority to regulate dicamba products under FIFRA Sections 24(a) and 24(c). Previously, some States issued registrations that were more restrictive than the federally-issued registration using Section 24(c). In a 2020 re-evaluation of the regulations and statutory language, EPA concluded that FIFRA Section 24(c) does not provide the authority to impose additional restrictions on a federal registration. If a state desires to impose an additional restriction to a federally registered product, state may exercise their authority under FIFRA Section 24(a) to regulate the sale or use of any federal registered pesticide in the state.

Many states have indicated that the shift to using Section 24(a) to add state level restrictions for dicamba has been a challenge (Illinois, 2021; Region 7, 2021; Petersen, 2021). Illinois indicated that this change will require two public comment periods and may take 120 days to complete state restrictions (Illinois, 2021). Iowa indicated that specific rulemaking would be a large undertaking for the state, and Nebraska indicated that they do not have the capacity to do rulemaking (Region 7, 2021).

In contrast, States with few reported incidents expressed frustration that they were not able to make labels less restrictive (e.g., extending the application cutoff dates) in their states using Section 24(c) in the 2021 growing season. The Agency disapproved Section 24(c) Special Local Needs registrations for Georgia, North Carolina, and Tennessee because these requesting states did not submit information that demonstrated how the use of the product would not cause unreasonable adverse effects. Texas withdrew their request after the Agency sent a notice of intent to disapprove.

5.9.3 Conclusions on Impacts to State Agencies

Some state agencies have adjusted the way they handle incidents to keep up with the volume of complaints. Some states struggle with budget and/or resources issues to cover both incidents and other programs. Several states officials feel as if growers have lost faith in the state's ability to enforce the label. States have also expressed frustration because they do not have the flexibility to make federal labels more or less restrictive depending on the state's needs.

5.10 Underreporting of Incidents

Generally, pesticide incidents are underreported.[5] In the 2020 impact memo, Chism et al. (2020) found that the number of offsite incidents reported to EPA compared with the incidents reported in USDA's 2018 Soybean Agricultural Resource Management Surveys (ARMS) showed incidents were underreported to EPA. Based on this information, the magnitude of underreporting was approximately 25-fold (i.e., one incident is reported to the Agency for 25 incidents reported to USDA). The Agency does not have an update to the ARMS survey, but based on stakeholder meetings, similar underreporting likely occurred in 2021. The EPA (1999) has previously estimated that incidents associated with rodenticides were underreported by a factor of 4.

The number of reported incidents may not reflect the damage that is occurring at the landscape level, including home gardens and natural areas (Unglesbee 2021c, Rook and Pates 2021, Dakotas, 2021). Stakeholders put forward various hypothesis to explain the dicamba damage including:

- Growers have lost hope that States can enforce the label (Region 7 2021). In many cases, no action is taken even when an incident is reported (Academics, 2021; Region 7, 2021; Ball, 2021). This could be because investigators were not able to identify the source of the damage (Unglesbee, 2021c; Rook and Pates, 2021), and dicamba is known to move more than a mile (Gere, 2021a; Arkansas, 2021), which further complicates finding the source.
- Similarly, if an investigation determined that there was no violation associated with the application (Illinois, 2021; Dakotas, 2021), no action was taken because the application was made within the parameters of the label. However, this is not a case of lack of enforcement, as the application was made within label parameters, but an incident may still have occurred.
- Herbicide drift may be considered as a "pollution exclusion" and may not be included under crop insurance (Kirk Hall, 2021). Given that several states reported severe drought in 2021 (Academics, 2021; Dakotas, 2021; Unglesbee, 2021c; Rook and Pates, 2021), it is likely that growers were concerned that if they filed a dicamba off-target movement complaint, their insurance company may not pay out on a drought claim. Therefore, there may be a financial incentive for a grower to not report incidents in states that could negatively impact insurance claims for other reasons, such as drought.

[5] Underreporting of pesticide incidents is the result of a number of factors including, but not limited to: the lack of a universal, mandatory legal duty to report; no central reporting point for all incidents; no requirement for active monitoring for incidents; symptoms associated with pesticide effects are often vague or mimic other causes leading to incorrect diagnoses; incidents are often not investigated adequately enough to identify the pesticide that caused the observed effects; and reluctance or inability to report. For further detail about underreporting of alleged dicamba incidents, see Chism et al. 2020.

- Growers were concerned that they could lose organic certifications if they report dicamba damage (Academics, 2021).
- Growers resolved the issue themselves and did not involve the state (AAPCO, 2021).
- Growers did not want to report in attempt to preserve relationships with neighbors (Academics, 2021; Unglesbee, 2021c; Stine, 2021).

As follow-up to the meeting with Academics (2021), Dr. Doohan (2021) shared additional information from the herbicide drift survey of Midwestern specialty crop growers which he discussed at the meeting. About 45% of the nearly 300 growers who responded to the survey indicated that in 2020, they had some level of herbicide drift impact their specialty crops. These growers named the herbicides responsible for the injury as: dicamba (47%); 2,4-D (44%); glyphosate (20%); or "unknown" (27%). However, Doohan (2021) reported that only an average of 6% of growers reported incidents anytime herbicide damage was detected in 2019 and 2020 (i.e., people do not report that they have an incident every time they have herbicide damage). Reasons included: self-inflicted drift (3%), required too much time/paperwork (10%), saw no benefit in reporting (40%), consequences to the offender were not meaningful (32%), damage was minor (23%), unable to identify the source of drift (26%), concerned with creating bad neighbor relations (51%), concerns over the ability to market the crop (4%), resolved the problem without the help of the state (9%), someone else filed (1%), or "other" (4%).

Registrants have indicated that any report called into their incident hotlines is reported to EPA. However, after review of information submitted in response the 6(a)(2) letters, EPA has some concern that registrants potentially are not capturing all incidents when they report to ESA. The missing reports may be attributable to a registrant's procedures that require a grower to report an incident through the incident hotline even if the grower contacts an employee of the registrant to report the incident (see Attachment C-5). In those situations, the grower may not have followed up by reporting to the incident hotline.

In response to the 6(a)(2) letters, a registrant produced additional incident reports that were not included in their official tally to the Agency. The additional incident reports represent a possible underreporting rate of 20% or more (see Attachment C-5).

5.10.1 Conclusions on Underreporting

A recent survey investigating reporting of herbicide incidents by specialty crop growers in the mid-western United States indicated that only 6% of growers reported incidents every time damage was detected in 2019 and 2020. The most common reasons for not reporting (>25% response rate, in order of most common) included: concerned with creating bad neighbor relations, saw no benefit in reporting, consequences to the offender were not meaningful, and unable to identify the source of drift. Additionally, information submitted in response to 6(a)(2) letters suggest that registrants may also be underreporting in their reports to the Agency.

5.11 Conclusions of Incidents Reported to the Agency

Some states indicate they have significant problems with dicamba incidents on non-DT soybean, while other states have relatively few reported incidents. States that have a relatively large

number of incidents on non-DT soybean report landscape level injury. In some instances, investigations suggest that the nearest known source of dicamba was more than a mile away from damaged field. Some homeowners and growers reporting incidents in 2021 have reported incidents in multiple years.

There have been approximately 290 incidents in counties with endangered species or critical habitat. The Agency is not aware of any "take" where an endangered species or critical habitat has been harmed. However, these incidents suggest the possibility that "take" could occur.

In addition to non-DT soybean, many states reported damage to large acre crops other than non-DT soybean (including several specialty crops) and vegetation around natural areas and residential landscapes. There were several reports that indicated other large acre crops, specialty crops, and other vegetation around natural areas and residential landscapes have received dicamba injury for multiple years. These reports demonstrate that off-field movement of dicamba is occurring in non-crop areas leading to widespread damage to plant species other than non-DT soybean. The severity of impact depends on several factors including, but not limited to, the frequency, duration, and dose of exposure; growth stage at the time of exposure; and species sensitivity. These findings indicate there are several crops and natural vegetation in the landscape that are being injured by dicamba. Additionally, the Agency became aware of a species (i.e., snap beans) that may be more sensitive to dicamba than soybean.

In addition to impacts to vegetation, social impacts (e.g., fractured relationships with neighbors, threats of physical harm) have existed and continue to exist since 2016, one year prior to registration of OTT dicamba, as a result of off-target dicamba damage. In some states, state officials have felt the burden of a high volume of incident reports that may result in a high number of investigations, which may distract from other state projects. Furthermore, several states have voiced frustration over losing the common practices of making federal labels either more or less restrictive depending on the state's needs prior to the 2020 decision.

Underreporting is likely occurring for several reasons including: no meaningful consequences to the offender, concerns over crop insurance claims, preserving neighbor relations, fear of having a non-marketable crop, and/or growers have worked out incidents amongst themselves.

6. FACTORS INFLUENCING INCIDENTS

In 2020, the Agency assessed the practicality of, and likely compliance with, individual control measures of the 2020 label (Chism et al., 2020). Chism et al. (2020) found compliance with the application cutoff dates is likely improved by the recordkeeping requirements of applicators as part of the Restricted Use Products (RUP) classification; however, they noted that compliance could be influenced by crop progress, weed pressure, and weather. At the time of the 2020 decision, the Agency did not have information about the current availability of the required buffering agents and was not able to estimate compliance with requirements to add buffering agents. Chism et al. (2020) found that the complexity of determining the appropriate buffer (varying distances dependent on county, wind direction, adjacent sensitive crops or other plants) suggested noncompliance was likely. This section summarizes what the Agency heard from the States and academics in regard to product usability of the 2020 label after OTT products were

used for the first time in 2021 and describes other factors that can contribute to symptomology consistent with dicamba injury.

6.1 Crop Acreage and OTT Dicamba Usage

Table 7 compares the rank order of 2021 incidents, OTT dicamba sales, and cotton and soybean acreage by state. Considering that incidents are likely underreported (Chism, et al. 2020) and that simple counts are imperfect measures of the actual number of incidents occurring, there is general agreement among incident reports, OTT dicamba sales, and soybean acres in many states.

Table 7. 2021 State Level Rankings of Incidents, OTT Dicamba Product Sales and Crop Acreages.

States	Rank by Number of Reported Incidents	Rank by OTT Dicamba Sales	Rank by Soybean Acreage	Rank by Cotton Acreage
Minnesota	1	10	3	
Iowa	2	1	2	
Arkansas	3	3	11	4
Illinois	4	2	1	
Nebraska	5	5	7	
South Dakota	6	12	8	
Kansas	7	8	9	9
Indiana	8	14	6	
Missouri	9	4	5	7
Texas	10	9	26	1
North Dakota	11	7	4	

Sources: Aggregated registrant sales data; USDA/NASS (2021)

6.2 Label Complexity Concerns

Prior to the addition of label restrictions on the 2020 label, there were concerns that the labels were complex. In 2020, the Agency removed all non-DT crops (and corresponding directions and precautions) from the labels and moved from crop growth-stage cutoffs to calendar date cutoffs. The Agency received feedback that growers understand that cotton and soybean have different cutoff dates, but do not understand why these cutoff dates are different. To many growers, it was unclear why they would be able to treat a cotton field with dicamba a month longer than an adjacent soybean field that was planted on the same day (in areas that produce both soybean and cotton). Based on the feedback received, the Agency considers the label complexity to be more of a problem with product usability concerns than a lack of comprehension of label requirements (see below).

6.3 Product Usability Concerns

Prior to the addition of label restrictions on the 2020 label, there were concerns that growers had difficulty complying with labels because there were too many application parameters that needed

to be met. Label changes made as part of the 2020 registration decision, including the change in application cutoff from a growth stage cutoff to a calendar date cutoff, may have further increased difficulty in compliance by reducing the amount of time a grower could lawfully apply OTT dicamba. Rook and Pates (2021) quoted a university extension weed scientist who noted that there are not enough hours in the day to spray the acres at the correct growth stage and follow label restrictions when considering weather and label parameters.

6.4 Use of Non-OTT Formulations of Dicamba

USDA's 2018 Soybean and 2019 Cotton Agricultural Resource Management Surveys (ARMS) also examined the timing of applications of different dicamba products to cotton and soybean. The results revealed that more than half of the acres of DT crops were treated with non-OTT products at planting or later in the season. These applications would be considered misuse because non-OTT dicamba products are not registered for applications to cotton or soybean at planting or later in the season (Chism et al., 2020). Two years prior to the first OTT-product being becoming available for use in 2017, incidents were reported due to illegal applications of old formulations of dicamba to DT cotton (Carey, 2016; BASF, 2021d) and to DT soybean in 2016 (USEPA, 2016).

In a previous section of this memo (see section *Cotton and Soybean Acreage and Dicamba Usage*), we mention that misuse involving non-OTT dicamba was estimated on small amount of soybean and cotton acres in 2020 (Kynetec, 2021). Similar data for 2021 are not yet available for 2021; however, there were anecdotal reports that non-OTT dicamba products were being used over-the-top in 2021 (Sowers, 2021; Dakotas, 2021; Unglesbee, 2021c). While this may occur, it is difficult to detect such misuse because an applicator generally would have to be caught in the act (Dakotas, 2021).

Indiana presents a unique case because Indiana has enacted state restriction making non-OTT dicamba formulations restricted use and has an earlier cutoff date for application to soybeans than the federal label (June 20 vs June 30, respectively). However, the state of Indiana had more than 130 incidents. Given the additional state restrictions, Scott (2021b) indicated that he does not think that there is usage of non-OTT products on DT crops in Indiana, which would suggest, if Scott (2021b) is correct, that the incidents would be attributed to use of the OTT dicamba products, not non-OTT products.

EPA recently imposed fines in Kansas for alleged violations with applications of OTT-dicamba products that had been cancelled as a result of the court vacatur in 2020 (USEPA, 2021c; Unglesbee, 2021e). Shortly after, the EPA ordered a pesticide distributor in Minnesota to stop selling a product that was cancelled as a result of the vacatur in June of 2020 (USEPA, 2021d).

6.5 Non-Compliance with Application Cutoff Dates

Several states reported some applications were made after the cutoff date (e.g., ND, IL, IA, AR) (Academics, 2021; Arkansas, 2021; Dakotas, 2021) based upon the date of the incident.

As mentioned earlier, in most cases, incidents reported to EPA do not specify the date; however, it was mentioned that some of the areas with the highest incident rates overlaps with areas where

soybeans are double cropped (Academics, 2021). While a representative from Illinois (a state that enacted an earlier cutoff [June 20] than the federal label [June 30]) had no direct knowledge of individuals applying after the cutoff date, they indicated that it was likely the cutoff date was not being followed based on planting dates of double cropped soybeans, and number of incidents (Academics, 2021). Additionally, Arkansas (2021) reported people spraying soybean fields with dicamba products approximately 4 weeks after the cutoff date.

A related, but different, topic around application cutoff dates that was voiced by many states that grow both cotton and soybean is the perceived inequities of having a longer application window for cotton than soybean. Several states that grow both cotton and soybean reported that soybean growers were frustrated and confused that the application window was longer for cotton than soybean (AAPCO, 2021).

6.6 Non-Compliance with Other Label Parameters

Gere (2021b) provided details on label violations for the investigations for dicamba incidents reported in South Dakota. Of the 23 incident investigations, 8 were found to have no label violations. In the other 15 cases, violations, accounting for multiple violations per incident, include: recordkeeping (11), dicamba training (7), dicamba rate (4), water rate (3), volatility reduction agent (1), operating pressure (1), unapproved tank mix (1), applications made 2 hours before sunset (1). Additionally, one company provided information about compliance with following the label during 37 investigations (BASF, 2021i). Some suspected causes of incidents were: wind was blowing towards a sensitive crops (2), incorrect nozzles (4), and tank contamination (4).

During the AAPCO (2021) dicamba meeting, the lack of or poor reporting was frequently mentioned as a violation discovered during an investigation. Recent media pieces have indicated that wind restrictions may not be followed (Rook and Pates, 2021; Unglesbee, 2021e). State agents and academics question whether farmers adhere to buffer requirements (Arkansas, 2021; Dakotas, 2021; AAPCO, 2021). However, no one had any direct knowledge that they were not being followed, and one academic indicated that even if farmers were adhering to buffer requirements, incidents would still occur (i.e., treating buffers is not the cause of the numbers of incidents reported). It was also mentioned that commercial applicators seem to be in better compliance than private applicators (Illinois, 2021; Dakotas, 2021).

6.7 Potential Other Causes of Symptomology Consistent with Dicamba Exposure

Registrants asserted that some incidents attributed to dicamba are the result of other reasons. Bayer provided information in their 6(a)(2) submission on other reasons that dicamba incidents or dicamba-like incidents were occurring (Bayer, 2021b; 2021c; 2021g). Alternative explanations for symptoms similar to those of dicamba were discussed in the media as well (Rook and Pates, 2021) and the Agency received inquiries about the other causes (Perreault, 2021). This section reviews the validity of these claims.

6.7.1 Non-OTT Dicamba Usage on Corn

The registrants claim that growers are making applications of non-OTT dicamba to corn later in the season and at higher rates than before 2017 when the OTT products were registered (Bayer, 2021o; 2021p; BASF, 2021q). Additionally, some academics and states also noted that corn use is a confounding factor of dicamba incidents, especially because these products do not have the same restrictions as OTT formulations, and the use in corn makes it much harder to track the source of damage (Academics, 2021; Illinois, 2021; Scott, 2021b).

The Agency looked at the national level of dicamba usage data on corn between 2014 and 2020 to assess this claim. Overall, there is a trend that each year farmers are applying more dicamba to corn than they did the previous year (Kynetec, 2021, Attachment C-6). Since 2014, there has been a 30% increase in corn acres treated with dicamba, and the application rate which farmers are applying dicamba to corn has nearly doubled. However, the average application rate in which farmers are applying to corn is less than half of the labeled rate for OTT dicamba in soybean and cotton.

The Agency also reviewed the registrant-submitted confidential sales data (Syngenta, 2021a; Corteva, 2021a; Bayer, 2021a; BASF, 2021a). OTT products are the most used dicamba products in some states (e.g., Arkansas). However, in some states, premixed products that include dicamba plus an active ingredient that would injure cotton or soybean are the predominant products in a state (e.g., Nebraska). Since these products would injure DT crops, the agency assumes that these applications are likely to be applications to corn but recognizes these products can lawfully be applied to other sites like, sorghum, pasture, or rights-of way. These data suggest that lawful applications of non-OTT dicamba applications to corn may play a role in some states, but not all states.

While this registrant-submitted sales data may indicate that use in corn could be a confounding source of incidents, it is only a partial picture of all dicamba sales. To have a more complete picture, the Agency would need access to dicamba sales data for all dicamba products, which it does not presently have. However, data suggest that, in some areas, corn could be a contributing source, but dicamba use in corn is not the primary reason incidents occur.

6.7.2 Other Potential Causes

Information submitted by registrants in response to 6(a)(2) letters suggested that there were other potential causes of damage that look similar to dicamba symptomology. Popular press also discussed claims that drought conditions and/or high temperatures (Rook and Pates, 2021), "poor genetics" of certain non-DT varieties (e.g., trait expression, ability to tolerate environmental conditions) (Gullickson, 2021a; 2021b), non-dicamba herbicide injury (Legleiter, 2021) or a combination of maladies contributed to the "dicamba-like" symptomology (Charles, 2021).

Drought and high temperatures were mentioned in meetings with states and academics, but most stakeholders who discussed drought indicated that the drought exacerbated dicamba injury, not that drought caused dicamba-like symptomology (AAPCO, 2021; Academics, 2021). However, Dr. Ikley, a weed specialist from North Dakota, indicated that there was "a lot of drought stress

across the state, and…in a lot of cases look like they might have dicamba problems…but we've also got a lot of plants out there that actually do have dicamba problems" (Rook and Pates, 2021). Dr. Ikley also indicated that dry conditions likely exacerbated dicamba injury (Rook and Pates, 2021).

In response to claims of *poor genetics*, Corteva and Stine Seed indicated that the symptomology was not linked to poor genetics but rather the lack of a dicamba-tolerance trait as the symptomology was seen on many different varieties and herbicide tolerant trait packages that were not tolerant to dicamba (Gullickson, 2021a and 2021b). No state or academic mentioned poor genetics as a concern related to incidents (AAPCO, 2021; Academics, 2021)

Non-dicamba herbicides usually produce a characteristic symptomology or pattern that is distinguishable from dicamba (Legleiter, 2021; Rook and Pates, 2021). Legleiter (2021) reported there were social media posts suggesting that WSSA Group 15 herbicides (e.g., s-metolachlor) was the cause of dicamba-like symptomology. While this group of herbicides can cause leaf distortion, it has symptomology resulting in a heart-shaped leaves with a crinkled appearance, not cupping (Sarangi et al., 2021). Rook and Pates (2021) reported that clopyralid, another Group 4 herbicide, was responsible for some early season damage to emerging/seedling soybean due to the residual herbicide from applications the previous growing season, likely the result of a compounding effect the drought in some regions. Sarangi et al. (2021) indicate that clopyralid damage looks similar to dicamba damage, but leaves have a strapping appearance and that problems are more common in areas of coarse soil texture. Moreover, once soybeans reached a certain growth point, clopyralid would not be the cause of injury.

While registrants suggested that these other reasons are contributing to incident reports, registrants have not provided substantive support for claims that a substantial portion of incidents could be attributed to factors other than exposure to dicamba.

6.8 Conclusion of Potential Causes of Incidents

The Agency concludes that there are many factors that could contribute to incidents. Some states indicated that growers think that they are implementing label requirements correctly and are able to adhere to the label restrictions. If most applicators are applying the product according to the label, then OTT dicamba does not stay on the field as intended after an application has been made following label requirements. Some states question the ability of the buffering agents to sufficiently reduce volatility.

However, state agents suggest that some applicators struggle with implementing the label requirements despite extensive training, and that some blatantly ignore the restrictions (AAPCO, 2021). EPA is not always capable of distinguishing incidents resulting from misuse (of non-OTT dicamba or illegal applications of OTT-formulations) from incidents occurring after lawfull use of OTT products.

Legal applications to corn also complicate the issue and the deregulation/commercialization of DT corn would further complicate investigations and enforcement. Each one of the factors reported likely contributes to dicamba related incidents, but the Agency is not able to quantify the proportion of incidents that can be attributed to any one variable.

7. STAKEHOLDER-SUGGESTED MITIGATION OPTIONS TO REDUCE INCIDENTS

State pesticide regulatory agencies and state agricultural Extension specialists from areas where dicamba incidents were common suggested mitigations that EPA may implement to reduce incidents resulting from the use of OTT dicamba and misuse of non-DT dicamba products on DT crops (AAPCO, 2021; Academics, 2021). These suggested mitigations could be generally grouped into near-term revisions of current label requirements and new longer-term mitigations. The Agency assesses these potential additional label restrictions or revisions, including: an earlier application cutoff date (AAPCO, 2021), a temperature-based cutoff (AAPCO, 2021), increased enforcement (Environmental Protection Network, 2021), requiring a tracer be added to OTT dicamba (Region 7, 2021), requiring non-OTT dicamba products to be sold as a premix with a contaminant that would injure DT cotton and soybean (Arkansas, 2021), making non-OTT dicamba restricted use products (RUP) (AAPCO, 2021; Region 7, 2021), and cancellation of some or all OTT uses (Environmental Protection Network, 2021). Suggested mitigations considered here only pertain to options within the Agency's mandates. For example, removing the DT trait from cotton and soybean seed is not within the Agency's mandates and is, therefore, not discussed in this memo.

7.1 Near Term Mitigation Options

Earlier Cutoff Date
Temperature Based Cutoff
Increased Enforcement

The cutoff dates for the currently registered OTT dicamba herbicides are June 30th for soybean and July 30th for cotton. Requiring earlier cutoff dates would preclude applications later in the season when air temperatures during and after application are likely to be high, which increases the likelihood of dicamba volatilization and off-target movement. However, requiring earlier cutoff dates would reduce the amount of time that growers have to apply OTT dicamba products and may render OTT dicamba products unusable for postemergence weed control in areas of the country with later planting dates, especially with soybean, resulting in reliance on limited other postemergence herbicide options (i.e., glufosinate) or decreased control of problematic broadleaf weeds. Furthermore, unseasonably warm temperatures may still occur before the earlier cutoff date (USEPA, 2020b).

Dicamba volatilization greatly increases with temperature and increases at a greater rate at temperatures above 80-85 degrees (USEPA, 2020b). Implementing a temperature-based application cutoff could reduce dicamba volatilization and off-target movement but would reduce the number of hours or days available to users to apply dicamba and is much less predictable than a calendar-based cutoff. The impact to users would vary by the cutoff temperature, with lower cutoff temperatures leading to a greater reduction in available application hours. Temperature-based cutoff may be less enforceable than a calendar-based

cutoff date and air temperatures days after application may influence dicamba volatility (USEPA, 2020b).

Increased enforcement would potentially deter illegal use of both OTT dicamba and non-OTT dicamba. However, state lead agencies have reported budget shortfalls and other resource constraints due to the number of dicamba-related incidents requiring them to divert or reallocate resources to investigate (Chism et al., 2020). Therefore, state lead agencies likely have limited resources to increase enforcement of dicamba related incidents.

7.2 New Longer-Term Mitigations

Requiring a Tracer
Premix non-OTT Dicamba with Contaminant That Would Injure Cotton or Soybean
Making non-OTT Dicamba Restricted Use Products

To help identify misuse of non-OTT dicamba products on DT crops, some stakeholders have suggested adding a chemical tracer premixed in OTT dicamba products that would identify particular products in the event of an incident. A chemical tracer may help an enforcement agent determine whether an OTT formulation was applied but not necessarily if a violation occurred. A chemical tracer would be effective only where dicamba drift was the cause of the incident as the tracer may not move with the dicamba during volatilization, unless specifically formulated to do so. In this case, enforcement would only be able to confirm that a farmer had used an OTT dicamba product and initiate an inspection to ensure that label parameters were followed. Additionally, the addition of a tracer would require reformulation of OTT dicamba products to include a tracer and is likely not feasible for the 2022 growing season. Growers may also face increased herbicide costs as a result of this measure.

In order to curtail misuse of non-OTT dicamba products on DT crops, as part of its registration review decision on dicamba the Agency could require that non-DT dicamba formulations be premixed with another herbicide (e.g., clopyralid, 2,4-D) that would damage the DT cotton or soybean if the non-OTT dicamba product were used. While this may discourage misuse of non-OTT dicamba on DT crops it would likely negatively affect or functionally eliminate the use of dicamba in the various other crops and use-sites where non-OTT dicamba is currently registered because the contaminant herbicide is not registered in these crops and use sites. This measure may also increase grower control costs. Furthermore, this requirement would result in changes to the formulation and labeling of the dozens of non-OTT dicamba products currently registered and is likely not logistically feasible as a mitigation.

Stakeholders suggested making non-OTT dicamba products restricted use products to reduce misuse of these products. If the Agency made non-OTT dicamba products restricted use products, this could increase production costs for growers wishing to use the products. For growers who are already certified applicators, this restriction would have limited impacts. Growers who are not certified applicators would need to become certified applicators, hire custom applicators to apply dicamba for them, or use other herbicides that are not restricted use. Hiring a custom applicator could increase application costs and growers seeking non-restricted use herbicides may face higher costs or reduced control of target weeds. Making OTT dicamba

restricted use would only reduce off-target movement due to misuse; it would not decrease any off-target movement that results from legal use of OTT dicamba.

7.3 Restriction of Some or All OTT Dicamba

7.3.1 Alternatives to OTT Dicamba

Growers currently using an OTT dicamba system in cotton and soybean could switch to using the OTT 2,4-D system. OTT 2,4-D is also a synthetic auxin that can be used over-the-top of 2,4-D-tolerant soybean and cotton and is capable of filling the role of OTT dicamba for control of glyphosate, ALS-inhibitor, and PPO-inhibitor resistant weeds like Palmer amaranth and waterhemp. Like OTT dicamba, OTT 2,4-D can be used in a tank mix with glyphosate or applied sequentially with glufosinate. EPA expects that alternative herbicides currently available would allow growers the ability to control troublesome weeds. While BEAD identified other alternative herbicide programs in the 2020 benefits assessments (Orlowski and Kells, 2020a and 2020b), increasingly widespread resistance to PPO-inhibitor herbicides means that only the OTT 2,4-D program (using glufosinate in a tank mix or sequential application) is capable of providing two efficacious modes of action to control problematic weeds like Palmer amaranth and waterhemp (Heap, 2021; Mansfield, 2021; University of Arkansas, 2021).

In the short term, growers may be unable to acquire 2,4-D tolerant seed and OTT 2,4-D herbicide as an alternative to the dicamba system. Seed manufacturers may not have time to plant, grow, and distribute 2,4-D tolerant seed for the 2022 cotton and soybean growing seasons, and chemical manufacturers may not have time to produce and distribute sufficient OTT 2,4-D herbicide. In the short term, growers who are unable to acquire OTT 2,4-D due to supply constraints will likely face increased control costs and may suffer yield losses due to worse control of problematic broadleaf weeds. These short-term impacts could be substantial if increased restrictions on OTT dicamba uses are adopted after growers have made their seed selections, which typically occurs months before planting.

7.3.2 Impact of Restriction on OTT Dicamba in Soybean

Registrants of OTT dicamba products, state pesticide regulatory agencies, and state Extension weed control specialists have suggested cancellation or significant curtailment of OTT dicamba use in soybean but not cotton, as cotton growing states have reported limited dicamba incidents. Based on BEAD's assessments (Orlowski and Kells, 2020a & 2020b), the per-acre benefits of OTT dicamba are similar in both cotton and soybean, if the 2,4-D-based system is available. The per-acre benefits of OTT dicamba are also similar across states. The Agency assessed how the restriction of OTT dicamba use in soybean while retaining OTT use in cotton may affect incidents in states that grow only/predominantly soybean (Soybean States), states that grow primarily cotton (Cotton States), and states that have significant acreage of both cotton and soybean (Soybean/Cotton States).

7.3.2.1 Impact of Soybean Restriction in Soybean States

Of the nine states with the highest numbers of dicamba incidents in 2021 (Minnesota, Iowa, Arkansas, Illinois, Nebraska, South Dakota, Kansas, Indiana, Missouri), only Arkansas, Kansas,

and Missouri have significant cotton acres indicating that predominantly soybean producing states had the highest levels of reported dicamba damage. Therefore, restriction against OTT dicamba use in soybean would likely result in reduced dicamba incidents in states with high soybean production in the future. However, incidents may still occur, if dicamba applied to other crops (e.g., corn) moves to soybean fields, or if soybean growers continue cultivating DT soybean varieties and illegally use dicamba products despite the restriction.

7.3.2.2 Impact of Soybean Restriction in Cotton States

In many cotton producing states, like Texas and Georgia, the acreage of cotton far exceeds the acreage of soybean. For example, in 2020 Texas produced 3.2 million acres of cotton but only 110,000 acres of soybean. As very few soybean are produced in these states, state restriction against OTT dicamba in soybean is expected to have limited impact on producers. Furthermore, as these states have historically reported limited dicamba incidents, The Agency expects reported incidents to remain limited in these states, but still potentially occur at the current levels.

7.3.2.3 Impact of Soybean Restriction in Soybean/Cotton States

There are states that have significant acreage of both soybean and cotton with crop producers in these states growing both crops side by side. These states include mid-South states like Tennessee, Arkansas, Mississippi, and Louisiana as well as southeastern states like North Carolina and Alabama.

In these states, the restriction of OTT dicamba on soybean but not cotton could have substantial negative impacts to soybean producers. As noted above, the primary alternative to OTT dicamba tolerant (DT) soybean is0 the 2,4-D tolerant system. If OTT dicamba use on soybean is restricted or substantially curtailed, soybean growers would be forced to switch to the 2,4-D tolerant soybean in order to utilize an OTT synthetic auxin herbicide (WSSA Group 4) to control problematic broadleaf weeds, like Palmer amaranth. However, as the majority of the cotton market is dicamba-tolerant (Kynetec, 2021), growers would likely continue to plant DT cotton and apply OTT dicamba. Research has shown that non-DT soybean are highly sensitive to dicamba. Therefore, restriction against OTT dicamba in soybean, but not in cotton could force growers to plant highly susceptible soybean next to DT cotton receiving multiple postemergence dicamba applications. This scenario could greatly increase the risk of off-target damage to soybean. To avoid this risk, soybean growers may continue to plant DT soybean, which could present a temptation to misuse dicamba products.

7.3.3 Impact of State-Specific Restrictions on OTT Dicamba

Stakeholders also suggested cancellation or substantial curtailment of OTT dicamba use in states reporting high numbers of dicamba incidents irrelevant of crop grown in the state. Based on BEAD's assessments (Orlowski and Kells, 2020a & 2020b) and new information on PPO-resistance, in the absence of dicamba, the Agency expects that growers of both cotton and soybean will switch to using OTT-2,4-D, regardless of their geographic location. State-specific restrictions could reduce incidents in states imposing the restrictions. Incidents may occur in

areas with restrictions if growers continue cultivating DT crops and illegally use dicamba in them despite the restriction.

8. CONCLUSIONS

Acreage, Usage, and Sales

- Nationally, about three-quarters of the cotton acreage and about two-thirds of the soybean acreage are planted with DT seed.
- About half of DT cotton and soybean were treated one or more times with a dicamba product in 2020 (2021 data not yet available). This may be due to defensive planting to protect against off-target movement, selection of the variety based on genetics/yield potential and not for the herbicide trait, or illegal use of dicamba products not registered for use on DT crops (non-OTT dicamba products).
- In a pesticide usage survey, misuse of non-OTT dicamba products was reported to occur on a small amount of DT soybean and cotton acres.
- Usage of non-OTT dicamba products on cotton and soybean has increased significantly since the registration of the OTT dicamba products. This may be due to misuse or to increased use of dicamba preemergence application.

Incidents Reported to the Agency

- Dicamba incidents continue at high numbers relative to recent past. They occur over a large geographic range and damage occurs on a wide range of plant species. There is no change from previous years in the number, severity, or geographic extent of incidents. In 2020, EPA estimated that dicamba incidents were underreported by a factor of 25; no evidence suggest that underreporting has changed.
  - The 2021 summary of incidents showed 3,461 incidents and more than 1 million acres of soybean affected as of November 17, 2021. In 2019, the most recent summary of incidents, there were 3,300 incidents; there was no reports of acres damaged.
    - 9 States reported a high number of incidents (more than 100): Arkansas, Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, South Dakota.
    - 14 States reported a relatively low number of incidents (less than 10): Delaware, Florida, Georgia, Louisiana, Maryland, Michigan, Mississippi, New Jersey, New York, North and South Carolina, Oklahoma, Pennsylvania, Virginia. None of these states rank high in terms of cotton or soybean acres or sale of OTT dicamba.
    - 6 States reported an intermediate number of incidents (more than 10, less than 100): Kentucky, North Dakota, Ohio, Tennessee, Texas, Wisconsin.
    - 5 States were absent from the AAPCO meeting and/or did not have incident reports from registrants: Alabama, Arizona, West Virginia, New Mexico, and Colorado.
  - There were 63 counties that have endangered species or critical habitat with at least one reported dicamba incident and total of 290 incidents across those counties.
  - Most incidents are to non-DT soybean, but there were also reports to other crops and vegetation. Most notable: 160,000A wildlife refuge in AR.
    - Non-soybean crops with reported incidents include: sugarbeet, rice, sweet potato, peanut, grapes/vineyards, cucurbits, vegetables, fruit trees, caneberries, cotton, tree nurseries, and timber.
    - Additional incident reports of vegetation around homes and natural areas include: landscape plants, home gardens, non-fruit trees, and native plant species.

    - Academics, registrants, and seed producers have indicated damage to research/breeding/seed production plots and in some cases, damage has occurred for multiple years.
- Damage has been documented on diverse properties including university research farms, cemeteries, churchyards, state fish and game properties, state natural areas, city parks, state and national wildlife refuges, state parks, several public spaces, and many county and state roads. Plant species damaged in these public/natural areas include over 20 species of trees and shrubs and many annual and perennial plant species. Sycamore was the most frequently reported type of tree showing damage.
- State agencies have had a substantial burden to field incident calls and follow up with site inspections to impacted members of the public. States view the label as overly complicated.
- Social impacts continue and range from fractured relationships amongst neighbors and threats of violence.

Weed Resistance to Dicamba

- State Extension weed control specialists have confirmed resistance to dicamba in both Palmer amaranth and waterhemp populations, and that resistance is spreading. As dicamba resistance spreads, the benefits of the DT-crop system declines.

Mitigation Measures Suggested by Stakeholders

- Stakeholders suggested mitigations intended to reduce off-target movement or misuse of OTT dicamba. Some suggestions may reduce off-target movement or misuse but EPA has not conducted a full assessment. Suggested mitigations may severely restrict user's ability to use dicamba for OTT weed control or are not feasible to be implemented in the near term.
- If restriction or significant curtailment of OTT dicamba is determined to be needed, state-level restriction may be more effective at reducing incidents than restriction of OTT dicamba in soybean but not cotton.

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ATTACHMENT A.

Table A-1. 2019, 2020, and 2021 Cotton Acreage by State (USDA/NASS, 2021) and Year-over-Year Changes.

State	2019 Acres Planted	2020 Acres Planted	2021 Acres Planted	2019-2020 Year-Over-Year Change	2020-2021 Year-Over-Year Change
Alabama	540,000	450,000	405,000	-20%	-11%
Arizona	167,500	131,500	129,000	-27%	-2%
Arkansas	620,000	525,000	475,000	-18%	-11%
California	258,000	181,000	111,000	-43%	-63%
Florida	112,000	98,000	91,000	-14%	-8%
Georgia	1,400,000	1,190,000	1,170,000	-18%	-2%
Kansas	175,000	195,000	110,000	10%	-77%
Louisiana	280,000	170,000	110,000	-65%	-55%
Mississippi	710,000	530,000	445,000	-34%	-19%
Missouri	380,000	295,000	315,000	-29%	6%
New Mexico	68,200	53,500	48,500	-27%	-10%
North Carolina	510,000	360,000	370,000	-42%	3%
Oklahoma	640,000	525,000	485,000	-22%	-8%
South Carolina	300,000	190,000	210,000	-58%	10%
Tennessee	410,000	280,000	275,000	-46%	-2%
Texas	7,062,000	6,838,000	6,367,000	-3%	-7%
Virginia	103,000	80,000	74,000	-29%	-8%
US Total*	13,735,700	12,092,000	11,190,500	-14%	-8%

* Change in national acreage between 2019 and 2021 is -23 percent.

Table A-2. 2019, 2020, and 2021 Soybean Acreage by State (USDA/NASS, 2021) and Year-over-Year Changes.

State	2019 Acres Planted	2020 Acres Planted	2021 Acres Planted	2019-2020 Year-Over-Year Change	2020-2021 Year-Over-Year Change
Alabama	265,000	280,000	310,000	5%	10%
Arkansas	2,650,000	2,820,000	3,050,000	6%	8%
Delaware	155,000	150,000	155,000	-3%	3%
Georgia	100,000	100,000	140,000	0%	29%
Illinois	9,950,000	10,300,000	10,600,000	3%	3%
Indiana	5,400,000	5,750,000	5,700,000	6%	-1%
Iowa	9,200,000	9,450,000	10,100,000	3%	6%
Kansas	4,550,000	4,800,000	4,850,000	5%	1%
Kentucky	1,700,000	1,850,000	1,800,000	8%	-3%
Louisiana	890,000	1,050,000	1,080,000	15%	3%
Maryland	480,000	485,000	490,000	1%	1%
Michigan	1,760,000	2,200,000	2,150,000	20%	-2%
Minnesota	6,850,000	7,450,000	7,700,000	8%	3%
Mississippi	1,660,000	2,090,000	2,230,000	21%	6%
Missouri	5,100,000	5,850,000	5,700,000	13%	-3%
Nebraska	4,900,000	5,200,000	5,600,000	6%	7%
New Jersey	95,000	94,000	100,000	-1%	6%
New York	235,000	315,000	325,000	25%	3%
North Carolina	1,540,000	1,600,000	1,650,000	4%	3%
North Dakota	5,600,000	5,750,000	7,300,000	3%	21%
Ohio	4,300,000	4,950,000	4,850,000	13%	-2%
Oklahoma	465,000	560,000	575,000	17%	3%
Pennsylvania	620,000	640,000	580,000	3%	-10%
South Carolina	335,000	310,000	390,000	-8%	21%
South Dakota	3,500,000	4,950,000	5,500,000	29%	10%
Tennessee	1,400,000	1,650,000	1,500,000	15%	-10%
Texas	80,000	120,000	110,000	33%	-9%
Virginia	570,000	570,000	600,000	0%	5%
Wisconsin	1,750,000	2,020,000	2,100,000	13%	4%
US Total*	76,100,000	83,354,000	87,235,000	9%	4%

* Change in national acreage between 2019 and 2021 is +13 percent.

ATTACHMENT B. CONFIDENTIAL AND PROPRIETARY DATA

This attachment contains confidential business data and estimates based on proprietary pesticide usage survey. These data are protected and must not be released outside the Office of Pesticide Programs.

Table B-1. Comparison of Cotton and Soybean Acreage based on Data Source.

Table B-2. Cotton Acreage Surveyed by Trait and Percent DT Adoption (Kynetec, 2021).

Table B-3. Soybean Acreage Surveyed by Trait and Percent DT Adoption (Kynetec 2021).

Table B-4. Use of Dicamba Product Type on DT and Non-DT Traited Cotton (Kynetec 2021).

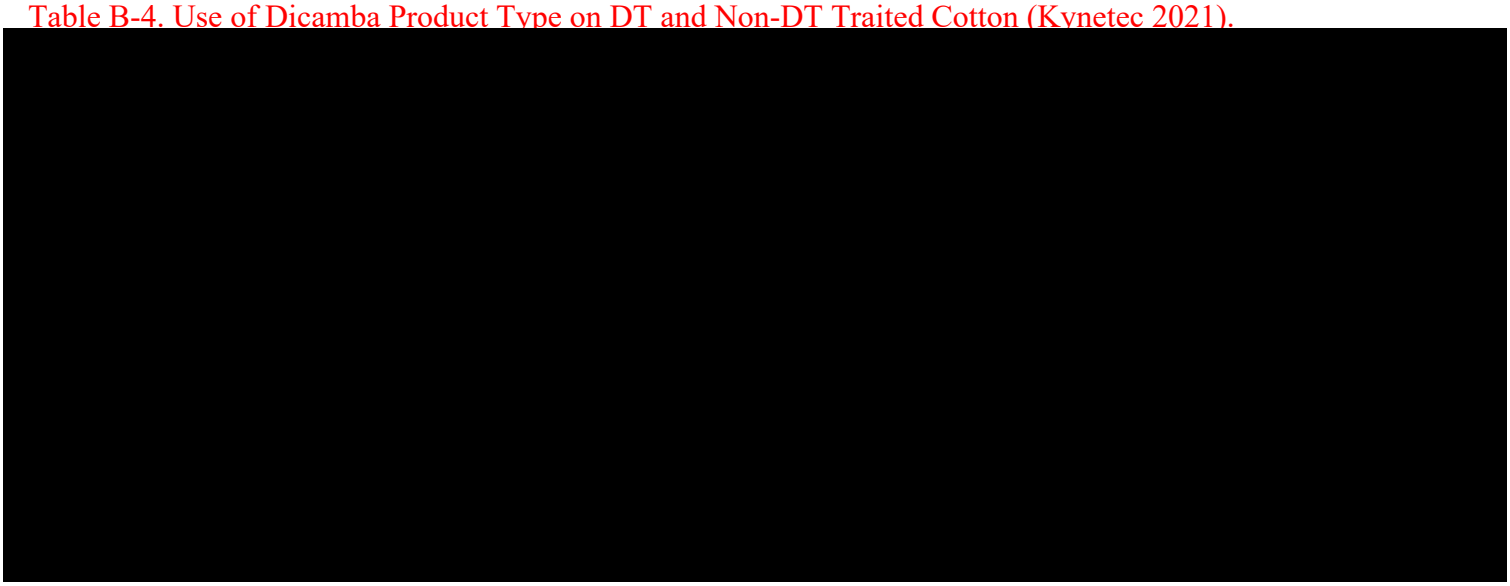


Table B-5. Use of Dicamba Product Types on DT and Non-DT Traited Soybean (Kynetec 2021).

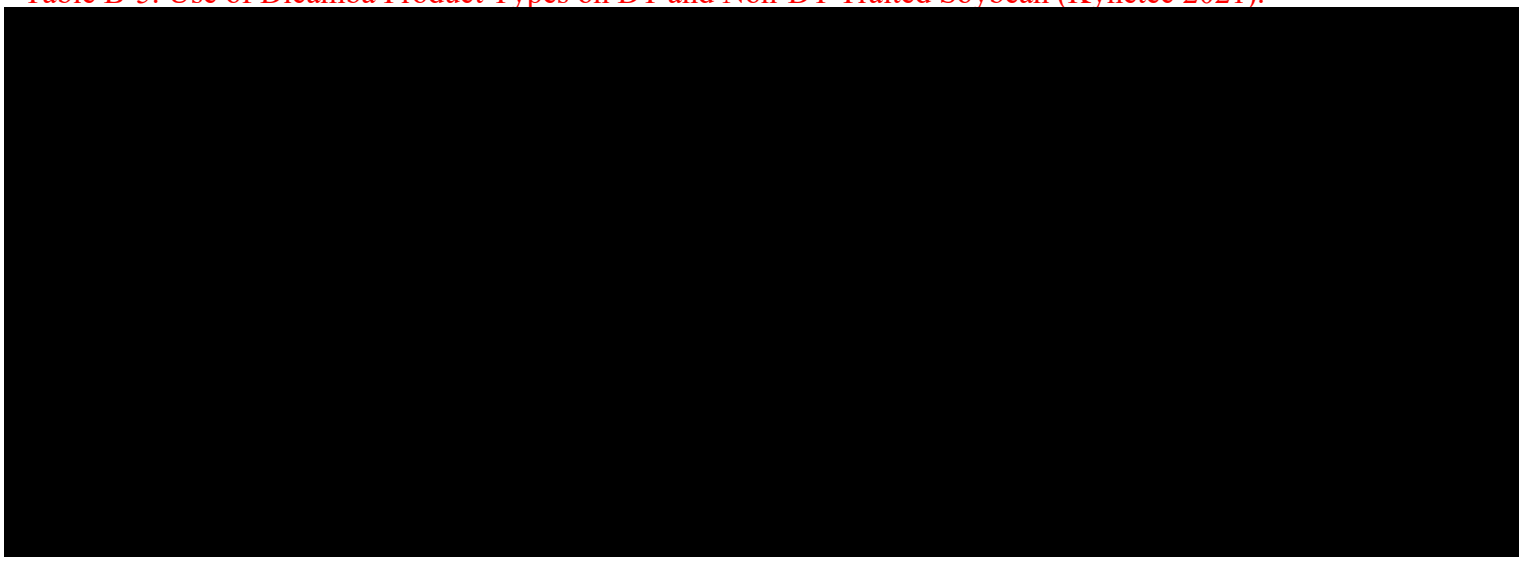


Table B-6. Cotton Acres Treated with Dicamba Products by Seed Trait and Application Timing (Kynetec, 2021). The postemergence use of non-OTT dicamba products on DT cotton is prohibited (**Bolded**).

Table B-7. Soybean Acres Treated with Dicamba Products by Seed Trait and Application Timing (Kynetec, 2021). The postemergence use of non-OTT dicamba products on DT soybean is prohibited (**Bolded**).

Table B-8. Cotton Acres Treated with Non-OTT Dicamba Products* Over Time (Kynetec 2021).

Table B-9. Soybean Acres Treated with Non-OTT Dicamba Products Over Time (Kynetec 2021).

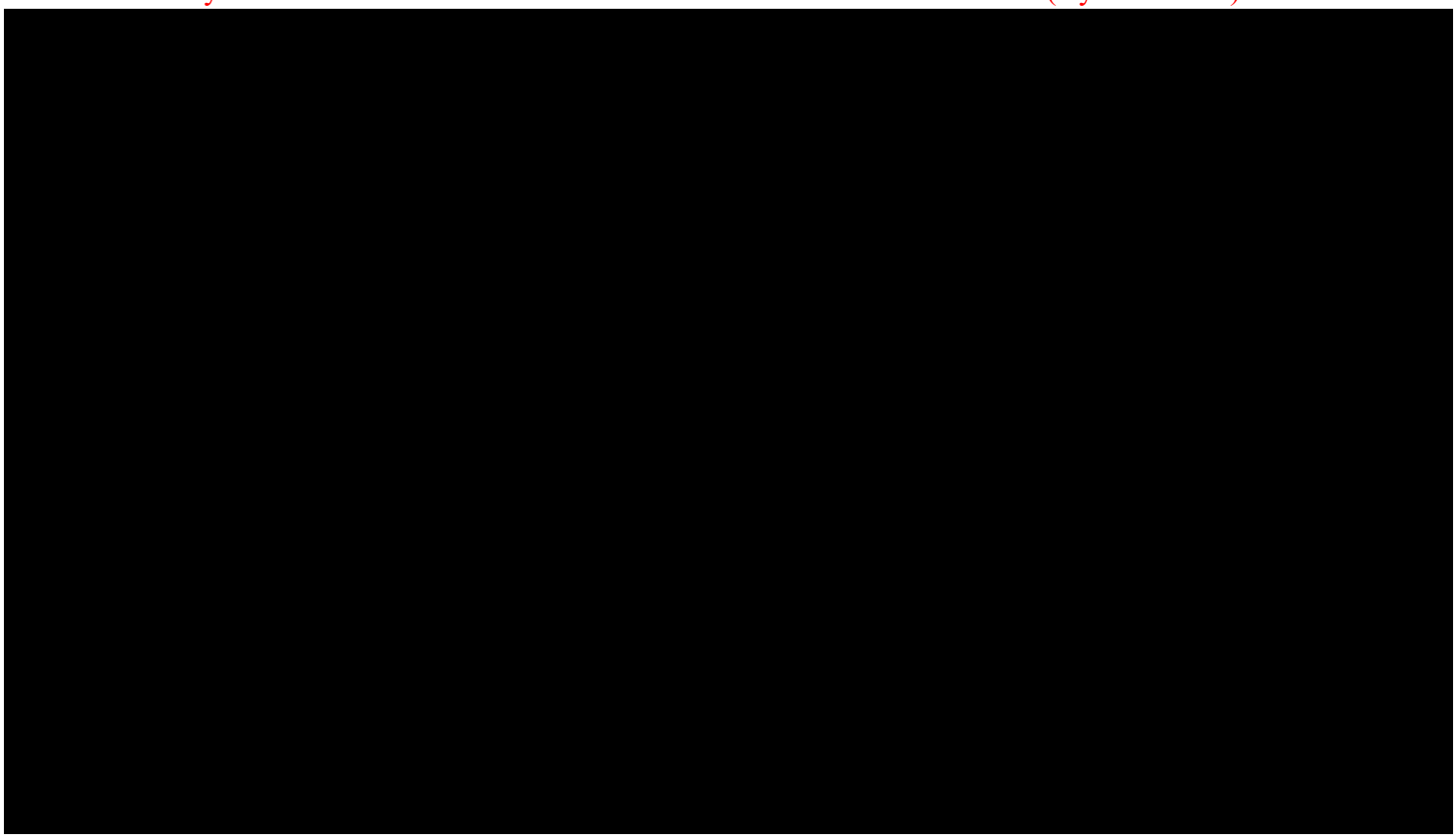


Table B-10. Percent of 2020 and 2021 Registrant Sales of OTT Dicamba Products* (lbs. a. e.) by State**. Based on sales data provided by each registrant. **Bolded** values indicate the market leader in each state. These data are Confidential Business Information

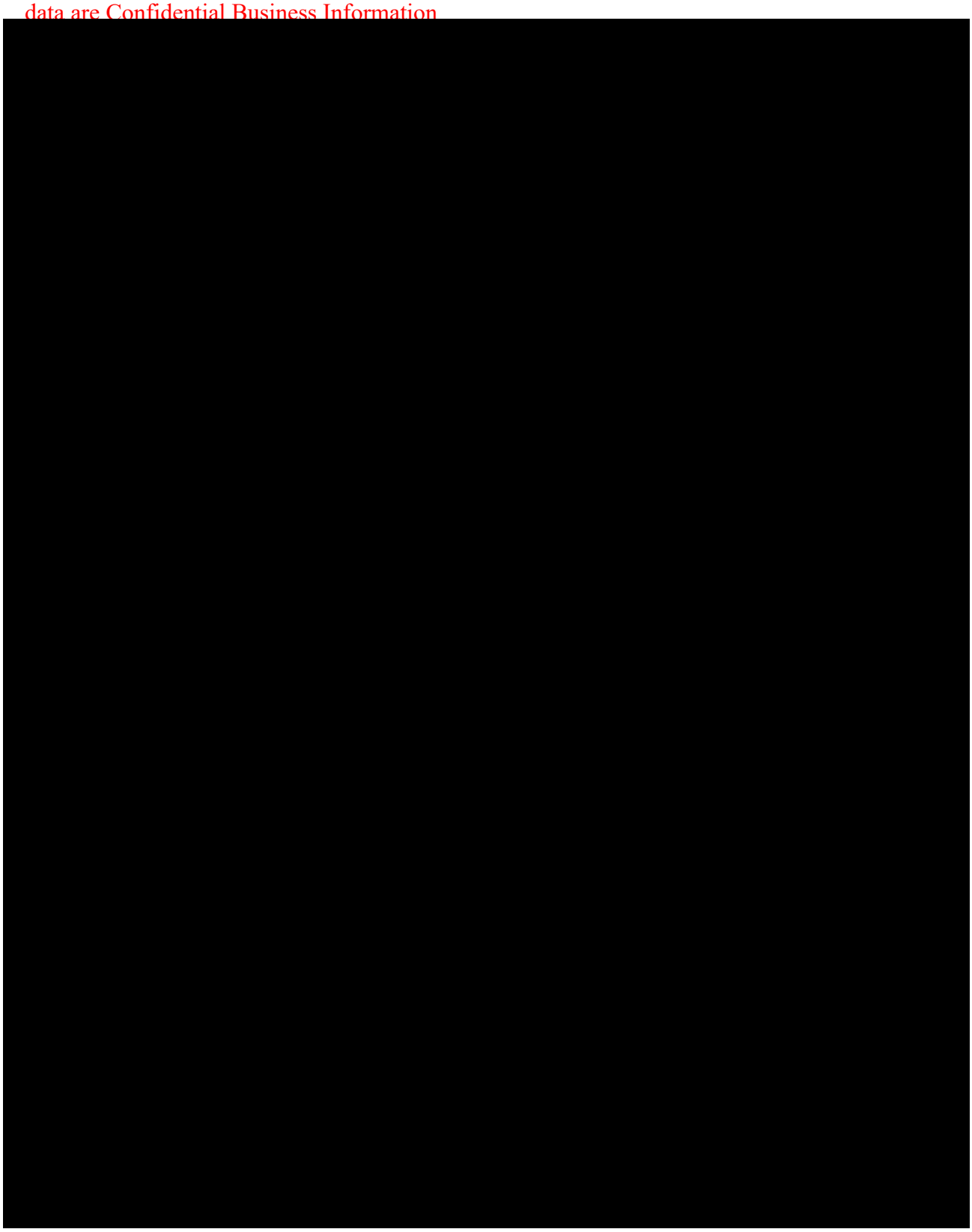
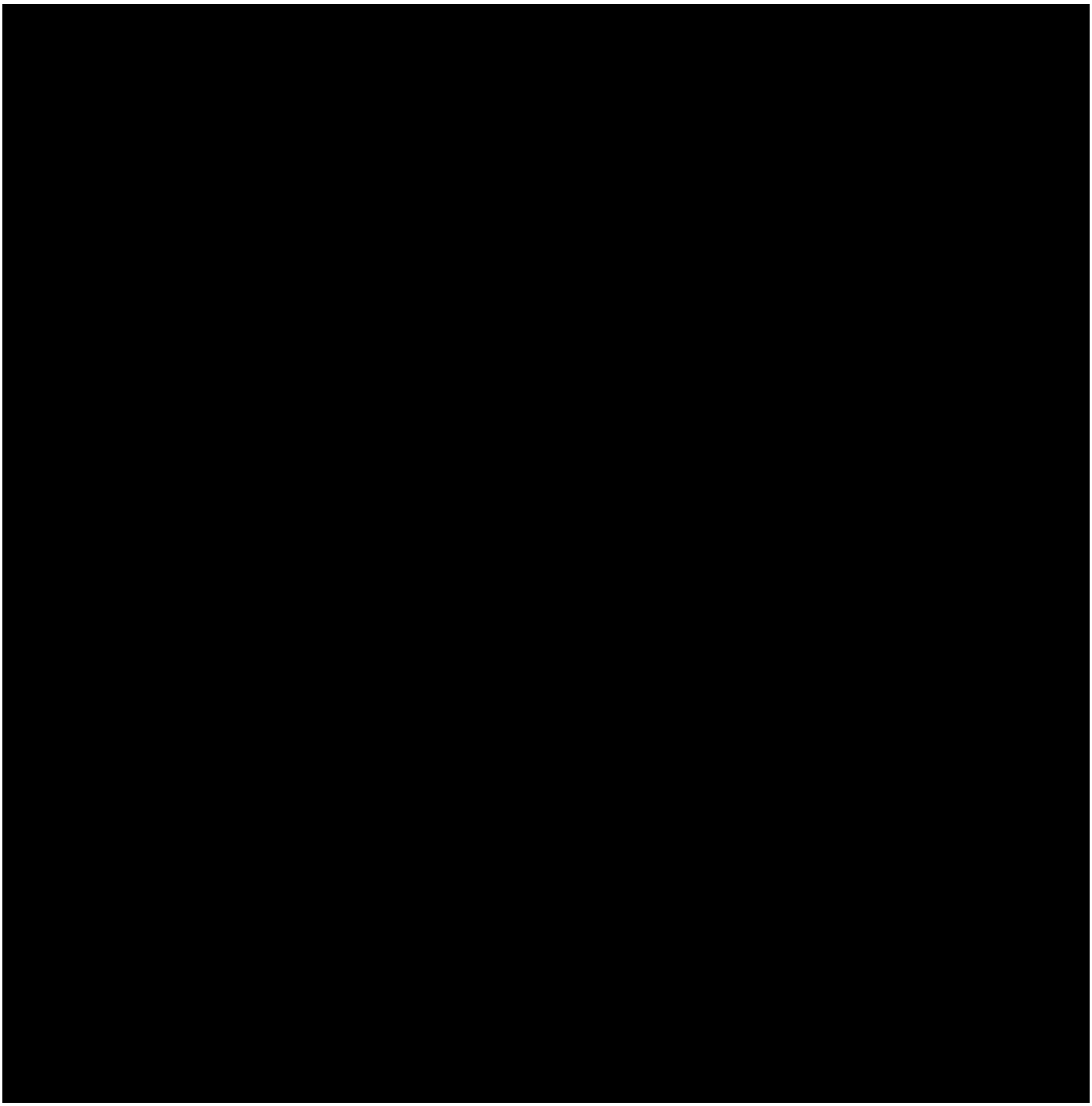


Table B-11. Comparison of Dicamba Tolerant Cotton and Soybean Acres and Acres Potentially Treated with an OTT Product. Based on Registrant Sales Data and Kynetec (2021).

ATTACHMENT C. CONFIDENTIAL AND PROPRIETARY DATA

This attachment contains confidential business data and proprietary pesticide usage survey data. These data are protected and should not be released outside the Office of Pesticide Programs.

C-1. New Information on the Status of Dicamba-Resistant Weeds

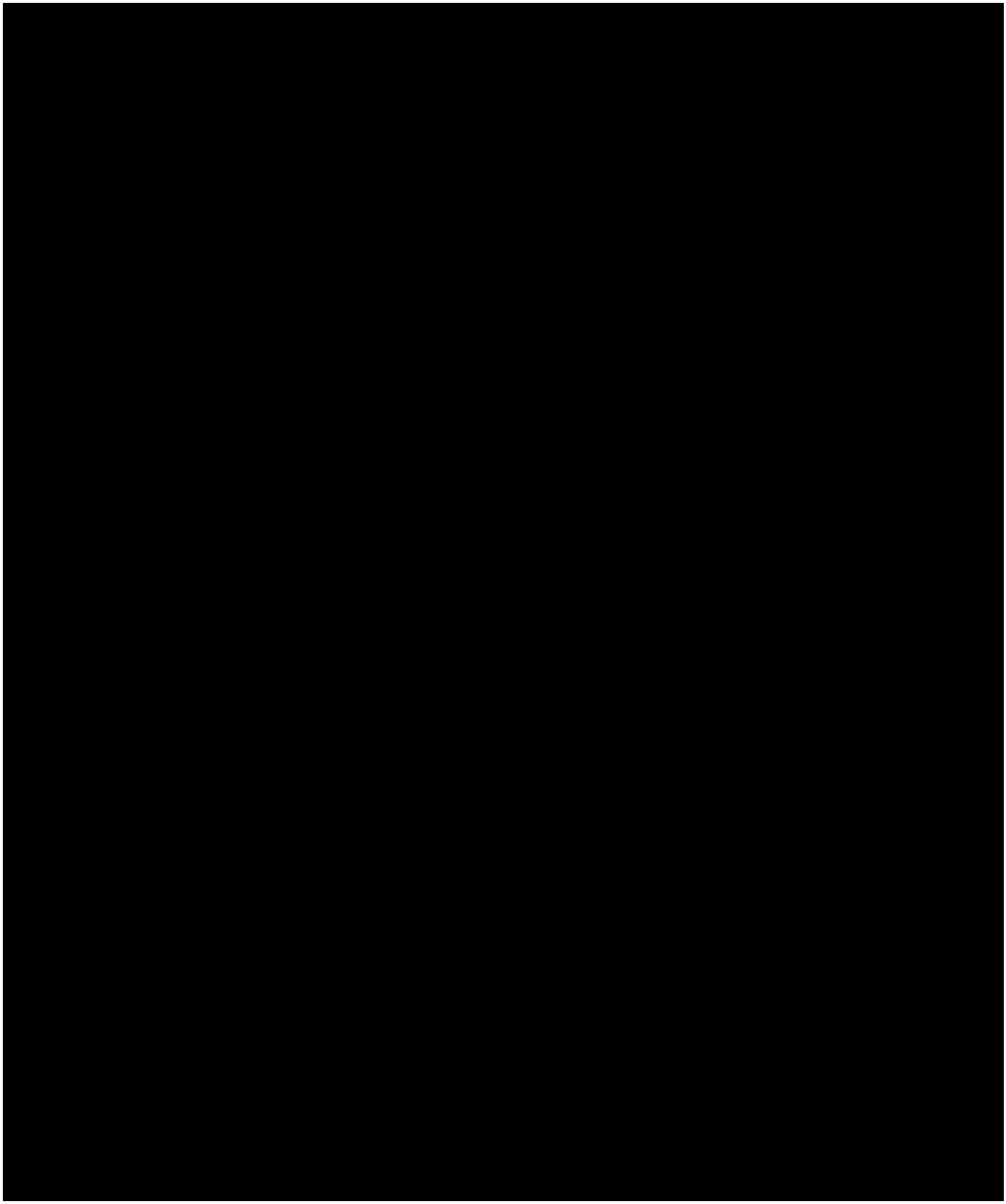


C.2 Description of Incidents

Table C-1. Summary of Incidents Reported by State, Not Crop Specific*, to the Agency through the States and FIFRA Section 6(a)(2) Reporting for 2021, as of 17 Nov 2021.

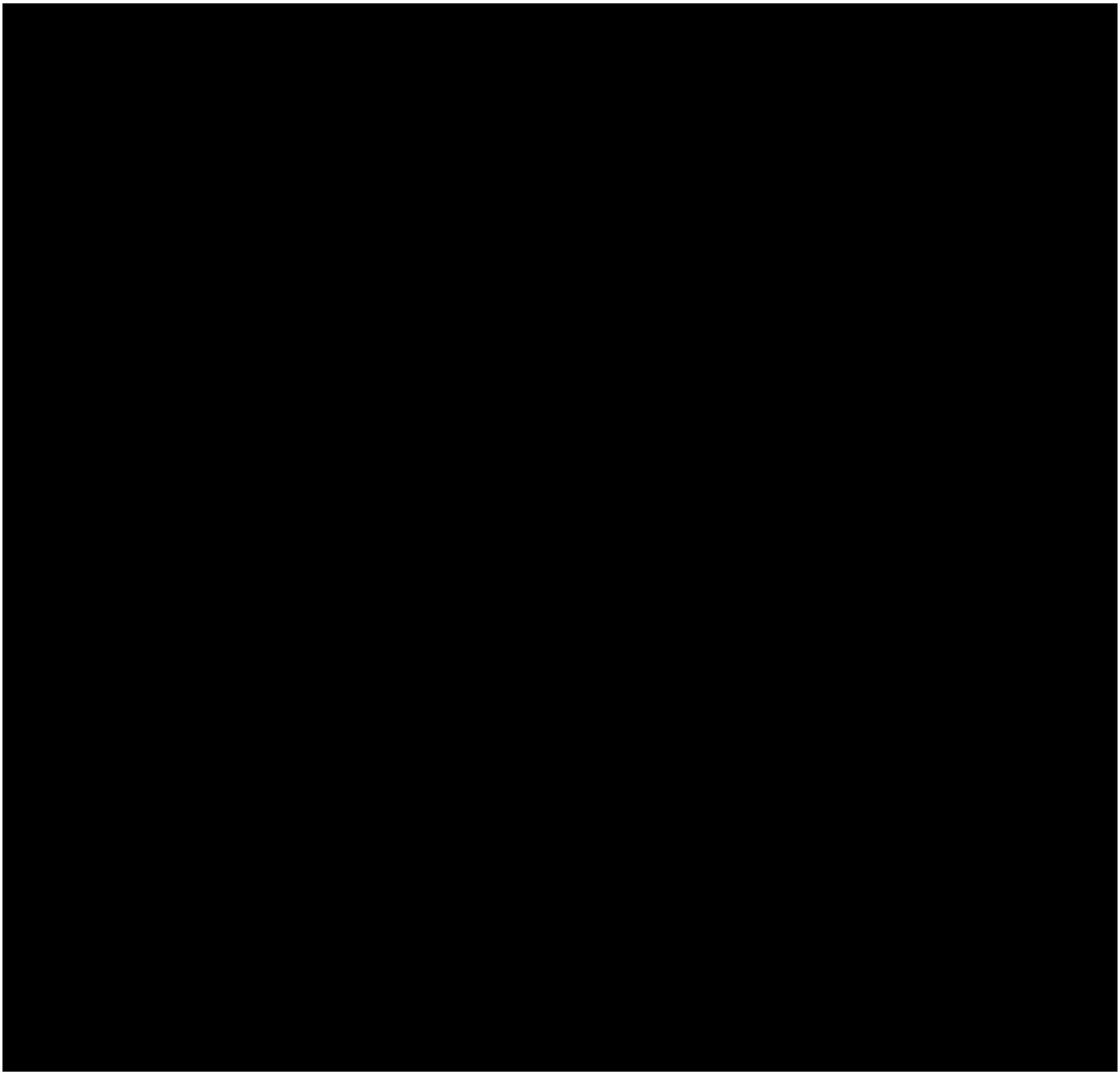
[redacted]

C-3. Non-Soybean Crops from Registrants and 6(a)(2) Letters



C.4. Research/Breeding/Seed Production Plots

C.5. Underreporting



[redacted]

C-6. Non-OTT Dicamba Use on Corn

[redacted]