Agricultural Experiment Station
Cooperative Extension

37860 West Smith-Enke Road
Maricopa, Arizona 85138
(520) 568-2273
FAX: (520) 568-2556

Sulfoxaflor Uses, Utility and Benefits in Arizona Agriculture

Prepared by Peter C. Ellsworth, Al Fournier & Wayne Dixon
Comments submitted by the Arizona Pest Management Center
University of Arizona

EPA Docket ID: EPA-HQ-OPP-2010-0889

Summary
As concluded in our previous comment to this docket in 2013, sulfoxaflor is a key, selective compound with detailed and rigorous research evaluations in Arizona cotton and vegetables showing its safe and effective use in Arizona agriculture. We now conclude that EPA's actions to grant a new Section 3 registration for the crops under consideration are justified by the large and varied benefits of sulfoxaflor use in Arizona agriculture and by the many risks that it helps our growers minimize. It is therefore decidedly in the public interest. We also conclude that these benefits extend beyond the currently considered crops and recommend expansion of the current action to cotton, cucurbits and other crops that were registered previously under the original sulfoxaflor Section 3. Bee safety has been established through rigorous Agency review and through the nearly 300,000 acres that were sprayed with sulfoxaflor (2013–2015) without incident in Arizona. Sulfoxaflor is a tool that will uniquely control both Lygus bugs and whiteflies without harming beneficials in cotton. This is the only compound available to growers with this specific spectrum of activity and utility. Registration in cotton is therefore paramount. We further conclude that there is no scientifically defensible basis for establishment of "on-field" buffers that needlessly waste natural resources, contribute to pest harborage and additional sprays along with all the concomitant environmental risks of additional exposures and contributions to pollution. There is also no basis for precluding the mixing of insect chemical control agents with sulfoxaflor or for any other insecticide. Sulfoxaflor has been used successfully in Arizona with more than 80 other active ingredients to accomplish efficient and effective pest control. Our growers carefully consider their needs and select those compounds and their combination that best fulfill their pest management, plant health, and production goals. About 3/4ths of all sulfoxaflor prescriptions for use between 2013–2015 in Arizona were tank-mixed applications. Tank mix compatibility considerations are the responsibility of the manufacturer and supporting institutions (e.g., Cooperative Extension).

As a prelude to the comments herein, we respectfully request that EPA incorporate our previous submission to this docket for addressing some of EPA's new request for public comment regarding their proposal for a Section 3 registration of sulfoxaflor on some crops. That comment is identified as EPA-HQ-OPP-2010-0889-0380. In that comment, we identified the extensive body of research on this compound in Arizona cotton and its importance to the continued stability and success of that industry's Integrated Pest Management program. A key point summary is provided here abstracted from the previous comment:

1. **Given that losses of >50% are possible, sulfoxaflor's ability to protect cotton from Lygus-related yield loss will save our growers millions of dollars.**
2. **Sulfoxaflor would provide a key alternative to flonicamid (and acephate or oxamyl) that would help stabilize and sustain our resistance management programs for Lygus.**
3. Arizona is almost unique worldwide in this distinct combination of these two cotton pests (Lygus bugs & *Bemisia* whiteflies), and **sulfoxaflor in uniquely positioned to help us protect our crops against both of these pests simultaneously, potentially reducing the number of total sprays required for economic production.**
4. As a distinct IRAC subclass (4C), different from the neonicotinoids and where cross-resistance studies in whiteflies and aphids have shown great safety, **we believe that sulfoxaflor can play an important role in relieving selection pressure from the current products we depend on for whitefly (Intruder and Knack) and Lygus (Carbine) control.**
5. The prospects for safe and effective use of Transform (sulfoxaflor) in cotton are great…; [Our results for Transform] show great safety for our key natural enemies that we depend on for biological control…. **This makes Transform ideally suited for our cotton IPM system where we have progressively introduced highly selective and effective technologies for the control of our key insect pests, while conserving the natural enemy fauna present in the field and available for suppression of all cotton arthropod pests.**

We also request that EPA Docket ID EPA-HQ-OPP-2010-0889-0007 as well as the newly submitted comments from Dr. John Palumbo of the University of Arizona, member of the Arizona Pest Management Center, be incorporated here for perspective on the specific benefits of sulfoxaflor to the vegetable / melon industries.

I serve as both Director of the Arizona Pest Management Center and State IPM Coordinator at the University of Arizona, where I have been an IPM Specialist / Professor for the past 25 years. My role requires that I research, develop, and extend integrated pest management programs that protect citizens from economic, environmental and human health risks associated with pests or pest management tactics. My individual research and Extension thrusts have been in the development of sustainable IPM programs for Arizona cotton growers, where we have made major gains over the last 20 years. Since the introduction of key technologies and IPM programs to support their use in 1996, we estimate cotton growers in our state have cumulatively saved over $451 million (Fig. 1). These gains are related to major reductions in the number and amounts of insecticides used as well as in the deployment of selective technologies that address target pest needs without harm to non-target arthropod beneficials (Fig. 2; Naranjo & Ellsworth, 2009a,b). Central to this has been the replacement of numerous applications of broadly toxic insecticides with fewer applications of very strategic and selective, reduced-risk insecticides like sulfoxaflor. The resulting gains in stability and sustainability of our system due to improved natural enemy conservation are difficult to measure but very significant and important to the future of this industry. Upland cotton in Arizona produces per acre yields larger than that of any other state or region of the world, while contributing over $700M annually to our state's economy. Major gains have also been made in IPM for melons and leafy vegetables in Arizona, where we produce >90% of the fresh lettuce consumed in the U.S. during the winter months.

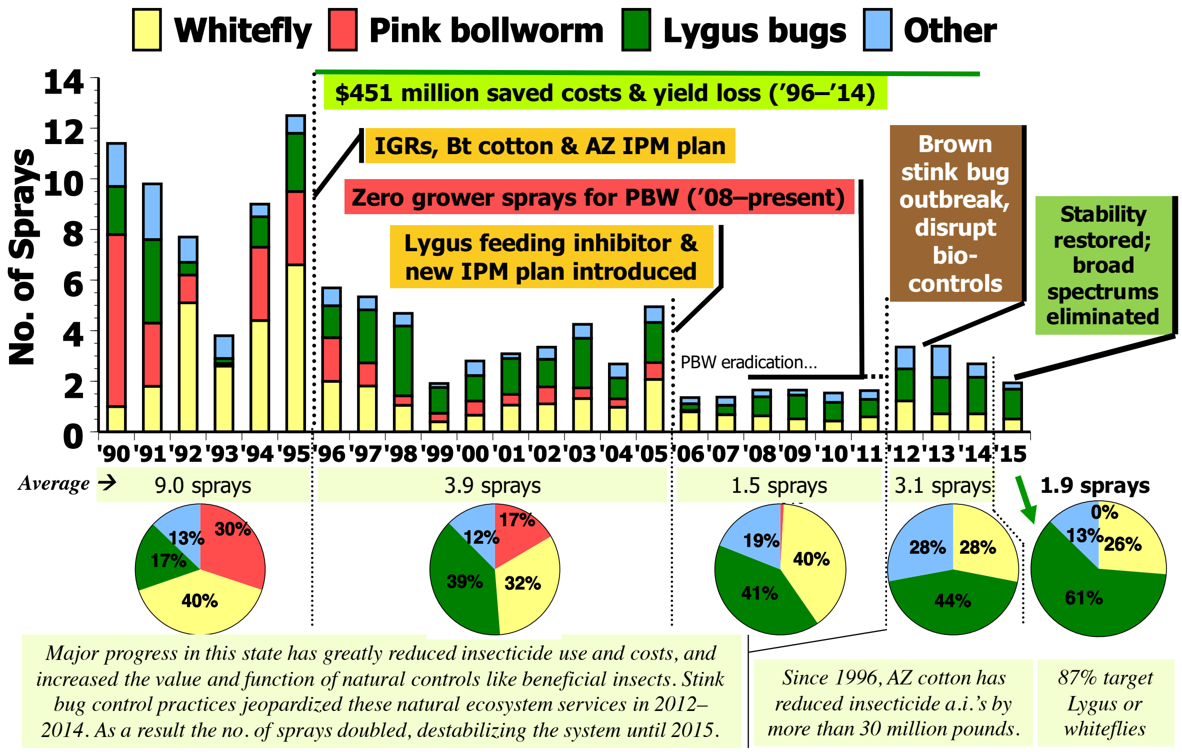

Figure 1. Statewide average cotton insecticide use patterns in Arizona, 1990–2015, by key pest. Estimated cumulative savings in control costs & yield in excess of $452M (1996–2014). Stability recently restored after growers curtailed broad spectrum sprays for stink bugs. But Lygus and whiteflies remain main targeted key pests of our system, uniquely addressed by sulfoxaflor's (Transform) spectrum of activity. No bee or pollinator incidents since Transform was registered in 2013 and used on nearly 300,000 cotton acres since. *Source: Cotton Insect Losses Database, Arizona Pest Management Center, Ellsworth et al. 2012; Figure adapted from Naranjo & Ellsworth, 2010.*

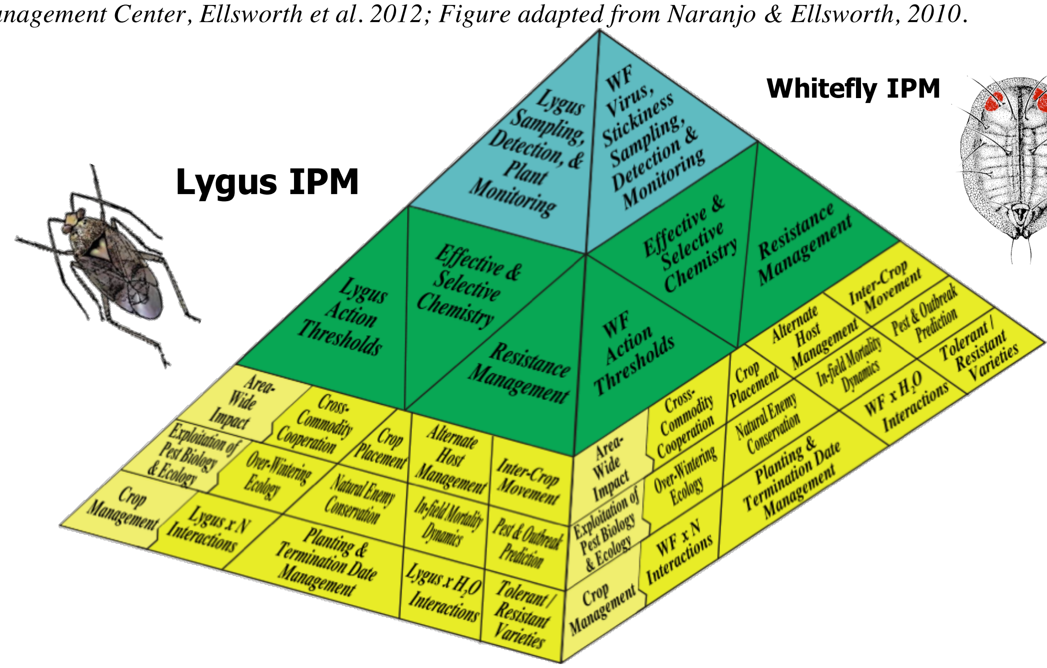

Figure 2. Cotton IPM system targets 2-key pests, minimizing risks of secondary pests with the help of effective and selective chemistries that conserve natural enemies and ecosystem services that contribute to pest control. Sulfoxaflor

(Transform), flonicamid, pyriproxyfen, buprofezin, and spiromesifen each have been extensively tested and proven safe to non-target organisms in the Arizona cotton system (Ellsworth & Naranjo, unpubl. data).

EPA is seeking comments on 3 items at this time, which we will address in order.

1. Comment on the proposed registration of sulfoxaflor

The cancellation of sulfoxaflor creates new economic, environmental and human health risks for our growers in Arizona by forcing them to consider riskier alternatives to accomplish their pest management goals. This new, proposed registration of sulfoxaflor after careful scientific review by the EPA is indeed welcomed by all those crops impacted. **This restores an important use pattern that contributes to IPM by reducing economic risks through more efficient pest control, environmental hazards by reducing reliance on organophosphate and carbamates alternatives that are acutely toxic to bees, other pollinators and other non-target invertebrates and vertebrates, and protects human health by limiting exposure of workers, handlers and others in agriculture who must handle the broadly toxic alternatives that sulfoxafor replaces.**

Unfortunately, the proposed registration fails to address the needs of all growers and restore these other important use patterns that have been proven safe and effective under a previous Section 3 registration. Our previous comment, docket ID EPA-HQ-OPP-2010-0889-0380, amply shows the rationale, justification and success of the previous use pattern, all without a single pollinator incident reported. That's 3 years of commercial use on hundreds of thousands of acres in Arizona where there is a significant honeybee industry and crops requiring pollination services with no incidents associated with that use pattern. Unfortunately, misguided litigation in the court system has led to some lapses in logic and scientific process by EPA in omitting these other important use patterns in its currently proposed action.

There is a false trichotomy established by EPA in their analyses of this Section 3 by categorizing crops as being:

Not Bee Attractive
Harvest Before Bloom
Bee Attractive but Applications Post-Bloom Only

Cotton is an indeterminate, blooming crop that does not require pollination nor pollination services of honeybees or other animals. It is a self-pollinating crop. It is also not a preferred foraging site for honeybees. Recent studies have shown an asynchrony between when honeybees are actively foraging and when cotton actually has open blooms during only a limited portion of the day. In our laboratory, we have conducted non-target organism studies in cotton under sprayed and unsprayed conditions for more than 20 years. This involves the intensive sampling of cotton for invertebrate organisms. It is exceptionally rare for us to even net a honeybee in cotton during these field studies.

Cotton is not harvested before bloom and is not truly bee attractive. **These facts are supported by the complete lack of bee health incidents during the 3 years of Transform usage in Arizona cotton on more than 259,000 acres** (Ellsworth, unpubl. data, 2013–2015; Arizona Pest Management Center Pesticide Use Database).

EPA has also cited in its proposal a scientifically and practically unrealistic goal for its analyses: "…*restricting the timing of applications results in essentially no exposure to bees on the treated field*." This is not a scientifically defensible, regulatory goal for any Section 3 registration (i.e. "no exposure"). Pesticides are used in biological systems. We do not support EPAs goal here, especially to the extent that it excludes registrations on crops that are in the public interest like cotton, melons and other current exclusions and where there is ample data to demonstrate sufficient bee safety and crop production in the public interest.

EPA's own hyper-conservative analyses, not required for Section 3 registrations, cites difficulty in even establishing exposures for honeybees or other pollinators: *"For the proposed sulfoxaflor products, EPA determined that an RT2s* ***value could not be calculated for either the Transform or Closer formulations because the toxicity was too low****, indicating that the toxicity of these formulations is short-lived in the field"* [emphasis added]. We agree with this analysis, because it is completely in line with on the ground research under real-world use scenarios.

EPA's proposal that reviews their own internal, scientific study and analyses is filled with exonerating facts and conclusions regarding sulfoxaflor in the proposed crops as well as all other crops previously registered under Section 3, including cotton. These passages, which are many, are reproduced here:

A. *For the proposed non-minor uses; potatoes, non-residential turfgrass and wheat, EPA considered whether registering sulfoxaflor is in the public interest because it is less risky comparatively to currently registered pesticides or whether the benefits provided by sulfoxaflor exceed those of registered alternatives or non-pesticide methods.*

EPA should consider the public interest and properly assess risks and benefits. The data, the science, and importantly the real-world outcomes are all uniformly and favorably weighted to the public interest and the incredible benefits that sulfoxaflor provides in the systems where it was originally registered under a Section 3. **EPA needs to expedite the re-registrations for cotton and melons, in particular, because of the overriding benefits, the minimal to non-existent risks, and to protect our nation's public interests in reducing economic, environmental (including bees) and human health risks.**

B. *Sulfoxaflor fits well as a critical tool in Integrated Pest Management programs, replacing multiple applications of compounds with a higher risk to humans and/or non-target organisms.*

We agree, have supplied data in previous comment, and also conclude similarly for the cotton use pattern. **We need Transform to enable and sustain a reduced-risk IPM program in the public's interest** (Fig. 1–2).

C. [Sulfoxaflor has a] *lack of cross-resistance to the neonicotinoid and other classes.*

We have made major investments in resistance management in Arizona that span multiple crops and commodities. We have unprecedented cooperation among growers of vegetables, cotton and melons (Palumbo et al. 2003). We have ongoing programs that monitor the effects of sulfoxaflor on insect targets. **Having access to a new class of chemistry without cross resistance to other classes is very important to minimizing downside risks of resistance and is also in the public's interest.**

D. *Protecting biocontrol efforts by using a compound like sulfoxaflor that has less impact on beneficial predatory beetles and mites, and parasitic wasps, helps to reduce treatment needs for later season damaging pests such as armyworms, spider mites and aphids.*

Please refer to our previous comments, docket ID EPA-HQ-OPP-2010-0889-0380, where we have shared just a sample of the large amount of data that we have on Transform's very safe profile for non-target organisms in the Arizona cotton system. **In all of our evaluations, we have never documented a significant non-target impact of Transform use in cotton (under repeated-use conditions even)**. Furthermore, conservation biological control is central to our cotton IPM system (e.g., Fig. 2; see Naranjo et al. 2009a,b), and is regularly shared with scientists and practitioners worldwide as an elegantly designed and documented system of IPM that values biological control and other ecosystem services (Ellsworth et al. 2012). A recent implementation of our IPM system in northern Mexican cotton production produced savings of over $1.6 million in a single year to growers, largely by eliminating most uses of broadly toxic insecticides (i.e., pyrethroids, organophosphates and carbamates) (Ellsworth et al. 2016).

E. *Sulfoxaflor is expected to become a valuable tool in Integrated Pest Management programs for both major and minor crops. It will replace applications* [of] *older chemistries which present a greater risk to human health and also may pose a higher ecological risk to non-target organisms, including pollinators. For these reasons, EPA believes it is in the public interest to register sulfoxaflor.*

We agree completely with EPA here. Sulfoxaflor had been replacing older chemistries when it was taken off the market by court action. Despite that action, the facts remain and were presented in previous comments. Transform in cotton replaces endosulfan (no longer registered), acephate (organophosphate), and oxamyl (carbamates) for Lygus control. Those older chemistries were hazardous to bees. Restore registration in cotton immediately, as this is in the public interest.

F. *Finally, the chemical profile has favorable attributes (i.e., the chemical is not persistent in the field, it's soft on beneficial insects, and has a narrow target pest spectrum) for integration into IPM programs…. The ecological risk profile of sulfoxaflor is very favorable compared to its alternatives.*

Again, we agree and **our research shows that Transform use in cotton is not significantly different from unsprayed controls when it comes to impact on non-target organisms**. This is only possible because of the narrow spectrum of this product. Transform uniquely addresses our dual need for control chemistry that addresses both *Lygus hesperus* and *Bemisia* whiteflies (Fig. 2).

G. *Sulfoxaflor does not share a common mechanism of toxicity with other chemicals and therefore does not present a cumulative risk to human health unlike alternative organophosphates and carbamates. Another alternative pesticide group, pyrethroids, are widely used and known to have effects on aquatic invertebrates, they are labeled as extremely toxic. In comparison, the acute and chronic risk of sulfoxaflor on aquatic invertebrates is below the level of concern…. Organophosphates such as chlorpyrifos, acephate and dimethoate are toxic to fish, aquatic invertebrates, small mammals, wildlife and/or birds. Carbamates are also very toxic to non-target organisms. For example, the* *label for carbaryl, a carbamate, states: "this product is extremely toxic to aquatic invertebrates" and another carbamate, oxamyl, is labeled with 'This pesticide is toxic to aquatic organisms (fish & invertebrates) and extremely toxic to birds and mammals.'*

Sulfoxaflor is the definition of a reduced-risk compound. It is unfortunate that populist efforts to misdirect and misinform have been so successful in the courts, because access to Transform and other sulfoxaflor-containing products represent such exceptionally high safety for our users of pesticides including workers, mixers/loaders, applicators, farmers, pest managers and others in our agricultural systems. Once again, **it is deeply in the public interest to protect these classes of workers by giving them access to reduced-risk chemistries to replace more broadly toxic alternatives.**

2. Off-site Risk to Pollinators

EPA requests comment on the idea of a "*downwind 12-foot on-field buffer when there is blooming vegetation bordering the field*." We understand EPA's need for due diligence. However, it is clear even in these analyses that the risks are exceptionally low (see previous section for all the scientific reasons why). Their own analysis suggests, *"that the spatial extent of acute risks beyond the treated field is very limited (<1 - 12 feet beyond the treated field)."* It is interesting that even this risk analysis includes distances LESS THAN ONE FOOT. But even in establishing this very conservative estimate, they have used some rather extraordinary, unrealistic and scientifically indefensible assumptions:

> *1) plants in the spray drift zone are blooming at the time of application, 2) 100% of the bee's diet comes from the blooming plants inhabiting the spray drift zone, and 3) residues in pollen and nectar of plants in the spray drift zone equate to the maximum residues observed in submitted studies. From a colony perspective, honey bees are known to forage over long distances from the hive (up to 5 miles) and from a wide variety of floral resources. Given these assumptions, off-site risks to bees appear limited both spatially and temporally.*

This analysis is extraordinary because it is known factually that all 3 assumptions are completely false. The spray drift zone is not always blooming, ever; bees will never acquire their entire diet from this small area; and maximum residues, by definition, could not be there always! EPA has, until now, avoided the scientifically flimsy and unsupported so-called "precautionary principle" in rendering scientific decisions. However, even here, that principle is most often deployed under conditions of greatest uncertainty where factual information is unavailable. The agency has access to a plethora of data that refutes each assumption above. They simply cannot calculate a buffer requirement based on these flawed assumptions. I could conjecture, "The surface of the sun is hot, so hot that it kills all life; therefore, we recommend never going outdoors while the sun is out." It is a ridiculous notion and this approach to establishing risk is not scientifically defensible.

On this basis alone, EPA need not pursue a draconian and precautionary buffer zone requirement. However, if needed, there are also plenty of practical reasons why such a buffer is impractical and virtually unenforceable by the agency. In Arizona, we grow plants with water. Water is one of the largest input costs and, in our continued plan for conservation, it is only used where it is productive. **It is not in the public's interest to invest a precious natural resource on production of in-field plants that do not meet production goals.** Worse, they would very likely serve as harborages for unwanted pest sources for re-infestation of main fields, requiring even more sprays. **The approach also penalizes small growers disproportionately because their small fields have larger edges as a proportion of total cropped land. It is not in the public interest to generate a recommendation or guideline like this for Arizona, let alone a burdensome regulatory requirement.**

3. Uncertainty in Potential Synergistic Effects Related to Tank-Mixes

EPA wishes input on synergism among crop chemicals and the potential for limiting tank-mixing with sulfoxaflor and presumably for many other crop chemicals. I have been working in the cotton and broader agricultural systems of Arizona for over 25 years. "Synergism" is in the popular vernacular and is often used in marketing campaigns to support sales of input products to end-users. These casual references are almost never backed up with any real data. But worse, they are almost always referring to "additive" effects and not true synergisms as we know this phenomenon scientifically.

The agency is running the risk of confusing the popular views of synergism with true chemical synergisms, the latter being exceptionally rare in crop protection chemicals. We have done extensive testing on mixtures of products for 25 years, sometimes mixing as many as 5 different products at one time. **I am aware of only a singular case of synergism with respect to insecticides and insects in Arizona.** And, even here, it is only under the extraordinary conditions of insect resistance to crop chemicals where this is seen. Specifically, the whitefly *Bemisia tabaci* MEAM1 with origins in the Middle East before invading the U.S. in the late 1980s and early 1990s brought with it a well-developed resistance to pyrethroids. Pyrethroids were virtually ineffective when used alone to combat this pest of cotton, vegetables and melons in Arizona and elsewhere. These resistances persist even today, 25–30 years later and have been monitored in organized resistance monitoring programs spanning 20 years here. Early on, researchers discovered that a small dose of an organophosphate either preceding or mixed with a pyrethroids was sufficient to overcome and disable the resistance mechanism to pyrethroids in these whiteflies. In effect the addition of an otherwise equally ineffective organophosphate was sufficient to restore pyrethroids to their original efficacy prior to this species developing resistance. Organophosphates or pyrethroids used alone were ineffective with nearly zero efficacy against this whitefly species. However, the two together worked dramatically well and helped us salvage a difficult control system in the early 1990s, before reduced-risk, effective chemistries became available in 1993 in vegetables and 1996 in cotton. This synergism is hardly reason to reconsider the ecotoxicological profile of pyrethroids or organophosphates or their mixtures.

EPA simply has no scientific basis for considering whether a rare synergism is enabled by one or more crop chemicals. **On this basis alone, we do not support any guidelines that would curtail mixtures of sulfoxaflor (or any other chemical) with other crop inputs. The central basis for any such guidelines will continue to be ones of chemical compatibility (e.g., preventing a precipitate from forming and dropping out of solution), phytotoxicity (to protect plant health and quality) and antagonism, where rarely the presence of one compound negatively impacts the activity of another. EPA should have no role here.** This is the responsibility of agricultural colleges at Land Grant public institutions, Cooperative Extension, and the registrant and marketers themselves. EPAs own assumptions and previous conclusions are reasonable and adequate to protect the public interest: *"Currently EPA does not* *require GLP studies for tank mixes suggested on the proposed product label, under the assumption that synergism is not occurring and that following the most restrictive limitations of each product in combination is adequate to mitigate any potential risks associated with the tank mixture."*

However, **there are also many practical reasons why any regulation in this regard is damaging to the industry, to farm production practices and therefore to the public interest. EPA is very articulate in their analyses of these practical limitations:** *"A common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of multiple chemical stressors to target pests. The practice of tank mixing can result in significant economic benefits to the grower by allowing control of a wider variety of pests in a single application without incurring the expense of sequential applications. Additionally, by reducing the number of visits to the agricultural field, the grower is also reducing fossil fuel use and emissions from large agricultural equipment, as well as the potential exposure to pesticides that can result from multiple visits to the same area being treated. It is also widely accepted that the practice of mixing products with different modes of action is essential to the management of insect resistance. Because insect resistance is known to have a very costly impact to overall crop yields, which in turn negatively impacts growers' harvests and the price of commodities to the consumer, tools that aid in the prevention of resistance are considered to be a very important benefit to agriculture."*

Really there is little more that could be said about this subject. EPAs summary is spot-on, accurate and well considered. Furthermore, they account for very large benefits and equally large risk reductions of the practice of tank-mixing. **They did not specifically mention dust control and surface compaction, which are large factors in western agriculture that impact the environment and plant productivity. Both would be worsened by any attempt to curtail tank-mixing**.

We present here and close with real world use data that demonstrates just how pervasive and important the practice of tank-mixing is in Arizona agriculture (Table 1). In this case, we have 3 years of data specific to sulfoxaflor use under the previous Section 3 registration. Sulfoxaflor was intentionally mixed at least once with each of 89 other active ingredients (data not shown) on nearly 300,000 acres, all without a single, reported incident of harm to non-target organisms, including bees and other pollinators.

Table 1. Reported prescriptions (on Form L-1080) of sulfoxaflor (2013–2015) uses in Arizona crops. Almost all sulfoxaflor sprays to vegetables were tank-mixed with other crop chemicals. Two thirds of sprays to cotton were tank-mixed; tank-mixing was less frequent in other field crops like small grains, sorghum, and other crops with lower insect control demands in Arizona.

Crop Group	Not Tank-Mixed	Tank-Mixed	Total 1080s	Total Acres	Not Mixed (%)	Mixed (%)
Cotton	1092	2157	3249	259157	33.6%	66.4%
Vegetables	48	1369	1417	22631	3.4%	96.6%
Other Field Crops	83	28	111	5713	74.8%	25.2%
Total	1223	3554	4777	287501	26.3%	73.7%

We conclude that:

1) In the public interest of limiting economic, environmental and human health risks, the sulfoxaflor Section 3 registration should be expanded to other previously registered crops including cotton and melons. Arizona has 3 years of demonstrated safety under the previous Section 3.
2) The current analyses by EPA continue to demonstrate great safety to insect pollinators with respect to sulfoxaflor use. There is no reasonable expectation of further risk reduction by establishment of "on-field buffers" for this compound. Furthermore, this practice would actually net major increases in consumption of natural resources and sprays of other insecticides including those that are more toxic to non-target organisms and human health. It is therefore not in the public interest to establish on-field buffers.
3) Tank-mixes are a legitimate tactic for accomplishing IPM goals. Real world, use-data for Arizona demonstrates just how prevalent the practice is and how wide-spread use of sulfoxaflor mixtures failed to result in a single, reported incident of harm to non-target organisms (Jack Peterson, Ariz. Dept. Agric., pers. comm.). The EPA does not have a scientifically defensible rationale for precluding tank mixes. True synergisms are very rare, and even when they occur to not imply any changes to the ecotoxicological assessment.

Finally, taking our conclusion from our previous comment, we close and re-affirm:

"This makes Transform ideally suited for our cotton IPM system where we have progressively introduced highly selective and effective technologies for the control of our key insect pests, while conserving the natural enemy fauna present in the field and available for suppression of all cotton arthropod pests."

References

Ellsworth, P.C., J.C. Palumbo, S.E. Naranjo, T.J. Dennehy, R.L. Nichols. Whitefly Management in Arizona Cotton 2006. IPM Series No. 18. University of Arizona Cooperative Extension Bulletin, AZ1404, 5/2006. URL: *http://cals.arizona.edu/pubs/insects/az1404.pdf*

Ellsworth P.C., A.J. Fournier, T. Vandervoet, S.E. Naranjo. 2016. The Arizona Whitefly IPM Model: Cooperative Extension as Key to Translating and Transforming the Mexican Cotton System. Second International Whitefly Symposium Arusha Tanzania, February 14, 2016. *http://cals.arizona.edu/crops/presentations/2016/15Arusha%20IWS%20Mexico%20EPAvFlo.pdf*

Ellsworth, P., L. Brown, A. Fournier, X. Li, J. Palumbo & S. Naranjo. 2011a. Keeping Cotton Green. Field Crops IPM Short. University of Arizona Cooperative Extension. http://ag.arizona.edu/crops/cotton/files/SelectiveChemicalControlsvF.pdf . July 2011

Ellsworth, P. C., A. Mostafa, L. Brown & S. Naranjo. 2011b. Soft-bodied *Collops* likes soft bodies. Field Crops IPM Short. University of Arizona Cooperative Extension. http://ag.arizona.edu/crops/cotton/files/CollopsVFlo.pdf July 2011

Ellsworth, P.C., A. Fournier, W. Dixon, J.C. Palumbo, D.H. Gouge, K. Umeda and J. Peterson. 2012. Enhancing Capacity for IPM Practice and Assessment in Arizona. An extended abstract for NIFA IPM Programs: Legacy and Impacts Mini-Symposium, 7th International IPM Symposium, Memphis, TN, March 27-29, 2012. pp. 19-21. https://www.ncipmc.org/action/NIFA%20IPM%20Programs.pdf . Presentation available at: http://ag.arizona.edu/crops/presentations/2012/12MemphisNIFA-EIPMvFc.pdf

Ellsworth, P.C., L. Brown & S. Naranjo. 2012. Being Selective! University of Arizona Cooperative Extension. Spanish translation: ¡Seamos Selectivos! http://ag.arizona.edu/crops/cotton/files/KeyChemistryShortvF.pdf http://ag.arizona.edu/crops/cotton/files/KeyChemistryShortvFSpanish.pdf

Ellsworth P.C., S.E. Naranjo, A. Fournier, L. Brown, W. Dixon. Successful Lygus Management as a Stabilizing Element of Cotton IPM in Arizona. Presented at the 3rd International Lygus Conference, Scottsdale, AZ. October 30, 2012. http://ag.arizona.edu/apmc/3rdILS/Presentations_and_Posters/12ScottsdaleLygusIPMvFc2.pptx.pdf

Mostafa, A., L. Brown, P. Ellsworth, V. Barlow & S. Naranjo. 2011. Untangling the Web… Spiders in Arizona fields! Field Crops IPM Short. University of Arizona Cooperative Extension. http://ag.arizona.edu/crops/cotton/files/SpidersWebsvFc.pdf July 2011

Naranjo, S.E. & P.C. Ellsworth. 2009a. The contribution of conservation biological control to integrated management of *Bemisia tabaci* in cotton. *Biological Control*, 51(3): 458–470.

Naranjo, S.E. & P.C. Ellsworth. 2009b. 50 years of the integrated control concept: moving the model and implementation forward in Arizona. *Pest Management Science*, 65: 1267–1286.

Naranjo, S.E. and P. C. Ellsworth. 2010. Fourteen years of *Bt* cotton advances IPM in Arizona. Southwest. Entomol. 35: 437-444.

Palumbo, J.C., P.C. Ellsworth, T.J. Dennehy, & R.L. Nichols. 2003. Cross-Commodity Guidelines for Neonicotinoid Insecticides in Arizona. University of Arizona Cooperative Extension Bulletin, IPM Series 17. Publ. No. AZ1319, 4 pp. URL: *http://cals.arizona.edu/pubs/insects/az1319.pdf*

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