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OFFICE OF CHEMICAL
SAFETY AND POLLUTION
PREVENTION

MEMORANDUM

SUBJECT: Characterization of Ethephon Use, Usage and Importance on Apples, Blackberries, Cherries, Grapes and Turf (PC Code #099801)

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SUMMARY

Ethephon is a plant growth regulator that is registered for use on many crops, including pome fruits, berries, cherries, grapes, walnuts, fruiting vegetables, cucurbits, cotton, tobacco, turf, barley, and wheat. Ethephon's primary use is on cotton as a harvest aid/defoliant, which accounts for more than 90 percent of usage nationally, when measured in total pounds applied. EPA's Health Effects Division identified a number of crops for which residues in juice could potentially drive a risk concern for children less than 2 years old. EPA's Environmental Fate and Effects Division identified potential risks of concern for birds and mammals, driven by feeding on ethephon treated turf and ornamental plants, as well as non-target risks for other outdoor uses. In this document, BEAD therefore focused its analysis on the use, usage, and characterization of the importance of ethephon on apples, blackberries, cherries, grapes, and turf, which were the most significant drivers of modeled risk concerns. BEAD also provides updated usage information for additional crops (including wheat, blueberries, pears, peppers, cucurbits, etc.) that had no reported usage in BEAD's prior screening-level usage analysis (SLUA). BEAD confirmed that negligible usage was reported on these crops, and this information, along with projected percent crop treated (PCT) estimates for the other food uses of interest will be incorporated into a revised dietary risk assessments.

On apples, ethephon is used primarily for fruit thinning and for inducement of return bloom in the following growing season, particularly for varieties with biennial bearing tendencies. On average, 15 percent of apples are treated with ethephon annually. On blackberries, ethephon helps in uniform maturity and loosening of fruits to improve harvesting. However, less than one percent of blackberries are treated with ethephon. On tart cherries, ethephon use promotes uniform ripening and loosening of fruits for efficient harvest, particularly in orchards that are harvested with mechanical shakers. Ethephon usage on sweet cherries is much lower, as only tart cherries require fruit loosening. While 25% percent of cherries are treated with ethephon on the whole, the annual average usage differs considerably between tart cherries and sweet cherries. Approximately 70% of tart cherry acreage is treated while only 10% of sweet cherry acreage is treated with ethephon annually. PCT values for these crops, along with the crops with no reported usage will allow for additional refinement of the Agency's dietary risk assessment.

On grapes, ethephon promotes uniform color development in table grapes and hastens maturity and induces ripening for all grapes. Overall, 5% of grapes are treated with ethephon, but only a negligible amount of ethephon is used on wine/juice grapes (<1% of acreage treated). Based on communications with producers and publicly available data, BEAD projects that no more than 5-10% of all grapes going to crush for juice production would be expected to be table grapes treated with ethephon. When adding a maximum PCT of 2.5% for juice grapes, the total upper-bound proportion of all grapes going to juice that could be treated with ethephon is therefore <12.5%

On turf, ethephon use slows the growth of grass, thus reducing mowing frequency. It also provides suppression of *Poa annua* weed and white clover seed heads. Golf Course Superintendents Association of America (GCSAA) (Graves, 2016) informed BEAD that most of the ethephon use is on golf courses greens and very limited spot treatment usage would be on

golf course tees and fairways. BEAD projects that this would account for less than 5% of typical golf course acreage. GCSAA also stated that typical usage rates are approximately half of the labeled maximum rates for turf, with 2-3 applications per season as the typical usage practice rather than labeled six application per season. This information will significantly reduce the projected ecological risks from turf exposure, since it was assumed that entire golf courses and institutional turf areas would be treated at maximum labeled rates per season.

BACKGROUND

FIFRA Section 3(g) mandates that EPA periodically review the registrations of all pesticides to insure that they do not pose unreasonable adverse effects to human health and the environment. This periodic review is necessary in light of scientific advancements, changes in policy, and changes in use patterns that may alter the conditions underpinning previous registration decisions. In determining whether effects are unreasonable, FIFRA requires that the Agency consider the risks and benefits of any use of the pesticide.

BEAD is providing an analysis of ethephon usage and an overview of ethephon's importance on apples, blackberries, cherries, grapes and turf because risk assessors have identified risks of concern driven by these use sites. Dietary risks are driven by apples, blackberries, cherries, and grapes, which can be used for juice that is consumed by children less than 2 years old. BEAD's estimates of PCT will help to refine exposure estimates for a revised human health risk assessment. Ecological risks were identified for small birds and mammals feeding on ethephon treated turf and ornamentals and non-target plant risks were associated with most uses. BEAD's estimates of usage on turf and ornamentals, as well as information on application methods (i.e., aerial vs. ground) and typical rates will provide information to characterize the likelihood of these modeled risks.

ETHEPHON USE AND USAGE CHARACTERIZATION

Ethephon Agricultural Usage

Leading Usage Crops

The greatest usage of ethephon nationally, by far, is on cotton, with approximately 7.2 million acres treated annually and 8.1 million pounds of active ingredient (AI) applied annually on average (Market Research Data, 2005-2014). Ethephon is used as a harvest aid in cotton, for enhanced boll opening and defoliation prior to harvest, often in combination with other herbicides or plant growth regulators in tank mixes. The second leading usage crop over the same time period is tomatoes, with an average of 49,000 pounds AI applied to an average of 73,000 acres of tomatoes annually (Market Research Data, 2005-2014). On tomatoes, ethephon is most often used as a harvest aid for enhanced uniform ripening, color, and maturity.

Apples, Blackberries, Cherries, and Grapes

Because specific dietary risk estimates were driven by residues on apples, blackberries, cherries, and grapes (used in juice products consumed by children), BEAD is providing available usage data for these crops in Table 1, to provide information for risk characterization and risk assessment refinement, via adjusting exposure values in accordance with PCT. The available pesticide usage data on apples, blackberries, cherries and grapes are presented in table 1. In addition to available MRD, some usage statistics are only available for certain crops via USDA's National Agricultural Statistics Service (USDA-NASS) and California's Department of Pesticide Regulation (Cal DPR). All of these sources are incorporated into a revised Screening Level Usage Analysis (SLUA, 2016), as noted below.

Table 1. Average Annual Pounds Applied, Acres Treated, and Percent of Crop Treated for Ethephon on Apples, Berries, Cherries, and Grapes.

Crop	Average Annual Pounds Applied (2005-2014)	Average Annual Total of Acres Treated (2005-2014)	Average Annual Percent of Crop Treated (2005-2014)
Apples	30,000	46,000	15%
Blackberries*	Negligible	Negligible	<1%
Cherries: Total	8,000	33,000	25%
<i>Tart Cherries</i>	5,000	32,700	70%
<i>Sweet Cherries</i>	3,000	<500	10%
Grapes	15,000	64,000	5%
<i>Table Grapes</i>	10,000	44,000	30%
<i>Raisin Grapes</i>	5,000	20,000	10%
<i>Wine/Juice Grapes</i>	<500	<600	<1%

Sources: SLUA, 2016; MRD, 2005-2014

*Blackberry usage was surveyed in 2009 and 2011 by USDA-NASS and no estimate of usage was reported in either year for ethephon (USDA, 2012b). USDA-NASS surveyed blackberry growers in Oregon, which according to USDA-NASS produces nearly 100% of U.S. commercial blackberries. (Proprietary data not available, see references). North American Raspberry & Blackberry Association (NARBA, 2016) provided contact information of blackberry experts in Oregon, Washington and California. Percent crop treatment was provided by these experts (Peerbolt, 2016, Schreiber, 2016, Refsnider, 2016).

National American Raspberry and Blackberry Association (NARBA, 2016), provided contact information for blackberry experts in Oregon, Washington and California (Peerbolt, 2016, Schreiber, 2016, Refsnider, 2016). Based on information received from the experts, blackberries are almost exclusively grown in Oregon, Washington and California and less than one percent of blackberry crop receives ethephon treatment. PCT for blackberry provides a more realistic estimate for the refinement of exposure estimates for ethephon residues in blackberry juice products.

While PCT for cherries averages 25% on the whole, most usage is on tart cherries, for fruit loosening in conjunction with mechanical harvest, which is discussed in more detail later. Usage on sweet cherries is not expected to exceed 10% of acreage treated (MRD, 2010-2014). Because

tart cherries are not typically used for juice, the specific PCT for sweet cherries provides a more realistic estimate for the refinement of exposure estimates for ethephon residues in cherry juice products.

Similarly, for grapes, PCT averages 5% overall. However, usage is not evenly distributed within this crop, as table grapes account for the majority of usage in terms of pounds applied, and has the highest PCT. Ethephon is used to enhance fruit color and as a ripening agent for table grapes, particularly grapes grown in areas with inadequate periods of cool weather prior to harvest. Ethephon is also used for the same purposes on raisin grapes, but to a lesser extent, with approximately 10% of raisin acreage treated. Grapes grown for wine or juice do not typically have these concerns, and accordingly, there is essentially no usage reported on grapes destined for wine or juice.

While the low PCT for wine and juice grapes is one point for refinement, the Agency's risk assessment utilized detection data for table grapes in developing exposure estimates for juice, based on application of a processing factor. Because table grape residue data were used to estimate potential ethephon residues in grape juice, BEAD investigated the relatively likelihood of treated table grapes ending up getting crushed for production of juice.

USDA-NASS (2016a) data indicate that over 99% of table grapes are produced in California, and that table grapes accounted for 2% of total CA grape crush in 2014-2015, which includes table, wine, and raisin grapes. The relative proportion of grape crush destined for juice vs. wine, vinegar, distilled spirits, etc., is unknown. However, in analyzing NASS grape production reports and crush reports for grapes in California (Cal DFA, 2016), BEAD notes that even if it is assumed that all table grapes in CA going to crush (~83,000 tons) are used for making juice instead of wine, this would account for roughly 16% of the total US grape juice production (~493,000 tons) (USDA-NASS, 2016a). By further accounting for ethephon usage on table grapes (30% of crop treated annually on average, 60% max), BEAD projects that as a worst-case upper-bound estimate, no more than 5-10% of total grapes used for juice production in the United States could conceivably come from ethephon treated table grapes. Adding this figure to the previously provided maximum PCT for ethephon usage on wine and juice grapes (<2.5%), BEAD's total estimate for the highest conceivable proportion of grapes crushed for juice that are treated with ethephon is <12.5%

Wheat, Blueberries, Pears, Peppers, and Cucurbits

Based on a revised Screening-Level Usage Analysis (SLUA, 2016), BEAD is providing updated usage estimates for a number of crops that had no reported usage of ethephon. BEAD is confirming this lack of reported usage so that risk assessors do not assume that 100% of these crops are treated with ethephon. Table 2 below summarizes the usage observed for wheat, blueberries, pears, peppers, cantaloupes, and squash for the years 2005-2014, which includes the most recent data available to BEAD.

Table 2. Average Annual Pounds Applied and Percent of Crop Treated for Ethephon by Crop

Crop*	Average Annual Pounds Applied (2005-2014)	Average Annual Percent of Crop Treated (2005-2014)
Wheat	<500	<1%
Blueberries	<500	<1%
Cantaloupes	<500	<1%
Pears	<500	<1%
Peppers	<500	<2.5%
Squash	<500	<1%

Source: SLUA, 2016.

* The 7/13/16 SLUA has wheat, blueberries, cantaloupes, and peppers noted as “use was observed but not reported during the 2005-2014 period”. Squash is marked with “Based on adjustment of August 28, 2014 SLUA to reflect use observed but not reported in USDA NASS and use reported in the California DPR database during the 2004-2014 period.” Pears is not qualified.

Method of Application

Because modeled ecological risks of concern often assume aerial applications, maximum use rates, and maximum number of applications allowed on the label, BEAD is providing additional information on these usage parameters for a number of crops.

Ethephon is applied to agricultural use sites by ground and aerial application. According to the available usage data, ethephon is applied on apples by ground and air, although aerial applications only account for a small fraction (~6%) of usage on apples. Because coverage is critical for many PGR uses on apples, aerial application is not likely to be appropriate in most situations. (Table 3). Ethephon is applied to cherries and grapes by ground only (Market Research Data, 2014).

Table 3. Average Total Acres Treated by Application Method for Ethephon by Crop

Site	Application Method	Average Total Acres Treated ¹ (2010-2014)	Percent of Total Acres Treated
Apples	Aerial	2,700	6%
	Ground	44,000	94%
Cherries	Ground	35,000	100%
Grapes, Raisin	Ground	21,000	100%
Grapes, Table	Ground	36,000	100%

Source: Market Research Data, 2014. Numbers may not sum due to rounding.

*Blackberry usage was surveyed in 2009 and 2011 by USDA-NASS and no estimate of usage was reported in either year for ethephon (USDA, 2012b). USDA-NASS surveyed blackberry growers in Oregon, which according to USDA-NASS produces nearly 100% of U.S. commercial blackberries. When applications are rarely made to blackberries, it is always by ground.

¹Total acres treated count acres treated multiple times.

Number of Applications

Table 4 lists the average number of applications of ethephon by crop. On apples an average of 1.2 application are applied per year whereas other crops received between 1.1-1.3 sprays per growing season (Market Research Data, 2014). It should also be noted that USDA-NASS reports on the number of applications made, including the number in the 90th percentile. Data from 2009 show that at the 90th percentile for apples there are two applications; for both sweet and tart cherries, one application; and for table grapes, there are three applications (USDA-NASS, 2016b).

Table 4. Average Number of Applications for Ethephon by Crop

Crop	Average Number of Applications ¹ (2010-2014)
Apples	1.2
Blackberries	NA*
Cherries	1.1
Grapes, Raisin	1.1
Grapes, Table	1.3

¹ Sources: Market Research Data, 2016; USDA, 2012a.

*Data on the average number of applications were not available in MRD (2010-2014) for blackberries.

Application Rates

Table 5 lists the label maximum application rates, average application rates and application rate distributions for ethephon by crop. Many of highest use rates are below the maximum label rate for the crop. For example, 97% of apple acres treated with ethephon is at an application rate of 1 pound per acre or less, which is half of the maximum label rate for apples of 2 pounds per acre. (Market Research Data, 2015)

Table 5. Label Maximum and Observed Application Rates for Ethephon by Crop

Crop	Label Maximum Single Application Rate (Pounds per Acre) ¹	Average Single Application Rate (Pounds per acre) ²	Single Application Rate Distribution ³ (Percent of Total Acres Treated at Rate)
Apples	2	0.52	97% of acres treated at less than 1 pound per acre
Blackberries	2	NA*	NA*
Cherries	1	0.21	98% of acres treated at less than 0.6 pounds per acre
Grapes, Raisin	0.5	0.24	98% of acres treated at less than 0.4 pounds per acre
Grapes, Table	0.5	0.28	90% of acres treated at less than 0.4 pounds per acre

Source: Market Research Data, 2015. USDA, 2012a. NA=not available in the usage data

¹ Maximum label rate.

² Average user application rate. 2010-2014 (Market Research Data, 2014)

³ Based on a distribution of observed application rates. The value represents the application rate at which at least 90% of the acres are treated (higher in most cases). The next highest observed rate is typically the label maximum application rate. 2010-2014 (Market Research Data, 2014)

*NA (Not Available)

Ethephon Non-agricultural Usage: Turf and Ornamentals

Because ecological risk estimates were driven by risks of concern of small birds and mammals feeding on ethephon treated turf and ornamentals at labeled use rate and frequency, BEAD is providing additional usage characterization for ethephon use on turf. The Agency's ecological risk assessment assumes that all turf is treated at label maximum rates and frequency. Therefore, additional usage information on use sites and relative proportions of area treated will be helpful for characterization of modeled risks.

Available usage data (Kline and Company, 2011) indicate that the vast majority of ethephon usage on turf in terms of pounds a.i. applied was on golf courses (93%) as shown in Table 6. Usage in all other turf sectors was negligible, and based upon the acreage of institutional/residential/public turf sites in the United States, BEAD projects that <1% of such acreage would ever be expected to be treated with ethephon in a given year. Ethephon, along with trinexapac-ethyl and paclobutrazol account for more than 97% of the plant growth regulator (PGR) active ingredient usage by golf courses, when measured by pounds of active ingredient applied (Kline & Co., 2011).

Table 6. Ethephon Use on Turf and Ornamentals.

Market Sector	Pounds A.I. Applied	
	2011	% of Total Lbs AI
Golf Courses	65,000	92.7
Lawn Care Operators	900	1.3
Horticultural Nurseries	550	0.8
Institutional Turf Facilities	3,500	4.9
Landscape Contractors	12	0.02
Turf Farms	160	0.23
Total	70,122	

Source: Kline & Company, Professional Turf and Ornamental Markets, 2012.

BEAD reached out to Golf Course Superintendents Association of America (GCSAA) (Graves, 2016) for usage information for golf courses turf. Dean Graves (representing GCSAA) indicated that nationally, ethephon is only used on golf course greens, which account for a very small percentage of a golf course's acreage. On average there are 3 acres of golf greens in a typical golf course. On average, a typical golf course is between 100-150 acres (Graves, 2016). This translates into approximately 2-3% area of a golf course receives ethephon treatment. Therefore,

BEAD projects that it can be reasonably and conservatively assumed that less than 5% of any golf course would be expected to be treated with ethephon in a given season. BEAD notes that while some applications might also be desired for tees and fairways, such treatments are most likely to be small, localized spot treatments rather than area-wide applications. Costs of ethephon are likely to be prohibitive for widespread use on golf course fairways, and registrants have indicated that the main use on fairways would only be for spot control of weeds such as clover, *Poa annua*, etc.

BEAD also queried GCSAA regarding typical application numbers per season and rates for turf. GCSAA indicated that ethephon is usually applied on golf greens twice a year (instead of labeled six times per season) at no more than 3.0 fl. oz. (21.7% ai) per application per 1000 sq. ft. (Graves, 2016). This means that approximately 3.2 pounds of ethephon (a. i.) is used per acre of golf greens, which is approximately half the currently labeled single application rate for turf.

QUALITATIVE CHARACTERIZATION OF AGRICULTURAL AND NON-AGRICULTURAL IMPORTANCE FOR SELECTED USE SITES

Apples

On apples, ethephon is mainly used for fruit thinning and for enhancement of return bloom for the subsequent growing season (MRD, 2010-2014). Thinning is a critically important task for apple production, due to the tendency of apples to produce far more flowers than are needed to set a full crop. Failure to adequately thin apple trees will result in a crop of fruit that are too small to be marketed. Over-cropping of apple trees can also cause excessive physiological tree stress, and some varieties of apples are sensitive to developing a biennial bearing tendency due to this stress, which can be difficult to break over time. Typically, if an apple tree were to set a high proportion of blossoms, approximately 95% of fruit will need to be subsequently removed by chemical or hand thinning in order to have a fresh apple crop of any marketable value (PSU, 2012). Many factors, including weather, spray coverage, and variety variation affect the chemical thinning decisions of apple growers (Schupp, 2016). While there are numerous PGRs registered for thinning of apples, as well as insecticides that have PGR properties (including the carbamates carbaryl and oxamyl), discussing alternatives to ethephon is not straightforward, given the need for tank mixes of 2-3 or more PGRs simultaneously to achieve the desired efficacy. This is further complicated by the tendency to tweak the application rates of various tank mixture components in response to timing, variety, fruit size, weather, and other factors that add significant variability to the task of thinning (PSU, 2012). Often times, multiple chemical thinning applications are necessary in the same season to get the desired crop load.

Ethephon is particularly effective for thinning larger apple fruit (PSU, 2012), which is a very important benefit for growers of fresh apples that may have under-thinned or completely missed a thinning window on smaller fruit. While there a number of alternative PGRs for thinning apples, ethephon has the most reliable efficacy for thinning larger fruit, whereas alternatives typically need to be applied much sooner after bloom while fruit are still very small. Apples typically undergo very rapid growth and cell division during the early stages of fruit development in the weeks following bloom. Because warm or wet weather can shorten the

windows of opportunity for chemical thinning, ethephon can provide an effective ‘rescue’ option for growers that missed their windows, and can preclude the need for expensive and labor-intensive hand-thinning.

Beyond the direct efficacy at thinning apples, research has also demonstrated that ethephon has a separate effect in enhancing return bloom of the trees in the following season (PSU, 2012). Often, after thinning is complete, growers may make 1 or sometimes 2 additional applications of ethephon at a reduced non-thinning rate, with the expected benefit of seeing a stronger return bloom in the following season. This effect is highly variable among varieties, but this benefit of ethephon has particular importance for apple cultivars that have stronger tendencies to fall into a biennial bearing cycle. Bloom promotion helps to break this cycle and allow for more consistent fruit loads year-by-year in subsequent seasons (PSU, 2012).

Blackberries

On blackberries, on the few acres where usage occurs, ethephon sprays will concentrate maturity and loosen fruit, improving harvesting efficiency while reducing cane injury from mechanical harvest. In the United States most of the blackberries are produced in Oregon, Washington and California. Most blackberry producers do not use ethephon because they prefer to harvest blackberries repeatedly over time, to produce a continuous supply of berries for fresh market demand (Peerbolt, 2016; Refsnider, 2016). Blemished and undersized blackberries are used for juicing purposes, and ethephon could potentially help to synchronize one single harvest for such sub-optimal fruit in certain situations. The experts in three states (Oregon, Washington and California) stated that less than 1 percent of blackberries receive ethephon treatment in any given year (Peerbolt, 2016, Schreiber, 2016, Refsnider, 2016). Therefore, the benefits of using ethephon on blackberry for fresh market production are relatively negligible.

Cherries

Ethephon only has significant usage on tart cherries in the U.S. Usage on sweet cherries, while sometimes applied to enhance return bloom, is low in terms of total treated acreage. On tart cherries, ethephon is used to loosen fruit and promotes early uniform ripening, in support of mechanical harvesting by tree shakers. Fruit loosening reduces the shaker force needed to mechanically harvest fruit. The primary benefit of this effect is to maximize yield, by minimizing the number of fruit that remain unharvested on the trees, for which manual harvest is not economical. A secondary benefit is that the reduction in shaker force reduces the likelihood of damaging trees during harvest, as heavily shaken trees are subject to outright limb breakage and other mechanical injury that provides entry points for disease infections and/or infestations by boring insect pests. While a small proportion of tart cherries are harvested by hand, most large-scale production is dependent on mechanical harvest, and in the absence of ethephon, growers would be expected to see decreased yields and increased damage to trees, which would have a large economic impact over time.

Grapes:

The primary benefit of using ethephon on grapes is that it promotes uniform color development on table grape varieties such as Cardinal, Emperor, Flame Seedless, Red Malaga, Queen and Tokay allowing for high quality attractive fruit and more efficient harvests of quality fruit. Besides color development, usage of ethephon can also enhance uniform ripening and provide desired sugar and acidity balance consistency. Usage of ethephon is particularly important for areas where there are inadequate cool temperatures, which normally induces production of anthocyanins in grapes near harvest. Usage of ethephon helps to compensate for this effect, allowing growers in warmer areas to produce grapes that meet customer and export demands for uniform red coloration. On raisin-grapes ethephon hastens maturity of grapes, resulting in an acid-sugar balance that is most desired for optimal raisin quality. The only usage reported on wine and juice grapes is sporadic, as occasionally needed for enhanced grape ripening on very limited acreage. On the whole, ethephon usage is essentially negligible for wine and juice grapes.

Turf:

The primary benefit of using ethephon on turf is that it slows turf growth thus reducing the required frequency of mowing and the volume of clippings collected. In addition, ethephon suppresses *Poa annua* weed and white clover seed heads on treated turf. Ethephon is currently labeled for use on golf course turf including greens, tees, fairways and roughs. However, BEAD projects, based on feedback from GCSAA (2016) ethephon is mainly used on golf course greens. Any usage on tees and fairways would be expected to be small, localized spot treatments only and ethephon would never be applied on an area-wide basis to golf course fairways and roughs. At the national level, the relative proportion of a golf course that would be expected to be treated with ethephon for a given application would be 5% or less per year. Typical applications are made at approximately half the currently labeled rate.

CONCLUSIONS

BEAD provided usage characterizations and overview of importance for a number of crops in support of a preliminary interim decision. BEAD focused its usage analysis and qualitative characterizations mostly on apples, blackberries, cherries, grapes and turf, which were the most significant drivers of modeled risk concerns. On apples, ethephon is used primarily for fruit thinning and for inducement of return bloom in the following growing season, with an average of 15% of apples treated with ethephon annually. On blackberries, ethephon helps in uniform maturity and loosening of fruits to improve harvesting, but less than one percent of blackberries are treated. On tart cherries, ethephon use promotes uniform ripening and loosening of fruits for easier and more efficient harvest, particularly in orchards that are harvested with mechanical shakers. Ethephon usage on sweet cherries occurs on approximately 10% of the crop. On grapes, ethephon promotes uniform color development (table grapes) particularly in warmer growing areas. Because table grapes account for a small proportion of the total amount of grapes crushed for juice production, BEAD projects as a very unlikely upper-bound estimate that no

more than 5-10% of grapes crushed for juice on an annual basis would be from ethephon-treated table grapes. Only a negligible amount of ethephon is used on wine/juice grapes. When adding the maximum PCT of 2.5% for wine/juice grapes, the total upper-bound proportion of all grapes going to juice that could conceivably be treated with ethephon is therefore <12.5%.

On turf, ethephon use slows the growth thus reducing mowing frequency. Ethephon also provides suppression of *Poa annua* weed and white clover seed heads. GCSAA (2016) informed BEAD that ethephon usage on golf courses is done on greens only, which would account for less than 5% of typical golf course acreage. It was also communicated that typical use rates are approximately half of labeled maximum rates for turf, with two applications per season as the typical usage practice rather than labeled six applications per season.

REFERENCES

California Department of Food and Agriculture; USDA-NASS, Pacific Regional Office – California. California Grape Crush Report, Final 2015. March 10, 2016.
https://www.nass.usda.gov/Statistics_by_State/California/Publications/Grape_Crush/Final/index.php

GCSAA. 2016. Golf Course Superintendents Association of America.
<http://www.maagcs.org/Sys/PublicProfile/9450963>
Accessed June 22, 2016.

Graves, Dean 2016. Certified Golf Course Superintendent. Chevy Chase Club. 6100 Connecticut Ave., Chevy Chase, MD 20815. Telephone No. 301-656-6323. Personal communication June 22, 2016.

Kline & Company, 2012. Professional Turf and Ornamental Markets, 2011.

Market Research Data. 2014. Data collected and sold by a private market research firm for the years 1998-2014. Data collected on pesticide use for about 60 crops by annual surveys of agricultural users in the continental United States. Survey methodology provides statistically valid results, typically at the state level.

NARBA. 2016. North American Raspberry & Blackberry Association.
<http://www.raspberryblackberry.com/for-growers/2016-annual-conference/>
Accessed on July 14, 2016.

Penn State University, 2012. PSU Tree Fruit Production Guide, 2012-2013.
<http://counties.uwex.edu/polk/files/2014/02/Tree-Fruit-Production-Guide-Penn-State-2013.pdf>

Peerbolt, Thom. 2016. Caneberries Production Consultant for Oregon. <http://www.peerbolt.com/>
Accessed on July 14, 2016. Telephone no. 503-289-7287.

Refsnider, Keith. 2016. Director, Global Food safety, Driscoll Strawberry Associates. Telephone No. 831-763-5020. Ethephon is used on less than 1 percent of blackberry crops.

Schreiber, A. 2016. Agricultural Development Group, Inc., 2621 Ringold Road, Eltopa, WA. Telephone no. 509-266-4348. Ethephon is not used on blackberry in Washington State.

Schupp, J. 2016. Factors that Affect Plant Growth Regulator Performance in Orchards. Penn State University Extension Publication. <http://extension.psu.edu/plants/tree-fruit/commercial-tree-fruit-production/growth-regulators-in-apple-and-pear-production/fruiting-capacity-fruit-quality-fruit-drop>

SLUA, 2016. Ethephon (099801) Screening-Level Usage Analysis. July 15, 2016.

Smith, E.D. 2009. Abscission, storability, and fruit quality of mechanically harvested fresh market stem-free sweet cherry.

http://www.dissertations.wsu.edu/dissertations/spring2009/e_smith_041009.pdf

Accesses on June 26, 2016.

US Department of Agriculture (USDA), National Agricultural Statistics Service (NASS). 2012b. Agricultural Chemical Use, Fruit Crops 2011.

US Department of Agriculture (USDA), National Agricultural Statistics Service (NASS). 2016a. Noncitrus Fruits and Nuts 2015 Summary. July, 2016.

<http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1113>

US Department of Agriculture (USDA), National Agricultural Statistics Service (NASS). 2009 Fruit Chemical Usage Report. Accessed via QuickStats: <https://quickstats.nass.usda.gov/>

US Environmental Protection Agency (EPA). February 2, 2015. Usage Report for Blackberry and Grapes (Raisin, Table and Wine) in Support of HED PRIA Action for Ethephon, PC Code #099801

US Environmental Protection Agency (EPA). June 21, 2016. Ethephon Screening Level Usage Analysis (SLUA). An estimate of the average pounds of ethephon applied in agriculture by crop, and an average and maximum percent of these crops treated for the years 2005-2014. [USDA NAAS. 2014. http://www.nass.usda.gov/](http://www.nass.usda.gov/)