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Memorandum

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SUBJECT: Biological and Economic Analysis of Diazinon on Pears

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SUMMARY

The impacts of cancelling diazinon on pears would be considerable in the Pacific Region of Washington, Oregon and California, which together account for 98% of U.S. pear production. Diazinon is used to control San Jose scale, which has two generations each year. Alternatives exist for control of the first generation, which occurs during the dormant or delayed-dormant period of the year. Only negligible impacts from increased costs are expected from cancellation for use during these months. However, viable alternatives do not exist for control of the second generation, which occurs during the summer growing season. Left uncontrolled, scale infestations could result in significant declines in fruit quality that could lower revenues to the grower. BEAD estimates that gross revenues could decline by 20 to 25% on affected acres and those growers would likely face losses of net revenues of $800-1000/acre. For these growers, revenues would not cover operating costs. About 2,240 acres, or 3.6% of the region's pear acreage, could be affected annually. The pear industry of the three states could face yearly losses of more than $2.1 million dollars, out of gross revenues of $267 million.

LIMITATIONS AND SCOPE OF ANALYSIS

The scope of this analysis includes an examination of potential regional-level impacts associated with elimination (through a phase-out) of the use of diazinon in pears. This mitigation scenario reflects the high health risks to mixers, loaders and applicators as identified by the Health Effects Division of the Office of Pesticide Programs. This analysis does not attempt to address impacts associated with mitigation efforts targeted at workers reentering fields treated with diazinon, or potential mitigation for various environmental risks (i.e., risk mitigation for risks to terrestrial plants and organisms or water contamination).

There are limitations to this assessment. The impacts estimated by this analysis only represent potential short-term – 1 to 2 years – impacts on the pear production system and grower returns. National impacts are calculated by simply scaling up the estimated per-acre impacts. We ignore potential changes in price that may result from production changes and, in estimating grower impacts, we assume there will be no shift from pears to other crops. Further, BEAD does not consider the possibility that growers would increase applications in the dormant period as insurance against a second-generation outbreak, which would, in any case, be less than 100% effective.

Assumptions about yield and quality losses associated with the various scenarios are based on the best professional judgement of BEAD analysts when estimates were not available from other sources. Assumptions are based on a review of available USDA crop profiles, state crop production guides, discussions with university extension and research entomologists knowledgeable in pear production, and other sources listed. Pear production is a very complex system that can be influenced by a variety of parameters (e. g., weather). BEAD's ability to quantitatively capture the wide array of events that could unfold given each hypothetical scenario listed above is limited.

CROP PRODUCTION

Pears (*Pyrus communis*) are a pome fruit related to apples. Bartlett is the most common variety grown in the U. S. Most of the production of Bartlett pears goes for canning, although early in the season, some will go for fresh market. D'Anjou, the next most common variety grown in the US, is grown primarily for fresh market.

U.S. and Regional Pear Production

Total U.S. pear production averages 991,000 tons per year, and is valued at nearly $275 million (see Table 1). California and the Pacific Northwest (Oregon and Washington) account for over 95% of U.S. pear production. The major production region is the Pacific Northwest, and the major production state is Washington.

Table 1. 1998-2000 Average Pear Production and Value of Production

Region	Bearing Acreage (Acres)	Production (Tons)	Percent of U.S. Production	Value of Production ($1000)
U.S.[1]	66,120	976,800	–	$276,631
California	19,300	315,000	32.2%	$74,168
Oregon	17,800	229,700	23.5%	$81,219
Washington	24,400	407,000	41.7%	$111,695

Source: USDA/NASS, Non-citrus Fruits and Nuts 2000 Summary.

[1] Production of pears in Michigan, New York, Pennsylvania accounts for 2% of U.S. production; production in Colorado, Connecticut, and Utah accounts for <1% of production.

In 2000, about 547,000 tons, or almost 60% of U.S. production, went to the fresh market (USDA 2000). At $173 million, this represents almost 70% of the total value. The price premium for fresh market production is considerable. The average U.S. price for fresh market pears in 2000 was $318/ton compared to $190/ton for processed. The U.S. exported 165,600 metric tons (MT) of fresh pears (FATUS, 2001) in 2000, with a value of $91 million. Almost half went to Mexico. Due to seasonality of production, the U.S. also imported about 93,600 MT of fresh pears, mostly from Argentina and Chile, with a value of $80.6 million.

DIAZINON USAGE ON PEARS

BEAD estimated that between 1987 and 1997, diazinon was applied to about 11% of pear acreage annually (BEAD, 2000). Bearing acreage of pears was somewhat higher during this period compared to the past several years, measuring about 78,000 acres. BEAD estimated usage to be approximately 16,000 lbs. active ingredient (a.i.) per year. USDA (2000) reports 7% of the acreage was

treated in 1999, the last year for which data are available, with 8,900 lbs a.i. This suggests that diazinon usage on pears is declining.

Usage in California is somewhat higher than the national average. USDA reports 11% of the acreage in California was treated in 1999, using 4,200 lbs of diazinon. Data from the California Environmental Protection Agency (2001) show an average usage of 4,100 lbs annually between 1997 and 2000. Washington reported 9% of acreage treated, representing over 2,000 acres, with 4,700 lbs a.i. (Table 2). Michigan, Oregon and Pennsylvania report using diazinon; however, usage was not quantified in 1999, and is assumed to be minor. Oregon treated 9% of pear acreage in 1997 with diazinon, about 1,600 acres, utilizing 1,700 lbs a.i.

Table 2. Diazinon Usage on Pears, 1999

Region	Percent Crop Treated	Base Area Treated	lbs. a.i. Applied	no. of Applications	lbs. a.i. per Acre per Year
U.S.[1]	7	4,600	8,900	1.2	1.9
California	12	2,500	4,100	1.1	1.6
Oregon[2]	5	900			
Washington	9	2,200	4,700	1.0	2.1

Source: USDA/NASS, Agricultural Chemical Usage, 2000.

[1] Columns may not sum due to rounding.

[2] Oregon figures are assumed, given no reporting in 1999.

Target Insect Pests and Control

The life cycle of a pear tree is similar to other fruit trees, such as apples. In general, the trees will break their dormant/delayed dormant phase in early to mid-April. Pink through petal fall stages occur from mid-April through mid-May. The fruit may mature as early as late July or as late as October depending upon variety and location.

Although there is little use of diazinon in pears, the primary target is San Jose scale, *Quadraspidiotus perniciosus*. There are generally two generations of San Jose scale per year. This insect infests branches, shoots, leaves and fruit. The insects feed by sucking plant juices from the trees and they may also inject a toxin. Female scales bear live young (crawlers), which move to new feeding sites including the fruit. Eventually they become sessile, lose their legs, and form a scale cover. Fruit infested by San Jose scale is often bumpy and, in extreme cases, fruit may be severely misshapen and stunted. Fruit with scale damage is downgraded to culls. Additionally, San Jose scale can seriously weaken branches and main scaffold limbs and kill fruiting spurs, thus causing permanent injury and even death to mature trees (OR Pear Crop Profiles, 1999).

Recommended Control: Horticultural oil plus an OP, like diazinon or chlorpyrifos, applied during the dormant or delayed dormant stage, is the most efficacious control for San Jose scale and many other overwintering pear insects. Thorough coverage is important for effective control. If a dormant spray is not applied, it is important to monitor for San Jose scale using pheromone traps and degree-day models in the spring. Although the timing of San Jose scale sprays in the spring may not be the same as codling moth sprays, usually a regular spray program of azinphos-methyl or phosmet against codling moth will also help to control San Jose scale crawlers. However, in many areas this crawler stage does not coincide with the codling moths and applying azinphos-methyl or phosmet again would be more than the pest situation warrants. Additionally, the number of applications of azinphos-methyl and phosmet are limited, and growers will want to save these chemicals for codling moth infestations.

Dormant or Delayed Dormant Applications for San Jose Scale

Horticultural Oils

In 1997, a total of 2,460,930 lb a.i. was applied to 89.8% of the pear acreage. Oils were applied an average of 3 times at a median rate of 23.57 lb a.i./acre. The 1998 use in Oregon was 100% in the Hood River Valley and 90% in southern Oregon (Oregon Crop Profile). Control is better if the oil is combined with diazinon or chlorpyrifos.

Pyriproxifen

In 1998, growers in Oregon treated 80% of the pear acreage in the Hood River Valley and 40% of the acreage in southern Oregon, under a Section 18 exemption. This Insect Growth Regulator was registered on pears in the fall of 1999. It appears to fit well with an integrated pest management strategy.

Liquid Lime Sulfur

Product labels allow a 7 lb a.i./acre rate and a 48-hour REI. In 1997, a total of 106,614 lb a.i. was applied to 19.77% of the CA pear acreage. Lime sulfur was applied an average of 1 time at a median rate of 18.41 lb a.i./acre. The 1998 usage in the Hood River Valley was 20% of the acreage and 45% of the acreage in southern Oregon was treated (Oregon Crop Profile).

Wettable Sulfur

Product labels allow an 8-16 lb a.i./acre rate and a 24-hour REI. In 1997, a total of 145,407 lb a.i. was applied to 46.08% of the pear acreage. Sulfur was applied an average of 1 time at a median rate of 10.4 lb a.i./acre. Applied at 5 lb/acre in the finger stage (pre-bloom) can also reduce mite populations. (Ca Pear Crop Profile) Oregon Crop Profile reported in 1998 80% of the Hood River Valley acres and 5% of southern Oregon acres

Post-Bloom Applications

There are no viable alternatives to diazion for control of San Jose scale during the growing season due to phytotoxicity concerns with oils, chlorpyrifos, pyriproxyfen and sulfur. Azinphos-methyl and phosmet could provide suppression activity, but the number of applications are limited and are needed for codling moth control. If an outbreak of San Jose scale should occur and not be controlled, a grower could potentially suffer quality reductions on 20-25% of the fruit (McClain, personal communication).

If control of San Jose scale is not accomplished by the dormant applications, the recommendation is an application of diazinon for the second generation during the summer.

Another potential use of diazinon in California is in orchards that border residential areas, schools, or public lands. According to the California Pear Advisory Board, County Agriculture Commissioners will not issue permits for the use of azinphos-methyl to control codling moths in the portions of the orchard that border these sensitive areas. Phosmet, though not as efficacious as azinphos-methyl, is still allowed in most of these areas and is more efficacious against the codling moth than diazinon. However, diazinon is an alternative currently available for this use. Diazinon is rated as fair and has to be applied more often to provide some control (50%) of codling moth. Some pear growers are concerned that in the future phosmet will no longer be allowed in these sensitive areas and then they will need diazinon.

IMPACTS OF CANCELLATION OF DIAZINON

Viable alternatives exist for control of San Jose scale during the dormant or delayed dormant stage of pears. Many growers already utilize these alternatives, depending on the level of pest pressure. Cancellation of diazinon would force growers currently using it to switch to another method. There are no viable alternatives to diazinon for summer sprays for San Jose scale, growers who fail to control the scale with dormant sprays, and get an outbreak, could see a decrease in the quality of the fruit, resulting in a 20-25% loss.

Economic Impacts

A crop budget approach was used to determine the economic impact of diazinon cancellation on pear growers. Sample production costs were obtained from the Agricultural Cooperative Extension programs of Oregon and Washington State Universities and the University of California. These budgets are reflective of the likely incurred costs, but are not based on cost of production surveys. This analysis assumes that farm gate prices are not affected by any changes at the grower level and that growers do not drastically alter their production practices. We focus solely on operating costs, ignoring overhead, the opportunity cost of land and amortized establishment costs, as these are difficult to measure. Thus net cash returns overstate actual profits to the grower.

Historical yield and price data were utilized to determine gross returns per acre. Table 3 presents gross returns, production costs and net cash returns to pear production in Central Washington, assuming

a San Jose scale infestation during the dormant or delayed-dormant period. Yields have averaged 16.7 tons/acre over the past several years, ranging from 16.0 to 17.4 (USDA, 2001). Yields are not expected to be impacted by the cancellation of diazinon because alternatives are equally effective for the dormant spray against San Jose scale. The price of $274.40/ton is a weighted average of fresh and processed pears.

According to the estimated crop budgets, insecticide costs cover eight applications throughout the year, with a total cost of $549/acre. EPA data provides a per acre cost of diazinon in Washington, for an application rate of 1.5 lbs a.i./acre, of about $13.50. Chlorpyrifos, applied at about 1.7 lbs a.i./acre, costs $19.50, while pyriproxyfen, applied at 0.05 lbs a.i./acre, costs over $40/acre. Sulfur costs less than diazinon, but BEAD assumes that growers use diazinon because sulfur is inappropriate for their situation. BEAD believes growers currently using diazinon would choose to apply chlorpyrifos in the case of cancellation, increasing chemical costs by nearly $6.00 per acre. This implies an increase of 0.2% in total operating expenses. Net cash revenues per acre are expected to decline about 0.4% for growers currently using diazinon. For a typical farm with 40 acres of pears, income losses are estimated at almost $235 if an infestation occurs.

Table 3. Gross Returns, Production Costs and Net Returns to Pear Production, Central Washington, with San Jose scale outbreak during dormant season.

	base scenario diazinon	alternative chlorpyrifos	% change
production (tons/acre)	16.7	16.7	0.0
price ($/ton)	274.40	274.40	
gross returns ($/acre)	4582.48	4582.48	
diazinon ($/acre) chlorpyrifos ($/acre)	13.50	 19.50	 42.8
other insecticide costs ($/acre)	535.00	535.00	
total insecticide costs	548.50	554.50	0.8
other pre-harvest costs ($/acre)	2049.50	2049.50	
harvest costs ($/acre)	601.20	601.20	
total operating costs ($/acre)	3199.20	3205.20	0.2
net cash returns ($/acre)	1383.28	1377.28	-0.4

Source: University of Washington Cooperative Extension, BEAD data.

Values are similar for Oregon. Although yields per acre are lower, 12.9 tons/acre, prices received are higher, $353.60/ton, resulting in gross returns of $4561/acre. Total insecticide costs are expected to be somewhat lower than in Washington, slightly more than $300/acre. The cost differential between diazinon, applied at 2.0 lbs/acre, and chlorpyrifos, at the same rate, is $5.35/acre, for a change in total insecticide costs of 1.7%. Total operating costs are expected to increase 0.2% and net cash returns to fall 0.5%, from $1006/acre to $1001/acre. Oregon orchards are smaller in size than in Washington, between 12 and 30 acres. A 20-acre farm would be expected to lose about $107 when there is an infestation.

California has a somewhat higher harvest cost, which reduces net returns, but is otherwise similar. Expected yields are 16.3 tons/acre and the weighted average price is about $235/ton for gross returns of $3840 per acre. Diazinon for scale control is applied at 1.7 lbs a.i./acre at a cost of slightly more than $13. At 1.3 lbs a.i., chlorpyrifos costs over $18/acre for a cost increase of $5.10. Total insecticide costs increase 1.5% and total variable costs increase 0.1%. Net cash returns in California are only $331/acre and would decline to $326, or 1.5%. Farm size is highly variable depending on the region of California, from only 5 acres of pears in the Sierra Nevada foothills to 100 acres in production in the Sacramento Delta area. Farm losses would thus vary from $25 to $510 due to cancellation of diazinon.

BEAD concludes that cancellation of diazinon would have negligible impacts on growers that use diazinon for dormant or delayed-dormant control of San Jose scale. However, for a summer outbreak of the pest, the loss of diazinon would result in disaster for impacted growers because chlorpyrifos and other alternatives are not appropriate for use during the growing season. Left uncontrolled, San Jose scale causes severe quality damage to the fruit. Damage would be such that the affected pears could not be marketed for either fresh or most processed purposes, including canning or drying. The pears could be used for juice, but at a significant loss in value.

California data (UC, 2000) indicate that about 34% of pears make it to the fresh market, 49% to processed and 17% is off-grade or culled and sold for juice. Average prices for the various categories from the same data are $360/ton fresh, $220/ton processed and $30/ton cull. As shown in the first column under California in Table 4, the weighted average price of pears is $236/ton. Quality losses of 25% from the fresh and processed categories (second column) to cull result in a drop in expected prices to less than $200/ton, a 22% decrease in the weighted average price. Gross revenues also decline by 22% for infested acres in California. While there would be a slight decrease in insecticide costs, California data suggests that harvest costs would actually increase because additional sorting of the fruit is required. Revenues for affected growers in California would not cover operating costs; shortfalls could be more than $500/acre. Most growers would have already paid the majority of their operating costs, so they may harvest despite the losses, since the income would at least pay the harvest costs.

Table 4 provides similar information for Oregon and Washington, however these data are less certain than for California. Data are unavailable for a precise breakdown of fresh, processed and cull yields or prices. Figures in Table 4 are based on USDA/NASS data for utilization of Bartlett pears only, the average price per ton of fruit and the fact that nationally, 60% of pears are currently destined for the fresh market. Consequences for Oregon growers with summer infestations of San Jose scale are similar to

California, with losses after paying costs of more than $450/acre; this represents a net loss of more than $1000/acre. Losses in Washington are of similar magnitude, but affected growers would maintain a slight positive return of about $375/acre.

Because scale is an occasional pest, growers would not necessarily incur these losses every year. Pear growers with consistent scale problems during the summer month would eventually be forced to exit the industry, possibly cultivating other crops. Most growers would expect to face an infestation at some point, however. Cancellation of diazinon for summer scale control would increase the probability of losses and the variability of income for nearly all growers.

Regional Level Impacts

Most growers obtain control of San Jose scale with dormant or delayed dormant applications. California data suggest that about 60% of the acres treated with diazinon are treated at this time. Assuming a similar distribution in Oregon and Washington allows us to make rough estimates of losses to the pear industry nationally.

Table 4. Impact on fruit quality and gross revenue of cancellation of diazinon for summer San Jose scale control, assuming no alternative.

	California		Oregon		Washington	
	with diazinon	without diazinon	with diazinon	without diazinon	with diazinon	without diazinon
yield fresh (ton/acre)	5.6	4.5	8.5	6.4	11.0	8.3
price ($/ton)	360	360	468	468	351	351
value ($/acre)	2016	1620	3978	2995	3861	2913
processed (ton/acre)	7.9	6.3	3.2	2.4	4.2	3.1
price ($/ton)	220	220	168	168	160	160
value ($/acre)	1738	1386	538	403	672	496
cull (ton/acre)	2.8	5.5	1.2	4.1	1.5	5.3
price ($/ton)	30	30	30	30	30	30
value ($/acre)	84	165	36	123	45	159
total (ton/acre)	16.3	16.3	12.9	12.9	16.7	16.7
value ($/acre)	3841	3003	4561	3518	4582	3562

	California		Oregon		Washington	
	with diazinon	without diazinon	with diazinon	without diazinon	with diazinon	without diazinon
average price ($/ton)	235.64	184.23	353.58	272.69	274.36	213.27
% change		-21.8		-22.9		-22.3

Source: BEAD/EPA calculations.

Given the estimates of acres treated found in Table 2, dormant season sprays occur on about 3,360 acres. With cost increases of $5-6.00/acre from switching to chlorpyrifos for dormant applications, BEAD estimates losses of between $16,800 and $20,200 annually for California, Oregon and Washington. Losses due to lack of control options for the second generation of San Jose scale are much greater, although the affected acreage, 2,240, is less. California growers would be expected to lose about $840,000 yearly, while for Oregon and Washington the figures are $378,000 and $880,000. Total losses to the pear industry of the three states are more than $2.1 million in net revenues out of a gross value of production of $267 million. Less than 3% of pear production occurs outside these three states, but some losses would be incurred there as well.

While the individual grower would face scale infestations only occasionally, at the national level some percentage of pear acreage will likely be affected every year. Thus, industry losses are expected to occur annually. Losses to the industry are estimated to be 0.8% of gross revenues.

CONCLUSION

Diazinon is mainly used on pears for control of San Jose scale, which has two generations each year. Cancellation of diazinon for the first generation, which occurs during the dormant or delayed-dormant period, would have negligible impacts on growers and the pear industry since effective, but slightly more costly, control options are available. However, without diazinon to control the second generation, which may occur during the summer growing period, individual growers could face a disastrous situation because there are no feasible control alternatives. A scale outbreak would cause severe quality losses resulting in declines of gross revenues between 20 and 25%. BEAD estimates that losses in net revenue for affected growers range from $800-1000/acre and would likely result in negative returns. The industry as a whole would lose about $2.1 million annually.

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