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

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

MEMORANDUM

DATE: 05-12-02

SUBJECT: Plum/Prune Benefits Assessment for Diazinon

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PRP REVIEW DATE: 05-01-02

SUMMARY

Based on available published information and personal communications with experts, BEAD believes that the impact of diazinon phase-out for pest control on plums and prunes will be minor since alternatives exist. Diazinon is used on plum and prune orchards to control primarily the peach twig borer, mealy plum aphid, leaf curl plum aphid, and San Jose scale during the dormant, delayed dormant, and bloom periods. As several efficacious alternatives exist for use against each of these pests, the main economic impacts of a diazinon phase-out are cost impacts. BEAD calculates that the cost increase per

application of losing diazinon for control of aphids, scales, and the peach twig borer on the affected acreage could be at most 2% of gross revenue, while the annual cost increase over the entire plum/prune acreage is expected to be less than 1% of the total production value.

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 plums/prunes. 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 plums/prunes 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 estimated grower impacts assume there will be no shift from plums/prunes to other crops.

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 plums/prunes production, and other sources listed. Plums/prunes production is a 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 very limited.

PLUMS AND PRUNES PRODUCTION

The main cultivars in U.S. plum production are the "Improved French" plum (*Prunus domestica* L.) and the Japanese plums (*Prunus salicina* L. and hybrids), in the family Rosaceae. Plums are the most taxonomically diverse of the stone fruits, and are adapted to a broad range of climatic and edaphic factors. Plums are small to medium sized trees, more erect than peaches, with flowers similar in morphology to peach flowers, but smaller, white, with longer pedicels. The fruit is oval-shaped or round in European types and round to conical or heart-shaped in Japanese types. Fruit size varies with thinning, but is generally larger in Japanese types. Native American types and their hybrids with Japanese plum often have small fruit size. Prunes are only made from plum varieties that are sufficiently firm and sweet enough to dry without fermenting.

Deep, fine-sandy loam soils with good internal drainage and freedom from alkali or salinity are best for optimum plum growth and production. Plum trees will not produce commercially acceptable crops under arid California conditions without supplemental irrigation water. Plum trees may flower in the second year, but substantial bearing does not begin until the fourth year. European plums are less precocious than Japanese types, with little spur and fruit production until the third or fourth year. Fruit

thinning is necessary for proper size development for Japanese plum hybrids, which can produce tens of thousands of flowers per tree. Thinning is not always necessary for prunes. The harvest season extends from mid May through early October.

Utilized production of plums and prunes in the U.S. in 2001 was 602,000 tons harvested from about 127,000 bearing acres. Average price was $287 per ton, for a total value in the U.S. of about $173 million. The leading state by far is California, with approximately 96% of the bearing acreage and 97% of the total production, followed by Oregon, Washington, Michigan and Idaho. Many other states grow relatively small numbers of plums and/or prunes which have not been included below. Most utilization of production is for processed products, including prunes. See Tables 1, 2 and 3 for details.

Table 1. Plums and Prunes: Bearing Acreage, Yield, Production and Utilization in 2001[1,2]

State/Total	Bearing Acreage (acres)	Yield per Acre[3] (tons)	Total Production (tons)	Utilized[4] Production (tons)	Fresh Utilization (tons)	Processed Utilization (tons)
California Plums	37,000	5.68	210,000	210,000		
California Prunes	86,000	4.82	414,400	372,400	0	372,400
Other States Plums & Prunes	4,410	4.72	20,800	19,600	11,000	8,600
Idaho			3,000	3,000		
Michigan	900	4.00	3,600	3,600	1,800	1,800
Oregon	2,000	4.50	9,000	7,800		
Washington			5,200	5,200		
Total Plums & Prunes	127,410	5.06	645,200	602,000		

[1]Missing data not published to avoid disclosure of individual operations.
[2]All production, yield and utilization, are on a fresh basis, where, for prunes, 1 ton dried equals 2.8 tons fresh.
[3]Yield is based on total production.
[4] For sale, home use, or storage
Source: USDA/NASS, Noncitrus Fruits and Nuts, 2001 Preliminary Summary

Table 2. Plums and Prunes: Price and Production Value in 2001[1,2]

State/Total	Fresh Price ($/ton)	Processed Price ($/ton)	Total Price ($/ton)	Fresh Production Value (1000 $'s)	Processed Production Value (1000 $'s)	Total Production Value (1000 $'s)
California Plums			316			66,443
California Prunes	NA	271	271	0	101,080	101,080
Other States Plums & Prunes	345	185	274	3,790	1,590	5,380
Idaho			582			1,745
Michigan	442	274	358	796	493	1,289
Oregon			166			1,298

State/Total	Fresh Price ($/ton)	Processed Price ($/ton)	Total Price ($/ton)	Fresh Production Value (1000 $'s)	Processed Production Value (1000 $'s)	Total Production Value (1000 $'s)
Washington			202			1,048
Total Plums & Prunes			287			172,903

NA = not applicable
[1]Missing data not published to avoid disclosure of individual operations.
[2]All prices are on a fresh basis.
Source: USDA/NASS, Noncitrus Fruits and Nuts, 2001 Preliminary Summary

Table 3. Other States Processed Plums and Prunes: Use, Utilization and Price in 2001[1]

Use	Processed Utilization (tons)	Price ($/ton)
Other States All Uses[2]	8,600	185
Canned	4,070	189
Frozen	1,280	241
Dried & Other	3,250	158

[1]Utilization and prices are on a fresh basis.
[2]Idaho, Michigan, Oregon and Washington
Source: USDA/NASS, Noncitrus Fruits and Nuts, 2001 Preliminary Summary

USE OF DIAZINON ON PLUMS AND PRUNES

Petroleum distillate was the most widely used insecticide on California plums in 1999 in terms of area treated, followed by esfenvalerate, carbaryl and chlorpyrifos, B.t. and phosmet, methidathion and diazinon, in that order. Diazinon was applied on 8 percent of the plum acreage (Table 4). Petroleum distillate was also the most commonly used insecticide on California prunes in 1999, followed by esfenvalerate, diazinon, B.t. and fenbutatin-oxide. Diazinon was applied on 14 percent of the prune acreage (Table 4). Diazinon used on plum and prune orchards is available as emulsifiable concentrate and wettable powder formulations. Diazinon may be applied to orchards using aircraft or ground application equipment.

Table 4. California Plums: Top Eight Insecticide Applications in 1999[1]

Insecticide	Area Applied (%)	Applications (no./year)	Rate per Application (lbs. a.i./acre)	Rate per Crop Year (lbs. a.i./acre)	Total Applied (1000 lbs. a.i.)
Bt[2]	16	1.2			
Carbaryl	19	1.1	4.08	4.64	38.9
Chlorpyrifos	19	1.3	2.00	2.75	23.6
Diazinon	8	1.1	1.94	2.22	7.6

Insecticide	Area Applied (%)	Applications (no./year)	Rate per Application (lbs. a.i./acre)	Rate per Crop Year (lbs. a.i./acre)	Total Applied (1000 lbs. a.i.)
Esfenvalerate	21	1.3	0.05	0.06	0.6
Methidathion	10	2.0	1.96	4.08	17.5
Petroleum distillate	52	1.5	33.77	50.51	1,179.3
Phosmet	16	1.7	2.91	5.15	36.2

[1]Total acres in 1999 for California were 44,500 acres. Acreage includes both bearing and non-bearing acres.
[2]Rates and total applied are not available because amounts of active ingredient are not comparable between products.
Source: USDA/NASS, Agricultural Chemical Usage, 1999 Fruit and Nut Summary

Table 5. California Prunes: Top Five Insecticide Applications in 1999[1]

Insecticide	Area Applied (%)	Applications (no./year)	Rate per Application (lbs. a.i./acre)	Rate per Crop Year (lbs. a.i./acre)	Total Applied (1000 lbs. a.i.)
Bt[2]	6	1.1			
Diazinon	14	1.0	1.48	1.62	22.9
Esfenvalerate	29	1.2	0.05	0.06	1.7
Fenbutatin-oxide	5	1.1	0.59	0.67	3.4
Petroleum distillate	38	1.2	20.36	24.42	913.3

[1]Total acres in 1999 for California were 98,000 acres. Acreage includes both bearing and non-bearing acres.
[2]Rates and total applied are not available because amounts of active ingredient are not comparable between products.
Source: USDA/NASS, Agricultural Chemical Usage, 1999 Fruit and Nut Summary

Target Pests

In the western states, diazinon is used on plum orchards to control primarily the peach twig borer (*Anarsia lineatela*), mealy plum aphid (*Hyalopterus pruni*), leaf curl plum aphid (*Brachycaudus helichrysi*), and San Jose scale (*Quadraspidiotus perniciosus*) during the dormant, delayed dormant, and bloom periods. The peach twig borer can inflict damage by feeding in shoots and causing shoot strikes, or by feeding directly on the fruit. Shoot damage is most severe on young, developing trees because feeding kills the terminal growth and can result in undesirable lateral branching. As fruit matures, it too becomes susceptible to attack. Twig borer larvae generally enter fruit at the stem end or along the suture and feed just under the skin. Aphids can infest shoot tips and leaves. The mealy plum

aphid, in particular, secretes large amounts of honeydew, which is a medium for black sooty mold growth. The mold, in turn, can reduce photosynthesis and affect vegetative growth. The San Jose scale , reported to be a serious pest of some stone fruits, is probably a minor pest of plums in California (W. Olson, personal communication). The oblique-banded leafroller (*Choristoneura rosaceana*), a stone fruit pest that is becoming increasingly common in California, feeds on leaves and buds during the bloom period, and also on the fruit surface in midsummer.

During the dormant and delayed dormant season, diazinon is applied to orchards, in combination with a narrow-range oil to control overwintering peach twig borer, San Jose scale, European red and brown mites, leafroller complex, and aphid eggs in California orchards. A dormant application of diazinon without the oil will control most overwintering pests, whereas a dormant application of the oil without diazinon (or another suitable insecticide) will only control scales and mites, but not overwintering aphid eggs or peach twig borer larvae. Field tests have shown that 50% of orchards develop treatable mealy plum aphid and leaf curl plum aphid problems if not treated with dormant diazinon sprays (W. Olson, personal communication). In spring, during the bloom stage, diazinon can be applied again to control aphids, scales, the peach twig borer, leafrollers, and other lepidopterous pests. During the post-bloom stage (mid-June through mid-September), diazinon may be used against the oblique banded leafroller. Control provided by diazinon is generally rated as excellent (PMSP for California, 2002).

ALTERNATIVE CONTROL METHODS

Alternative insecticides rated as good to excellent by the 2002 Pest Management Strategic Plan (PMSP) for California Prune Production for control of overwintering aphids on plum/prune orchards during the dormant and delayed dormant period are chlorpyrifos, methidathion, and esfenvalerate. Phosmet is also used occasionally against aphids, but its effectiveness is unknown. Alternatives rated as good to excellent for twig borer control are chlorpyrifos, methidathion, phosmet, esfenvalerate, and carbaryl. Alternatives similarly rated for scale insect control during the dormant season are chlorpyrifos, methidathion, and narrow range oils. When applied by itself, oil will control scales and mites, but not aphids or overwintering lepidopterous pests like the peach twig borer. Thus, during the dormant season, oils are applied in combination with another insecticide, usually an organophosphate. Chlorpyrifos may be applied only during the dormant or delayed dormant period.

During the bloom period chlorpyrifos and methidathion are rated as good to excellent for aphid control by the California PSMP, whereas narrow-range oils may provide fair to good control when aphid infestations are light. Azinphos methyl is also rated as excellent aphicide, although its registration for this use on plums/prunes is currently under review. Phosmet, is available for aphid control, but there is little information regarding its efficacy. Insecticides rated as good to excellent for control of the peach twig borer, leafrollers, and other lepidopterous pests during this season are phosmet, chlorpyrifos, methidathion, Bt, and spinosad. Chlorpyrifos and methidathion are known to provide excellent San Jose scale control during the bloom period. Oil, applied by itself, is rated as good to excellent for light infestations of the scale. During the post-bloom season (summer), B.t. and phosmet are available for control of the oblique banded leafroller.

Numerous natural enemies attack the stone fruit insect pest complex, but by themselves generally do not reduce pest populations below economic damaging levels. Nonetheless, because natural enemies contribute to insect pest mortality, they need to be protected to the extent possible from exposure to pesticides.

ECONOMIC IMPACT OF LOSING DIAZINON IN PLUM/PRUNE PRODUCTION

Based on the 2002 Pest Management Strategic Plan for California Prune Production and consultations with crop advisors, suitable alternative chemicals exist for control of aphids, scales, the peach twig borer and other insects which are controlled by diazinon on plums/prunes. Thus, since alternatives can be assumed to be comparable in effectiveness to diazinon for controlling these pests, the main economic impacts of losing diazinon are cost impacts. Tables 6, 7 and 8 summarize pesticide usage and the cost impacts of replacing acre-treatments of diazinon with acre-treatments of each of several alternatives, assuming one-for-one replacements, no yield losses, and equal application costs for aphid control, scale control and peach twig borer control, respectively.

As summarized in Table 6, replacing diazinon with petroleum oil or esfenvalerate for aphid control leads to a reduction in pesticide cost since diazinon costs more per acre than each of these. Replacing diazinon with chlorpyrifos increases cost by $5.70 per acre-treatment or by about $110,000 annually over the affected acreage, while replacing diazinon with methidathion increases cost by $23.80 per acre-treatment or by about $440,000 annually over the same acreage. With average gross revenue of $1357/acre computed from Tables 1 and 2, the cost increase per application of losing diazinon for control of aphids on the affected acreage even with the most expensive (but less used) chemical is only 2% of gross revenue. With total production value of $172,903,000 from Table 2, the annual cost increase over the entire plum/prune acreage is less than 1% of that value.

Table 6. Major Treatments on Plums/Prunes for Aphids and Cost Impact of Replacing Diazinon with Alternatives

Insecticide	Acre-treatments (000)	Cost[1] ($/acre-treatment)	Expenditures[1] (000)	Cost Increase[1] ($/acre-treatment)	Expenditure Increase[1] (000)
Diazinon	19	$11.60	$210		
Petroleum Oil	15	$8.20	$130		
Esfenvalerate	10	$10.80	$100		
Chlorpyrifos	4	$17.30	$80		
Methidathion	4	$35.40	$150		
Replacing Diazinon with :					
Petroleum Oil	19	$8.20	$150	($3.40)	($60)
Esfenvalerate	19	$10.80	$200	($0.80)	($20)
Chlorpyrifos	19	$17.30	$320	$5.70	$110
Methidathion	19	$35.40	$660	$23.80	$440

[1] Material Assumptions: - One for one replacement of diazinon acre-treatment with alternative.
- Constant costs.

Table 7. Major Treatments on Plums/Prunes for Scales and Cost Impact of Replacing Diazinon with Alternatives

Insecticide	Acre-treatments (000)	Cost[1] ($/acre-treatment))	Expenditures[1] (000)	Cost Increase[1] ($/acre-treatment)	Expenditure Increase[1] (000)
Petroleum Oil	68	$10.30	$710		
Diazinon	19	$13.10	$250		
Chlorpyrifos	14	$19.50	$280		
Methidathion	11	$34.10	$380		
Replacing Diazinon with :					
Petroleum Oil	19	$10.30	$200	($2.80)	($50)
Chlorpyrifos	19	$19.50	$370	$6.50	$120
Methidathion	19	$34.10	$650	$21.00	$400

[1] Material Assumptions: - One for one replacement of diazinon acre-treatment with alternative.
- Constant costs.

As shown in Table 7, replacing diazinon with petroleum oil for scale control leads to a reduction in pesticide cost since diazinon costs more per acre. Replacing diazinon with chlorpyrifos increases cost by $6.50 per acre-treatment or by about $120,000 annually over the affected acreage, while replacing diazinon with methidathion increases cost by $21 per acre-treatment or by about $400,000 annually. The cost increase per application of losing diazinon for control of scales on the affected acreage with the most expensive chemical is less than 2% of gross revenue, while the annual cost increase over the entire plum/prune acreage is less than 1% of production value.

Replacing diazinon with esfenvalerate or B.t. for peach twig borer control leads to a reduction in pesticide cost since diazinon costs more per acre for each Table 8). Replacing diazinon with chlorpyrifos increases cost by $8.30 per acre-treatment or by about $200,000 annually over the affected acreage, while replacing diazinon, for example, with methidathion increases cost by $20.80 per acre-treatment or by about $510,000 annually. The cost increase per application of losing diazinon for control of the peach twig borer on the affected acreage with the most expensive chemical is again less than 2% of gross revenue, while the annual cost increase over the entire plum/prune acreage is again less than 1% of production value.

Table 8. Major Treatments on Plums/Prunes for Twig Borer and Cost Impact of Replacing Diazinon with Alternatives

Insecticide	Acre-treatments (000)	Cost[1] ($/acre-treatment)	Expenditures[1] (000)	Cost Increase[1] ($/acre-treatment)	Expenditure Increase[1] (000)
Esfenvalerate	27	$9.80	$270		
Diazinon	24	$12.70	$310		
Chlorpyrifos	12	$21.10	$250		
Phosmet	7	$18.20	$120		
Bt	6	$11.70	$70		
Methidathion	6	$33.50	$190		
Carbaryl	1	$17.80	$20		
Replacing Diazinon with :					
Esfenvalerate	24	$9.80	$240	($2.90)	($70)
Chlorpyrifos	24	$21.10	$510	$8.30	$200
Phosmet	24	$18.20	$440	$5.40	$130
Bt	24	$11.70	$290	($1.00)	($20)
Methidathion	24	$33.50	$810	$20.80	$510
Carbaryl	24	$17.80	$430	$5.10	$120

[1] Material

Assumptions: - One for one replacement of diazinon acre-treatment with alternative.
- Constant costs.

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