Department of Pesticide Regulation
Environmental Monitoring Branch
1001 I Street
Sacramento, California 95812

Soil and Water Requirements for Conducting Pesticide Terrestrial Field Dissipation Studies as Required by the California Pesticide Contamination Prevention Act

Murray Clayton
John Troiano

August 29, 2017

BACKGROUND

The Pesticide Contamination Prevention Act (PCPA) was enacted in 1985 to prevent further contamination of California ground water from legal agricultural use of pesticides. One aspect of the PCPA requires registrants of pesticide products to provide data on specific environmental fate and chemistry properties of active ingredients in pesticide products submitted for registration in California (California Food & Agriculture Code (FAC), 13143 (a)). These data are intended to be used to identify those active ingredients with the potential to pollute ground water. Data from terrestrial field dissipation (TFD) studies is one such requirement; these studies characterize the fate and movement of pesticide active ingredients and their major degradates in the soil environment. In order to guarantee the most accurate prediction of a pesticide's likelihood to pollute California ground water, the PCPA specifies that data from at least one TFD study be derived from a study conducted in California or under similar environmental use conditions (FAC, 13143 (a) (6)). However, the PCPA failed to define California conditions or specify what would constitute 'similar environmental use conditions'.

Registrants have generally interpreted 'similar environmental use conditions' to mean air temperature, or a range of air temperatures, for a specific location in the state where their pesticide product(s) could be designated for use on a particular crop. However, many California crops are produced under highly diverse environmental conditions. For example, alfalfa is the state's largest crop by acreage with approximately one million acres harvested annually with primary production areas in the Central Valley, Low and High Desert areas, and Coastal and Intermountain Regions. Thus, defining a similar environmental use condition for pesticides applied to alfalfa with respect to a representative climate is unrealistic. In the context of the PCPA, a more intuitive definition would relate to conditions representative of regions of known pesticide contamination of ground water in California. An environmental use condition where there have been numerous detections of pesticides in California ground water is in semi-arid and intensively irrigated coarse-textured soil areas of the Central Valley. Coarse soils with low organic matter are highly permeable so that dissolved substances move with percolating water. Therefore, studies designed to test a pesticide's likelihood to pollute ground water should be conducted at a site with soil and irrigation conditions to best test its potential to leach.

TFD studies are conducted under guidance issued by the US Environmental Protection Agency (EPA) (Corbin et al., 2006) where the principal pesticide dissipation pathways must be characterized. The guidance specifies a modular approach to designing TFD studies where identification of multiple dissipation pathways that are incompatible under a single testing scenario are evaluated in separate studies. For example, a modular approach would be advisable when evaluating a pesticide for soil persistence and for soil mobility in the presence of percolating water, particularly if residue losses occurred due to leaching. The US EPA guidance states that water applications are to be applied at 110 to 120% of normal crop demand or average monthly rainfall records. Water applications at these suggested rates do not represent the range applied to crops in the Central Valley of California, and this range does not produce sufficient percolating water to test the leaching potential of a pesticide. Review of numerous TFD studies submitted to DPR has indicated that little to no deep percolation of water is generated in studies that follow the US EPA guidelines for water application. When the objective of the study is to characterize the leaching potential of a pesticide, lack of sufficient percolation water invalidates the study for the stated purpose. DPR's standard ground water model (Troiano and Clayton, 2009) provides further evidence that water input up to 125% of crop demand actually mitigates pesticide movement to ground water. Water input at or below125% of crop demand reflects efficient irrigation practices where leaching is limited.

The objective of this analysis is to provide a specific set of conditions that fulfill the requirement for conducting at least one TFD study under California conditions as intended by the PCPA. Parameters are given defining soil properties that are vulnerable to leaching of pesticide residues to ground water and that define a regime of water applications that assures production of sufficient percolating water to test the leaching potential of a chemical.

ANALYSIS METHODOLOGY

DPR staff previously developed the CALVUL model, which is a vulnerability analysis that includes identification of soil conditions that are related to pesticide detections in California ground water (Troiano et al., 2000). Development of the vulnerability analysis was based on correlations between existing detections of pesticides in California ground water and soil types in the sections of land overlaying the detections, where sections of land are geographically identified by the US Geological Service (USGS) public land survey coordinate system. Using this vulnerability analysis, studies were conducted to identify pathways of ground water contamination. These included residue leaching in coarse-textured soils high in sand content and residue runoff from soils containing hardpans near the soil surface. For runoff, water is conveyed to sites or structures that enhance direct movement to ground water or to underlying leaching vulnerable soils. Depth to ground water was later determined as a factor related to ground water contamination and was included in the CALVUL model. In 2004 ground water protection areas (GWPAs) were formed based on predictions from the CALVUL model of soil vulnerability to off-site movement of pesticides, and were designated accordingly as either leaching or runoff vulnerable sections.

This report contains an analysis conducted to determine the predominant soil properties in sections of land classified by the CALVUL model as containing coarse-textured soils that are vulnerable to leaching of pesticide residues to ground water. Only those sections where pesticide residues have been detected in ground water by DPR prior to 2015 and confirmed as a result of legal agricultural use were used because they provide an unequivocal association between coarse-textured soils and ground water contamination. Runoff areas were excluded from the analysis because many of these sections are characterized by finer-textured soils near the surface, which are not conducive to percolating water and leaching residues. In the context of the PCPA, coarse-textured soils with a sand content above a minimum threshold represent the most appropriate California condition under which a pesticide field dissipation study should be conducted and submitted to DPR to meet the requirements of the PCPA.

In addition to soil texture, organic carbon (OC) is a soil constituent that is correlated to pesticide soil adsorption potential and is used to derive an OC-normalized soil adsorption coefficient (Koc). This coefficient is one of several pesticide properties used to identify chemicals that have a high potential to leach to ground water (FAC, 13144(a)), and a maximum threshold value has been set accordingly (California Code of Regulations, 6804(b)). The relationship between OC and Koc is proportional whereby for any given soil a lower OC content presents an equally greater calculated potential for pesticide leaching. Soil OC content below a maximum threshold would therefore also constitute a California condition under which a pesticide TFD study should be conducted in order to meet the requirements of the PCPA. An analysis was conducted to determine the organic matter (OM; OC is the main constituent) content of soil in the same CALVUL-designated coarse soils used to establish the minimum soil sand content.

For this analysis, soil data from sections of land identified in the CALVUL model as containing predominantly coarse-textured soils were included where confirmed pesticide detections had occurred in the underlying ground water as a result of legal agricultural use. These data included sand and OM content and were specific to the layered soil horizons within each soil Mapping Unit ID (MUID) or soil type in the section. Since the soil horizons were often of variable thickness, sand and OM content within each horizon layer was proportionally adjusted to provide a depth-weighted average for the entire soil column, which for this analysis was consistent with the depth used for the CALVUL model of 30 cm.

The spatial surface area of each MUID within a land section was unknown at the time that the CALVUL model was developed in the late 1990s. Consequently, soil characterization of a land section by the CALVUL model was based on an equal weighting of soil conditions from each MUID in the land section. More recently soil surveys in California have been digitized, facilitating an estimate of each MUID’s surface area within a section of land. Sand and OM content in each section has since been calculated as the weighted average of the spatial proportions of measured values for each MUID in the section of land.

RESULTS AND DISCUSSION

Soil Condition: A total of 192 sections of land were identified as a CALVUL-classified coarse soil where at least one pesticide or pesticide degradation product has been detected and confirmed by DPR in the underlying ground water (Appendix 1). Frequency distributions and percentiles of the sand and OM content in these sections revealed the basic structure of these data (Figures 1 and 2). Digitizing of the MUIDs and correctly proportioning the sand and OM content for each land section has identified some GWPAs currently classified as coarse-textured and vulnerable to leaching despite being of relatively low sand composition (Figure 1). A pending update of the CALVUL model utilizing these digitized section data will enhance identification of leaching and runoff GWPAs and likely result in reclassification of some sections. In accordance with this projected statistical correction, the 10th percentile of the frequency distribution of soil sand content (68%) was selected as a threshold limit below which these sections may not qualify as leaching GWPAs under future CALVUL analyses. Censoring of these sections would appear reasonable as the range in soil sand composition between the 0th and 10th percentiles (36 – 68%) is exceptionally large compared to that between the 10th and 20th percentiles (68 – 69%). To maintain this consistency for OM content, the upper 10th percentile of its frequency distribution (1.4%) was selected as a threshold limit above which the relatively high OM content may not be characteristic of soils that are high in sand content. As explained earlier, high OM content soil is not conducive to the movement of pesticide residues and may not provide adequate conditions in which to conduct TFD studies as intended by the PCPA. This censoring threshold also would appear reasonable based on the exceptionally large variability in soil OM content between the 90th and 100th percentiles (1.4 – 2.7%) relative to that between the 80th and 90th percentiles (1.0 – 1.4%).

Cropped plots are not typically used in TFD studies, but US EPA guidance does allow for the presence of crops or turf that are consistent with sites of use for the pesticide being evaluated, particularly if they are expected to significantly influence pesticide dissipation. US EPA guidance advises that any studies on cropped plots be conducted concurrently with bare soil studies to ascertain the effects of the crop. Accordingly, TFD studies conducted to satisfy the PCPA would be limited to bare soil in order to remove any potential influence of the crop on residue fate and movement in the soil. If bare soil studies are not planned or conducted for a new active ingredient, a cropped or turf TFD study may be acceptable to meet the PCPA requirement provided that sufficient justification is given. Under these circumstances the soil sand and OM content requirements specified above would still apply.

Water Inputs: Leaching of pesticide residues in coarse-textured, high sand-content soil has been associated with the amount of water application to pesticide-treated soil. Troiano et al. (1993) showed that increasing water application amounts as a proportion of reference evapotranspiration (ETo) from approximately 0.6 to 2.2 correlated with deeper movement in the soil profile of the herbicide atrazine. Atrazine movement in response to sprinkler irrigation inputs of less than 1.0 was largely contained to near the soil surface, but larger water inputs showed movement to over 3 m and with greater residue persistence. Therefore, to effectively test the fate and mobility of pesticides in soil and their potential to impact California ground water TFD studies would need to receive minimum threshold water inputs. Such inputs should be based on irrigation practices and water application efficiencies in areas of California where the ground water has been impacted by pesticides. Water application efficiencies for agricultural crops grown in California have been reported at 60% and lower for unpressurized surface delivery systems such as flood, furrow and border irrigation methods (California Agricultural Technology Institute, 1988; Snyder et al., 1986). This level of efficiency reflects an effective water application rate of 166% and above of evapotranspirative demand. A computer modeling study with effective water inputs at 160% of evaporative demand predicted ground water concentrations for several pesticides that were in good agreement with concentrations measured in ground water below coarse-textured soils in Fresno and Tulare Counties, California (Spurlock, 2000). Accordingly, water inputs at 160% of evapotranspiration (ET) would be a reasonable minimum threshold limit to produce sufficient percolating water to test residue leaching potential in a TFD study. To determine the amount of water and timing of applications to a coarse-textured soil, daily ET values would be accumulated since the previous water input. The accumulated amount of ET would be multiplied by an excess demand factor of 1.6 to account for the water application efficiency and the product would then be the water application amount.

Daily ETo, calculations and methodology used to estimate ET, and water input amounts need to be tabulated and provided with TFD studies submitted to meet the requirements of the PCPA. Allen et.al. (1998) (Chapters 5 and 6) is one of several sources that provide guidance for estimating ET from bare soil and cropped plots.

Ideal testing procedures would dictate that pesticide interaction with percolating water occur within 7 days of pesticide application – before residue dissipation losses on the soil surface impact the potential for characterizing residue fate and movement in soil. Subsequent water applications throughout the study would be at a frequency to support a hypothetical crop or vegetative cover the pesticide is intended for, which depending on environmental factors would approximate a 7-day interval or less. In winter when ET is low, water input intervals could be extended to accommodate for periods when irrigation to the study site is impracticable or not feasible. For example, water inputs could be postponed during freezing conditions when damage to the irrigation system is likely or during saturated soil conditions when access to the study site is impeded. However, daily ET remains accountable during this period and subsequent water inputs would still be based on cumulative daily ET since the previous water input multiplied by the excess demand factor of 1.6. Water inputs from rain events are subtracted from the scheduled water input amounts.

Study Initiation: The TFD study conducted to satisfy the PCPA would be initiated in the spring or summer (April 1 – September 30) to ensure a leaching environment with respect to the amount of percolating water produced relative to ET. An exception for initiating the study during this period would be possible with sufficient justification. For example, if preferred a TFD study could be initiated in the fall or winter for a pesticide active ingredient only applied during this period.

SUMMARY

The PCPA was enacted to prevent further contamination of California ground water by legal use of agricultural pesticides. A provision of the PCPA requires registrants to submit several TFD studies during the pesticide registration process, one of which must be conducted in California or under similar environmental use conditions. Since passage of the PCPA, conditions responsible for pesticide movement to ground water have been identified primarily as residue interactions with specific soil types and percolating water. These conditions have been identified in field- and computer modeling-based studies and published in peer-reviewed scientific journals. Further analysis of soils data from these studies has revealed more specific soil-related conditions responsible for pesticide movement to ground water. The intent of the PCPA is to conduct at least one TFD study in California and under these conditions, or if conducted outside of California under similar environmental use conditions. Therefore, a TFD study conducted in California need not necessarily comply with the PCPA California conditions requirement provided that one of the remaining submitted studies conducted elsewhere does comply. All TFD studies submitted to DPR must be conducted following US EPA guidelines including the study submitted to meet the PCPA requirements. However, the study meeting the PCPA requirements has added provisions of specific soil, water input and study initiation requirements:

Soils:

- Studies shall be conducted in a coarse-textured soil with no less than a depth-weighted average sand content of 68% in the top 30 cm of soil. In accordance with US Department of Agriculture (USDA) soil textural classification this would include sand, loamy sand, and some sandy loam classified soils (Table 1).
- The soils used for the TFD study should have no layer that restricts the movement of water as indicated within the soil profile, such as a hardpan or compacted layer, or an abrupt change in texture.
- The depth-weighted average OM content will not exceed 1.4% in the top 30 cm of soil.
- Studies shall be conducted on bare soil plots. Exceptions are possible for studies conducted in the presences of a crop or turf with sufficient justification.

Water inputs:

- Studies shall receive water inputs sufficient to create percolating water that reflect the potential amount lost from crop irrigations. Such inputs would equate to at least 160% of ET. Therefore, a scheduled water input would approximate the cumulative daily ET since the previous water input multiplied by an excess demand factor of 1.6.
- Initial water input would occur within 7 days of chemical application. Subsequent water inputs would be at frequency to support a crop or turf, or in the case of a bare soil study a hypothetical crop, and generally occur at 7-day intervals or less for the duration of the study. Water inputs could be postponed, but only when irrigation to the study site is impracticable or not feasible and sufficient justification is provided. The subsequent water input following the postponed event would still be based on cumulative daily ET since the previous water input multiplied by an excess demand factor of 1.6.
- Water inputs from rain are subtracted from scheduled water input amounts.

Study initiation:

- The field study shall be initiated in the spring or summer (April 1 – September 30) to ensure sufficient water is applied relative to ET rates to produce a potential residue leaching environment. An exception for initiating the TFD study in spring or summer is possible with sufficient justification.

REFERENCES

Allen, R.G., L.S. Pereira, D. Raes and M. Smith. 1998. Crop evapotranspiration – Guidelines for computing crop water requirements – FAO Irrigation and drainage paper 56. Food and Agriculture Organization of the United Nations, Rome, Italy.

California Agricultural Technology Institute. 1988. Irrigation systems and water application efficiencies. CATI Center for Irrigation Technology, publication 880104. California State University, Fresno, California.

Corbin, M., W. Eckel, M. Ruhman, D. Spatz and N. Thurman. 2006. NAFTA guidance document for conducting terrestrial field dissipation studies. Office of Pesticides Programs, US Environmental Protection Agency. http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/nafta-guidance-document-conducting-terrestrial-field (verified Feb, 2016).

Snyder, R.L., B.R. Hanson and R. Coppock. 1986. How farmers irrigate in California. Univ. of Calif. Division of Ag. And Nat. Res., Leaflet 21414. Oakland, California.

Spurlock, F. 2000. Effect of irrigation scheduling on movement of pesticides to ground water in coarse soils: Monte Carlo analysis of simulation modeling. CA. Dept. Pesticide Regulation, Environmental Monitoring Branch, Sacramento, CA. EH 00-01. http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps.htm (verified Feb, 2016)

Troiano, J. and M. Clayton. 2009. Modification of the probabilistic modeling approach to predict well water concentrations used for assessing the risk of ground water contamination by pesticides. Memorandum to J. Sanders, Branch Chief, Environmental Monitoring, DPR. <http://www.cdpr.ca.gov/docs/emon/pubs/analysmemos.htm> (verified, Feb, 2016).

Troiano, J., C. Garretson, C. Krauter, J. Brownell and J. Hutson. 1993. Influence of amount and method of irrigation water application on leaching of atrazine. J. Enviorn. Quality 22:290-298.

Troiano, J., F. Spurlock and J. Marade. 2000. Update of the California vulnerability soil analysis for movement of pesticides to ground water: October 14, 1999. CA. Dept. Pesticide Regulation, Environmental Monitoring Branch, Sacramento, CA. EH 00-05. http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps.htm (verified Feb, 2016).

TABLE 1. USDA textural classes of soils[z]

Common names of soils (General texture)	Sand	Silt	Clay	Textural class
Sandy soils (Coarse texture)	86-100	0-14	0-10	Sand
	70-86	0-30	0-15	Loamy sand
Loamy soils (Moderately coarse texture)	50-70	0-50	0-20	Sandy loam
Loamy soils (Medium texture)	23-52	28-50	7-27	Loam
	20-50	74-88	0-27	Silty loam
	0-20	88-100	0-12	Silt
Loamy soils (Moderately fine texture)	20-45	15-52	27-40	Clay loam
	45-80	0-28	20-35	Sandy clay loam
	0-20	40-73	27-40	Silty clay loam
Clayey soils (Fine texture)	45-65	0-20	35-55	Sandy clay
	0-20	40-60	40-60	Silty clay
	0-45	0-40	40-100	Clay

[z] Based on the USDA particle-size classification.

Figure 1. Soil sand content in CALVUL-designated coarse-soil sections of land where pesticide detections by DPR have occurred in the underlying ground water

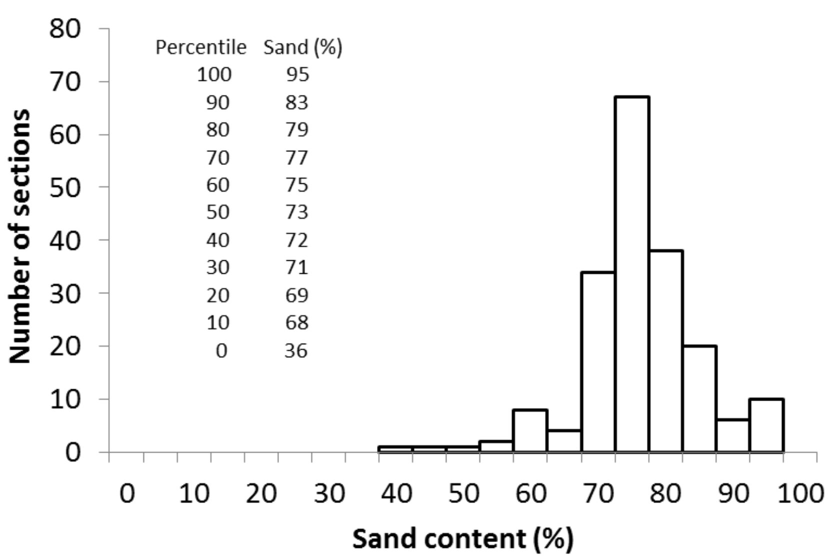
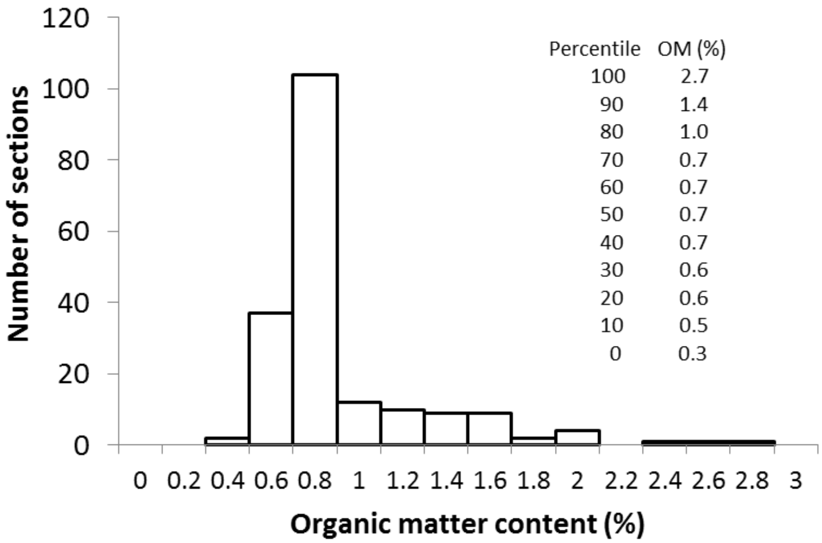


Figure 2. Soil organic matter content in CALVUL-designated coarse-soil sections of land where pesticide detections have occurred in the underlying ground water



APPENDIX 1. Sand and organic matter content of soil in CALVUL-designated coarse soil sections where pesticides detections by DPR have occurred in the underlying ground water as a result of legal agricultural use.

Land section[Z]	Sand (%)	OM (%)	Pesticides detected in ground water[Y]
10M13S21E16	76.13	0.65	Atrazine DEA Diuron
10M13S22E33	73.15	0.67	ACET Bromacil DSMN DACT Diuron Norflurazon Simazine
10M13S23E34	71.71	1.38	ACET Diuron Simazine
10M14S18E15	68.30	0.73	ACET DACT
10M14S18E29	69.50	0.70	DACT
10M14S19E02	61.42	0.69	DACT
10M14S20E32	68.39	0.71	DCPA TPA
10M14S21E03	68.52	0.68	ACET DACT
10M14S21E20	67.70	0.72	Diuron Simazine
10M14S21E30	68.42	0.71	DACT
10M14S21E32	68.37	0.72	Simazine
10M14S21E34	76.85	0.54	Simazine
10M14S21E35	77.02	0.58	Simazine
10M14S21E36	74.72	0.63	Diuron Simazine
10M14S22E22	69.97	0.68	ACET Atrazine DEA DACT Prometron Simazine
10M14S22E23	71.39	0.62	ACET Simazine
10M14S22E31	77.59	0.61	ACET DSMN DACT Diuron Imidacloprid Simazine
10M14S22E33	72.22	0.75	ACET Bromacil DACT Diuron Norflurazon Simazine
10M14S22E35	70.48	1.28	ACET DACT Simazine
10M14S23E15	73.42	0.78	ACET Bromacil Diuron Simazine
10M14S23E22	70.65	0.70	ACET DSMN DACT Diuron Norflurazon Simazine
10M14S23E28	71.15	0.82	ACET Diuron Norflurazon Simazine
10M14S23E32	69.84	2.31	ACET DSMN DACT Diuron Simazine
10M14S23E33	71.16	0.87	ACET DSMN DACT Diuron Norflurazon Simazine
10M14S23E34	68.86	0.62	ACET Bromacil DSMN DACT Diuron Norflurazon Simazine
10M14S24E30	43.25	1.42	ACET DACT Simazine
10M15S19E25	71.51	0.68	ACET DACT Simazine
10M15S21E02	79.78	0.56	Simazine
10M15S21E03	78.72	0.55	ACET Bromacil DSMN DACT Norflurazon Simazine
10M15S21E04	76.19	0.60	Diuron Simazine
10M15S21E05	75.88	0.60	ACET DACT Diuron Simazine
10M15S21E08	72.06	0.67	Prometron Simazine
10M15S21E09	70.03	0.69	ACET DSMN DACT Diuron Norflurazon Simazine
10M15S21E12	72.76	0.68	Simazine
10M15S21E13	70.79	0.68	Diuron Simazine
10M15S21E14	69.54	0.73	ACET Atrazine DEA DACT Diuron Simazine
10M15S21E15	69.28	0.71	Simazine
10M15S21E17	71.28	0.65	Simazine

10M15S21E24	74.76	0.70	Atrazine Diuron Simazine
10M15S21E34	74.56	0.64	ACET DACT Norflurazon Simazine
10M15S22E03	83.58	0.50	ACET DSMN DACT Diuron Norflurazon Simazine
10M15S22E04	63.65	0.69	ACET Diuron Simazine
10M15S22E05	58.99	0.63	ACET Atrazine Bromacil DEA DSMN DACT Diuron Hexazinone Norflurazon Simazine
10M15S22E06	71.02	0.69	ACET DACT Diuron Simazine
10M15S22E07	72.88	0.67	Simazine
10M15S22E08	67.68	0.67	Simazine
10M15S22E09	65.98	0.57	ACET Bromacil DSMN DACT Norflurazon Simazine
10M15S22E11	74.20	0.61	Simazine
10M15S22E13	73.41	0.65	ACET DSMN DACT Diuron Norflurazon Simazine
10M15S22E15	72.66	0.67	ACET DSMN DACT Diuron Norflurazon Simazine
10M15S22E16	74.73	0.60	ACET Bromacil DSMN DACT Diuron Prometron Simazine
10M15S22E17	71.83	0.69	Prometron Simazine
10M15S22E18	76.45	0.62	Simazine
10M15S22E19	71.11	0.74	Simazine
10M15S22E20	78.04	0.54	ACET DACT Diuron Simazine
10M15S22E21	71.13	0.71	ACET DSMN DACT Diuron Norflurazon Simazine
10M15S22E22	72.16	0.73	Simazine
10M15S22E28	74.8	0.65	Simazine
10M15S22E30	76.51	0.57	Diuron Simazine
10M15S22E32	72.48	0.70	Simazine
10M15S22E33	70.89	0.72	Simazine
10M15S23E06	72.14	1.85	Bromacil Diuron Simazine
10M15S23E27	70.45	0.72	Atrazine Bromacil
10M15S23E32	73.45	0.66	ACET DACT Simazine
10M15S23E34	72.06	0.80	Simazine
10M15S24E07	64.86	0.72	DSMN DACT
10M15S24E31	74.06	0.65	Bromacil Diuron Simazine
10M16S19E02	74.70	0.63	ACET DACT Simazine
10M16S19E03	78.48	0.61	ACET DACT Simazine
10M16S19E10	77.20	0.62	ACET DACT Simazine
10M16S19E14	70.13	0.71	ACET Simazine
10M16S19E16	76.85	0.71	ACET DACT
10M16S19E20	76.89	0.70	ACET DACT Simazine
10M16S19E22	76.02	0.69	ACET DACT Simazine
10M16S19E23	73.49	0.70	ACET Simazine
10M16S20E09	69.88	0.69	ACET DACT Simazine
10M16S20E15	79.06	0.58	ACET DACT Simazine
10M16S20E22	80.08	0.54	ACET Simazine
10M16S20E25	71.33	0.67	ACET Simazine
10M16S20E26	73.58	0.64	ACET DACT Simazine

10M16S21E04	81.79	0.52	ACET Simazine
10M16S21E05	80.34	0.54	ACET Simazine
10M16S21E07	81.05	0.53	ACET DACT Simazine
10M16S21E16	79.27	0.55	ACET DCPA DSMN DACT Norflurazon Simazine
10M16S21E21	73.72	0.64	ACET Simazine
10M16S21E33	79.54	0.53	ACET DACT Simazine
10M16S21E34	72.63	0.64	ACET DACT Prometron Simazine
10M16S21E36	72.57	0.66	ACET
10M16S22E01	70.81	0.75	ACET DACT Diuron Simazine
10M16S22E02	76.23	0.63	ACET
10M16S22E03	82.48	0.54	ACET DACT Simazine
10M16S22E11	79.94	0.52	1,2-D ACET DSMN DACT Simazine
10M16S22E17	71.05	0.67	DACT
10M16S22E21	77.04	0.70	ACET DACT Simazine
10M16S22E33	81.27	0.52	ACET Bromacil
10M16S22E34	80.3	0.53	ACET DACT Diuron Simazine
15M25S26E18	64.86	0.35	ACET DACT Simazine
19S04N15W21	69.29	0.69	Prometron Simazine
20M12S15E26	72.36	0.77	Diuron
20M12S17E04	72.82	1.24	Diuron
20M12S17E35	71.68	0.67	DACT
20M12S18E30	72.32	0.67	ACET
20M13S16E07	72.84	0.75	ACET DACT
24M05S11E25	82.59	0.56	ACET DSMN DACT Norflurazon
24M05S11E26	86.11	0.54	ACET
24M05S11E33	82.29	0.68	ACET DACT
24M05S11E34	91.59	0.40	ACET DACT Simazine
24M05S12E31	84.41	0.58	DACT
24M06S10E35	70.70	0.98	ACET DSMN DACT Diazinon Norflurazon Simazine
24M06S11E01	92.93	0.50	Atrazine DEA DSMN DACT
24M06S11E04	93.42	0.42	ACET DSMN DACT Simazine
24M06S11E33	93.91	0.65	ACET DACT
24M06S12E05	91.02	0.67	Bromacil
24M06S12E28	91.84	0.75	ACET DACT
24M06S12E30	93.96	0.41	ACET DACT
24M06S12E32	93.52	0.68	Simazine
24M06S12E33	94.99	0.71	DACT
24M07S12E05	89.74	0.74	DACT
24M07S12E18	92.97	0.32	ACET Norflurazon
30S04S09W03	55.16	1.83	Bromacil Diuron Simazine
30S04S09W07	78.73	0.70	Atrazine Simazine
30S04S09W18	77.65	0.82	Atrazine Simazine
30S04S10W03	77.88	0.86	Atrazine Simazine

30S04S10W04	75.91	0.89	Atrazine Simazine
30S04S10W09	77.46	0.93	Atrazine Simazine
30S04S10W14	78.26	0.74	Simazine
30S04S10W24	78.12	0.71	Simazine
30S04S10W25	77.00	0.67	Atrazine Simazine
33S02S05W11	83.57	0.51	Atrazine DEA
33S02S05W21	78.31	2.75	Simazine
33S02S07W36	72.11	1.34	Simazine
37S15S01E18	83.37	1.17	Tebuthiuron
37S15S01W24	71.64	1.53	Tebuthiuron
37S16S05E32	87.63	1.14	Tebuthiuron
37S17S05E19	87.45	1.18	DEA
39M01S06E12	69.62	1.13	Bromacil
39M01S07E26	80.18	1.18	DACT
39M01S07E27	77.32	1.32	DACT
39M02S07E09	85.61	1.06	ACET DACT Simazine
39M02S07E10	82.37	1.69	ACET DSMN DACT Norflurazon Simazine
39M02S07E13	82.85	1.85	ACET Atrazine Bromacil DEA DACT Simazine
39M02S07E15	86.52	1.21	ACET DSMN DACT Simazine
39M02S07E16	82.68	1.52	ACET DACT
39M02S07E20	78.79	1.63	ACET DACT
39M02S07E23	80.27	1.81	ACET
39M02S08E09	77.73	0.63	DACT
39M02S08E13	75.53	0.87	ACET DACT Diuron Norflurazon Simazine
39M02S09E07	82.12	0.58	ACET DSMN DACT
39M02S09E09	78.89	0.51	ACET DSMN DACT Diuron Norflurazon
39M02S09E14	69.44	0.79	DSMN DACT
39M02S09E16	70.83	0.97	ACET DSMN DACT
40M32S13E33	36.30	2.55	DCPA TPA
40S11N35W25	69.24	1.57	DCPA TPA
50M02S08E25	70.92	1.04	DACT Metolachlor-ESA Metolachlor-OXA
50M03S08E09	67.70	0.73	ACET
50M03S11E31	70.12	0.76	ACET Atrazine DEA DSMN DACT Diuron Norflurazon Simazine
50M04S08E14	72.26	0.93	ACET DSMN DACT Norflurazon
50M04S09E10	72.01	0.72	Simazine
50M04S09E15	68.94	0.74	Simazine
50M04S09E16	69.63	0.73	Simazine
50M04S09E19	68.22	0.69	ACET DSMN DACT Diuron Hexazinone
50M04S09E22	68.71	0.70	Atrazine Diuron Simazine
50M04S09E23	70.35	0.71	Diuron Simazine
50M04S09E30	69.95	0.67	ACET
50M04S10E13	69.36	0.74	DSMN DACT
50M04S11E06	67.62	1.22	ACET DACT Diuron

50M04S11E07	69.82	0.74	DSMN
50M04S11E19	72.51	0.70	DSMN DACT
50M04S11E29	68.48	0.71	ACET Alachlor-ESA DSMN DACT Metolachlor-ESA
50M04S11E30	69.13	0.70	DSMN DACT Metolachlor-ESA
50M04S11E31	73.65	0.70	ACET Bromacil DACT Hexazinone Metolachlor-ESA Metolachlor-OXA
50M05S09E14	79.07	0.58	DACT Metolachlor-ESA Metolachlor-OXA
50M05S09E20	68.63	0.64	Simazine
50M05S09E36	81.87	0.56	Alachlor-ESA Metolachlor-ESA Metolachlor-OXA
50M05S10E01	72.52	0.70	Bromacil Prometron
50M05S10E31	74.28	0.62	DACT
54M16S23E03	72.58	0.57	Simazine
54M16S23E16	70.82	0.48	Diuron
54M16S25E06	59.60	1.19	ACET Atrazine Bromacil DACT Diuron Simazine
54M17S25E13	68.30	1.56	Bromacil Diuron Simazine
54M17S25E24	55.20	1.49	ACET Bromacil Diuron Simazine
54M17S26E19	56.00	1.45	Bromacil Diuron Simazine
54M18S26E14	69.95	1.14	Simazine
54M21S26E06	70.83	1.22	ACET DACT Diuron Metolachlor-ESA
54M21S26E32	56.50	1.58	Diuron Simazine
54M21S26E33	59.28	1.53	Simazine
54M21S27E35	54.94	0.75	Simazine
54M21S29E11	76.48	0.93	Atrazine Bromacil Diuron Simazine
54M22S27E18	51.66	0.55	ACET Atrazine Bromacil Diuron Simazine
54M24S26E07	69.37	1.40	Simazine
57M10N02E12	55.88	0.83	Metolachlor-ESA
57M10N03E07	49.36	1.01	Simazine

[Z]Land section identification used by public land survey system.

[Y]Pesticide key:

1,2-D	1,2-dichloropropane
ACET	Deethyl-simazine or deisopropyl-atrazine
DACT	Diaminochlorotriazine
DCPA	Chlorthal-dimethyl
DEA	Deethyl-atrazine
DSMN	Desmethylnorflurazon
TPA	2,3,5,6-tetrachloroterephthalic acid