United States Department of Agriculture
Agricultural Marketing Service

2010 – 2011 Pilot Study

Pesticide Residue Testing of Organic Produce

USDA National Organic Program
USDA Science and Technology Programs

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Contents

Executive Summary

The Organic Foods Production Act of 1990 established national standards for the production and handling of organic agricultural products. The Act authorized the United States Department of Agriculture (USDA) to create the National Organic Program. This program is responsible for developing the USDA organic regulations and ensuring that organic farms and business comply with them. USDA accredits third-party certifying agents to certify organic farms and processing facilities, allowing them to sell, label, and represent their products as organic.

The majority of pest control materials permitted in organic agriculture are naturally derived from a plant (e.g., pyrethrum), microorganism (e.g., *Bacillus thuringiensis*), or other natural sources. Organic standards prohibit the use of most synthetic substances—including most pesticides used in conventional agriculture—for at least 3 years prior to the harvest of an organic crop. Synthetic pest control materials allowed in organic crop production include elemental sulfur, insecticidal soap, horticultural oils, and copper hydroxide.

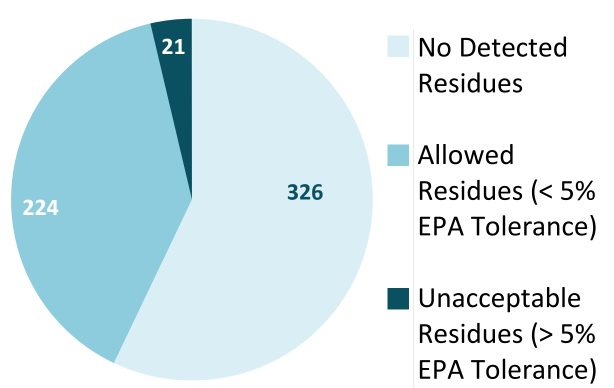
The U.S. Environmental Protection Agency (EPA) establishes the maximum allowed levels of pesticides, or EPA tolerances, which may be present on foods. Although most EPA-registered pesticides are prohibited in organic production, there can be inadvertent or indirect contact from neighboring conventional farms or shared handling facilities. As long as the operator hasn't directly applied prohibited pesticides and has documented efforts to minimize exposure to them, the USDA organic regulations allow residues of prohibited pesticides up to 5 percent of the EPA tolerance.

In 2010, the National Organic Program worked with the USDA Agricultural Marketing Service's Science and Technology Program to evaluate pesticide residues on USDA organic produce. The study involved 571 domestic and foreign fruit and vegetable samples bearing the USDA organic seal, which were obtained from retail establishments across the United States. Using sensitive equipment, an accredited Government laboratory tested each sample for approximately 200 pesticides typically used in conventional crop production.

Of these 571 samples, 96 percent were compliant with USDA organic regulations (see Figure ES1). This means that the produce either had no detected residues (57 percent) or had residues less than 5 percent of the EPA tolerance (39 percent). Four percent of the tested samples contained residues above 5 percent of the EPA tolerance and were in violation of the USDA organic regulations. The findings suggest that some of the samples in violation were mislabeled conventional products, while others were organic products that hadn't been adequately protected from prohibited pesticides. The National Organic Program is working with certifying agents to provide additional scrutiny in these areas.

Overall, the pilot study demonstrated that it can serve as a model for future pesticide residue testing projects of organic produce. It should be noted that the pilot study did not measure pesticide levels in all types of USDA organic products; it only analyzed 571 samples across 6 select commodities. Organic certifying agents are encouraged to use the methods described in this report when conducting required periodic residue testing of organic products. Since certifying agents will be testing samples most likely to contain prohibited substances (and not selecting products at random), it will not be possible to draw overall conclusions from these results.

Figure ES1 – Overview of Results by Sample for All Commodities



Introduction

In December 2000, the USDA National Organic Program published national standards for the production and handling of USDA organic products. The regulations describe the allowed and prohibited methods, practices, and substances for organic crops, livestock, and processed products. These regulations also require that certifying agents test organic products when there is reason to believe they have been contaminated with prohibited substances, including synthetic pesticides.

The EPA establishes the maximum allowed levels of pesticides, or EPA tolerances, which may be present on foods. Although many of these pesticides are prohibited in organic production, there can be inadvertent indirect contact from neighboring conventional farms or shared handling facilities. To recognize that inadvertent or unavoidable contact with prohibited substances may occur, the USDA organic regulations allow residues of prohibited pesticides—up to 5 percent of the EPA tolerance level—if those residues are present due to unavoidable or inadvertent contact. If an organic producer used a prohibited pesticide or didn't take adequate steps to avoid contamination from it, any level of pesticide residues would be a violation of the organic standards.

In March 2010, the USDA's Office of the Inspector General (OIG) audited the National Organic Program to determine whether products marketed as organic met the requirements of the Organic Foods Production Act. The OIG published its findings in March 2010 (1). One of the OIG's findings was that, although Section 2107 of the Act requires that certifying agents conduct periodic residue testing, this requirement was not fully implemented in the USDA organic regulations. The OIG's observation that residue testing was necessary provided the catalyst for developing and implementing a pilot project focused on surveillance testing.

The pilot project was initiated to measure the presence of pesticide residues in products labeled as organic and displaying the USDA organic seal. Samples were collected from retail market sites throughout the United States. The 571 samples of apples, bell peppers, broccoli, potatoes, strawberries, and tomatoes were collected from 19 States based on availability. They were then analyzed for 195 pesticide residues using liquid and gas chromatographic methods with mass spectrophotometric detection.

Residue testing has a dual role in organic certification. It provides a means for monitoring compliance with the USDA organic regulations and discouraging the mislabeling of agricultural products. A residue testing program also provides State Organic Program and certifying agents with a tool for ensuring compliance.

The residue testing requirements of the USDA organic regulations permit USDA, the State Organic Program, or certifying agent to inspect all agricultural products sold, labeled, or represented as USDA organic. These parties may require products from organic farms and handling operations to undergo preharvest or postharvest residue testing at their discretion.

Materials and Methods

The National Science Laboratory (NSL) of the Science and Technology Program (S&T) in the USDA Agricultural Marketing Service (AMS) administered and implemented the project. S&T provided statistical assistance for this project, including a survey plan, distribution data on organic products in the Nation, and an evaluation of the testing results from NSL. Samples were collected by USDA AMS, Fruit and Vegetable Programs, Fresh Products Branch. The agents visited retail marketplaces across the Nation and purchased certified USDA organic apples, tomatoes, strawberries, potatoes, bell peppers, and broccoli. Based on the most recent data on organic production in the Nation, these products are the six most widely sold organic products (2). Samples were packed and shipped to NSL for pesticide residue analysis. NSL used a standard pesticide residue analysis methodology on homogenized samples for 195 pesticides (see Appendix A). A total of 571 USDA organic samples were collected and tested. Samples were collected from October 2010 to January 2011 and tested November 2010 to February 2011.

The pilot study used the quota sampling method, in that each commodity had a different target number of samples (3). The estimate for the sample size was based on detecting residues in commodities in terms of proportions between 0.0052 and 0.0053 at a 95-percent confidence level. In other words, the sample size was large enough to detect residue levels as low as 0.52 percent in commodities at a confidence level of 95 percent. Since pesticide distribution in organic samples is not always homogeneous in the lots, multiple individual samples were taken. The sampling plan was adjusted to accommodate variability in the available types and quantities of each commodity. Table 1 displays the production volume as well as the estimated and final numbers of samples using quota sampling. As long as each sample represented a different variety or commodity, multiple samples could be obtained from the same retail market. In order for a sample to be acceptable, it had to be labeled with the USDA organic seal along with the name of the certifying agent.

NSL coordinated the sample collection and then tested the samples for pesticide residues. NSL personnel did not rinse, peel, core, or remove the seeds from any sample. Excluding bruised portions of produce and spoiled tissue, samples were homogenized using food processors. Portions of the homogenized sample were stored at minus 40 degrees Celsius. The samples were then extracted for potential pesticide residues. Samples were analyzed using gas chromatography with mass spectrometry and liquid chromatography with tandem mass spectrometry. The results from the analyses were reported in parts per million (ppm). Appendix B has additional details on the laboratory procedures and methods used in this pilot project.

Data recorded for each sample included product description, collection date, certifying agent, collection site location (city and State), production source (domestic or import), country of origin, and retail operation. Before testing, NSL assigned a sample identification number and internal laboratory number to each sample. NSL added the analytic results to each sample after completion of the analyses. The NSL then added the residue testing results and incorporated the type of pesticide detected.

SAS® was used for data management and analysis. Raw data sets were examined for completeness and coding consistency as they were received. They were converted into SAS® data sets using two different methods and then compared for agreement. If the two data sets were in complete agreement, the SAS® data sets were then subject to quality control checks. The quality control checks included examination for responses outside defined bounds and summation to aid in the identification of errors in the data. Data analytic procedures using frequencies and descriptive statistics were used to explore the relationship between the variables.

Based on the level of pesticide residue detected, the data set was divided into 3 groups based on these criteria: (1) whether or not pesticide residues were detected, (2) whether or not detected pesticide residues were more than 10 parts per billion, and (3) whether or not the detected pesticide residues were greater than 5 percent of the EPA tolerance for the specific residue (4). Since less sensitive equipment is not able to detect residues at or below 10 parts per billion, this cut-off was established to differentiate between trace detections and more significant findings that were below 5 percent of the EPA tolerance. The purpose of the 5-percent cut-off was to identify residue levels that were in violation of the USDA organic regulations. The EPA tolerance levels were obtained from Title 40 of the Code of Federal Regulations (CFR) (5).

Results

Twenty Fruit and Vegetable (F&V) inspectors at 20 locations throughout the United States collected 593 samples and sent them to the NSL. Of the 593 samples, 571 samples were analyzed for 195 pesticide residues. The remaining 22 samples were not analyzed due to some form of spoilage. All of the samples were extracted using the QuEChERS method (Quick, easy, cheap, environmentally friendly, reliable, safe—QuEChERS). Pesticide residue detection and identification were accomplished using liquid or gas chromatography with either single quadrupole or triple quadrupole mass spectrometry. The average number of pesticide residues targeted for detection in each sample ranged from a low of 191 for broccoli to a high of 194 for apples and tomatoes. Figure 1 shows the number of samples collected in each State for all six organic commodities.

Table 2 shows the distribution of samples according to the commodity and its production source (domestic or imported). The country of origin for three samples was recorded as unknown or unlisted; however, the source of production was coded as imported. Of the 571 samples, 443 were of domestic origin (77.6 percent) and 128 were imported (22.4 percent). Figure 2 shows the number and percentage of origin for each commodity.

Table 3 identifies the number of tested samples by certifying agent and whether the production source was domestic or imported. The samples in this study were certified by 24 different certifying agents, 22 of which were based in the United States and 2 of which were foreign. Of the 571 samples, 559 were certified by the 22 domestic certifying agents and 12 were certified by the 2 foreign certifying agents. The 22 domestic certifying agents represent 41.5 percent of the total domestic certifying agents, while the 2 foreign certifying agents are 4.9 percent of the total foreign certifying agents. Examination of the 22 domestic certifying agents by Census Region shows that 12 are located in the West, 4 are located in the Midwest, 2 are located in the South, and 4 are located in the Northeast.

Table 4 shows the number of samples by certifying agent and organic commodity, including the number of samples by certifying agent and organic commodity for domestic and import production sources.

Table 5 displays the number of samples analyzed and a summary of results for each organic commodity. This table captures the total number analyses performed and the breakdown of total non-detections and detections in the study. The average number of pesticides screened for each commodity varied as a result of quality control acceptance criteria. The percent of residue detections is obtained by comparing the total number of residues detected to the total number of analyses actually performed in the laboratory for each organic commodity. The percentage of total residue detections ranged from 0.1 to 0.8 percent, with a mean of 0.4 percent. Different pesticide residues were detected on each of the commodities tested. The number detected in each commodity is reflected in the table. The mean number of different pesticides detected was 15, while the number of different pesticides detected ranged from 8 to 30. Of the 110,190 analyses performed on 571 samples, 0.4 percent had pesticide residue detected. Appendix C tabulates the distribution of the samples having pesticide residue detected.

Table 6 shows a summary of the data by commodity: number of samples analyzed, samples with detections exceeding EPA tolerance (EPA violation), samples with detections exceeding 5 percent EPA tolerance (USDA organic violation), samples with detections at or exceeding 0.01 ppm, samples with detections at or less than 0.01 ppm, and samples with no detections. No samples in the study exceeded the EPA tolerance, but 21 samples (3.7 percent) had residues exceeding 5 percent of the EPA tolerance level and were in violation of the USDA organic regulations.

Discussion

Under 7 CFR 205.670, any USDA organic product or production input may be tested if there is reason to believe it has come into contact with a prohibited substance or has been produced using excluded methods. This provision allows a State Organic Program or certifying agent to test the following at the expense of the State program or certifier: agricultural inputs used or agricultural product to be sold, labeled, or represented as "100 percent organic," "organic," or "made with organic (specified ingredients or food group(s))." The preharvest or postharvest samples must be collected by an inspector representing the USDA, State Organic Program, or certifying agent. Sample integrity must be maintained throughout the chain of custody, and residue testing must be performed in an accredited laboratory. Chemical analysis must be made in accordance with the methods described in the most current edition of the Official Methods of Analysis of the Association of Analytical Communities (AOAC) International or other current applicable validated methodology determining the presence of contaminants in agricultural products.

This pilot study fulfilled the criteria described above: samples were collected by USDA inspectors, NSL is an accredited laboratory, and the methods used were AOAC official methods of analysis. In general, the project was successful as a model for undertaking pesticide residue analysis in organic products.

The most comprehensive study looking at the relationship between pesticide residues in conventional foods and those in organic foods was conducted by Baker et al (6). This study focused on the United States and used results from pesticide residue testing by USDA's Pesticide Data Program (PDP), the Marketplace Surveillance Program of the California Department of Pesticide Monitoring (MSP), and a Consumers Union private residue-testing program (CU). Sensitivity, analytical scope, and sample collection techniques differed markedly between programs.

PDP. The PDP provided the highest quality data and the best representation of the U.S. food market. However, the PDP's underrepresentation of foods identified as organically grown limited its analytical purposes for the pilot study. Additionally, the CU and MSP testing programs tested for important pesticide residues not included in the PDP pesticide residue panel.

MSP. The MSP program sampled the market broadly, but the samples were not precisely representative. The PDP and MSP data taken together provided a broad view across a wide array of different fruits and vegetables, which were purchased over a multi-year period and from a large, representative sample of locations within the U.S.A. and California, respectively. Neither data set offers the depth of sampling needed for convincing comparisons of residues in individual foods as a function of market claim.

CU. In contrast, the CU tests examined only four foods purchased in a few locations over a short period. The CU sampled each food from each market sector in comparative depth. More organically grown samples were included in the CU data sets than provided in the larger PDP and MSP data sets.

These differences make direct comparisons of the findings from the different programs inappropriate. However, similar relationships between pesticide residues of conventional and organic produce were observed in each program. The percentage of samples from organic produce having pesticide residues ranged from 6.5 percent for the MSP to 27 percent for the CU. When examined as a whole, the occurrence of pesticide residues on organic produce is considerably lower than the occurrence on conventional produce.

These results indicate that while pesticide residues are less common in organic produce than in conventional produce, detection of pesticide residues in organic produce is still common. The factors identified by Baker et al. as accounting for the presence of pesticide residue in organic samples include product mislabeling; misidentification of the samples during data entry; post-harvest contamination; inadvertent, unavoidable contamination from environmentally persistent pesticides; or drift from pesticides applied to adjacent land.

Lairon updated the 2003 report from the French Agency for Food Safety, which established an expert working group to review the available scientific literature on the nutritional and sanitary quality of organic food (7). The studies examined by the expert working group used data on organic food production throughout developed and developing countries. A key finding was that 94 to 100 percent of organic food does not contain pesticide residues.

A review by Winter and Davis in 2006 supported the findings of Baker et al (8). Winter and Davis concluded that organic produce had fewer pesticide residues than conventional produce.

In the preceding publications, the method used to identify the produce as organic was not stated. This report is the first presentation of data about organic produce where the produce grown, processed, and handled is known to be organic prior to sample collection and analysis. The criteria for sample selection were explicit and well defined. Only produce samples having either a label or packaging displaying the USDA organic seal and the name of the certifier were selected and collected.

These results indicate that while pesticide residues are less common in organic produce than in conventional produce, detection of pesticide residues in organic produce is still frequent. In this study, residue detections were placed into one of four categories:

- Samples with detections exceeding EPA tolerance (EPA violation)
- Samples with detections exceeding 5 percent of EPA tolerance (USDA Organic violation)
- Samples with detections exceeding 0.01 ppm
- Samples with detections at or less than 0.01 ppm

In the pilot study, 327 samples (57.3 percent) had no detectable levels of pesticide residue and 244 samples (42.7 percent) had detectable pesticide levels. Of the 244 samples with detectable pesticide levels, 21 samples had values that were greater than 5 percent of EPA tolerance levels and in violation of the USDA organic regulations. The values of the other 223 samples with detectable residues were less than 5 percent of the EPA tolerance level. This outcome was consistent with the results from previous studies and reviews.

The pilot study was an observational study that was not designed to collect and analyze data representative of the organic industry as a whole. It focused on method feasibility. However, the pilot study did identify specific areas of concern that warrant increased scrutiny to prevent contamination. The residue detections varied widely by commodity:

Apples. Two pesticides, diphenylamine and thiabendazole, were present within the allowed range (but over 0.01 ppm) for several samples. Diphenylamine and thiabendazole are applied post-harvest within the apple packing sheds to control scald (diphenylamine) or disease (thiabendazole). The levels of these compounds indicate inadequate separation and cleaning within organic packing houses. Additionally, three apple samples contained residues of chlorpyrifos—an insecticide used in conventional apple production—at 0.001 ppm. These residues most likely indicate pesticide drift from neighboring orchards.

Bell peppers. Thirteen samples were in violation of the USDA organic regulations for having levels over 5 percent of the EPA tolerance for at least one pesticide. These violations were scattered across 12 pesticides, with 3 samples having levels in violation for 2 pesticides. The high levels and number of detections indicate that some samples may have been mislabeled, improperly handled, or misrepresented as organic.

Broccoli. No broccoli samples were in violation, nor were any detections over 0.01 ppm.

Potatoes. One potato sample was in violation of the USDA organic regulations. Over half of detections in the compliant range (under 5 percent of the EPA tolerance level) came from potatoes containing chlorpropham, a post-harvest sprout inhibitor used when storing conventional potatoes. This pesticide's label cautions that the product may remain active up to 6 months post-use. Separate storage areas or documented clean-out procedures are already required for organic products, but these results show that additional efforts to separate organic potatoes are necessary.

Strawberries. Two strawberry samples were in violation of the USDA organic regulations. Additionally, one pesticide, piperonyl butoxide, was present at allowed levels (but over 0.01 ppm) in several samples.

Tomatoes. Four tomato samples were in violation of the USDA organic regulations. Additionally, two pesticides, imidacloprid and piperonyl butoxide, were present at allowed levels (but over 0.01 ppm) in several samples.

Limitations

During the course of the pilot study, a number of limitations that affect the interpretation of the results became evident:

First, the organic produce samples were collected during the winter months in the United States. The origin and distribution of tested samples may have been different if the sampling occurred closer to harvest periods in the United States.

The results of the project provide data on specific pesticide residues in selected organic commodities being marketed and sold in the United States over a fixed time period. The results may not be representative of market conditions, which vary from year to year.

The pilot study's design was non-experimental and can only provide the number of detections in the sampled group. Since the samples do not represent all possible organic commodities and no additional data on the national distribution of pesticide residues in organic commodities is available, pesticide residues for all organic commodities cannot be described. The results from the 571 samples analyzed in this pilot study cannot be generalized to a larger group and cannot be compared to other studies.

Additionally, the individual samples were not obtained using probability, but instead the judgment of the sample collector. The method of collection was not evaluated to ensure that the sample selection and collection was random and not biased.

Retail markets were used as sampling sites since they are both the closest point to where the public consumes organic products and convenient for USDA sample collectors. This study did not assess specific sources of contamination with prohibited pesticides (field exposure versus storage or packing facility).

Potential confounding factors were not incorporated into the study design. These factors could include alternate sampling sites, consideration of seasonality in crop planting and harvesting, methods of processing organic commodities, packaging of organic commodities, and different pesticide panels.

The training of the sample collectors was ad hoc; it was not systematic. Pretests and pilot runs to identify areas and factors needing additional consideration were not conducted. The results of this pilot study may have varying utility depending on the audience.

Conclusion

Pesticide residue testing is an important tool for monitoring compliance with the USDA organic regulations. This pilot project demonstrates that periodic pesticide residue testing is also operationally feasible. Additionally, the methodology used to implement the project is sufficiently flexible and will allow certifying agents to adapt it as necessary to test products from the operations that they certify.

In this study of 571 produce samples from 6 commodities, 96 percent of analyzed samples were in compliance with the USDA organic regulations. However, it also identified several areas of the organic production and handling system that require additional scrutiny to prevent contamination.

Since the pilot study was not designed to measure pesticide residue levels in all types of USDA organic products, it only analyzed a small number of samples from select types of commodities labeled as USDA organic. It was conducted to confirm that this study design is appropriate for the periodic residue testing of organic operations by certifying agents. However, the National Organic Program and certifying agents will use this limited information to provide organic operations with additional guidance to enhance efforts to reduce pesticide residues. Indirect contamination from neighboring fields, the environment, and shared handling facilities must be minimized, and efforts to eliminate this must be documented in each operation's organic system plan. Overall, the results support additional attention to maintaining the organic integrity of USDA organic products throughout their life cycle.

References

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7. Denis Lairon, "Nutritional Quality and Safety of Organic Food. A Review," *Agronomy for Sustainable Development* 30(2010): 33-41.

8. Carl K. Winter and Sarah F. Davis, "Organic Foods," *Journal of Food Science* 71(2006): R117-R124.

Tables and Figures

Figure 1 – Distribution of Organic Commodity Samples Collected per State

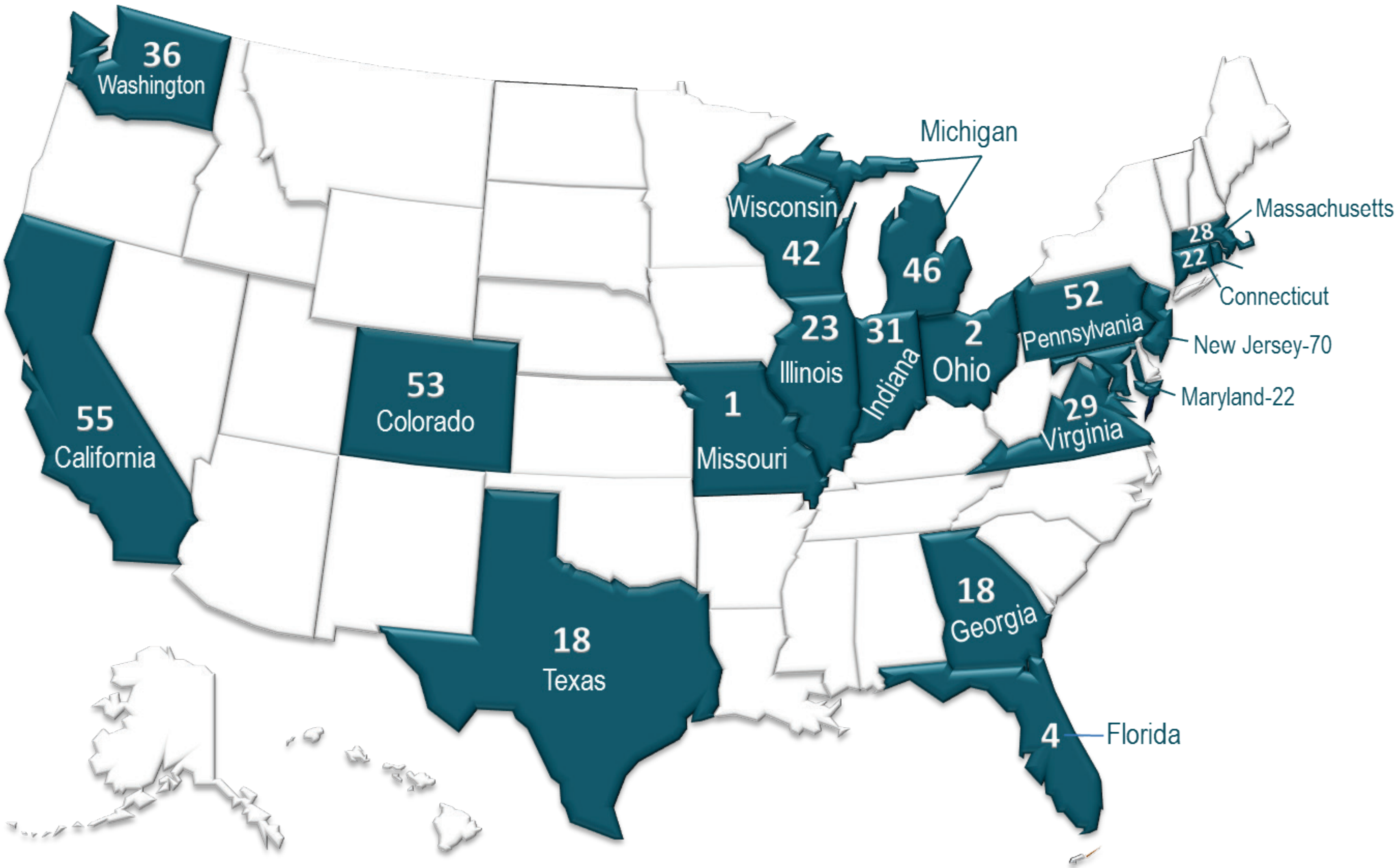

Figure 2 – Origin of Organic Commodities

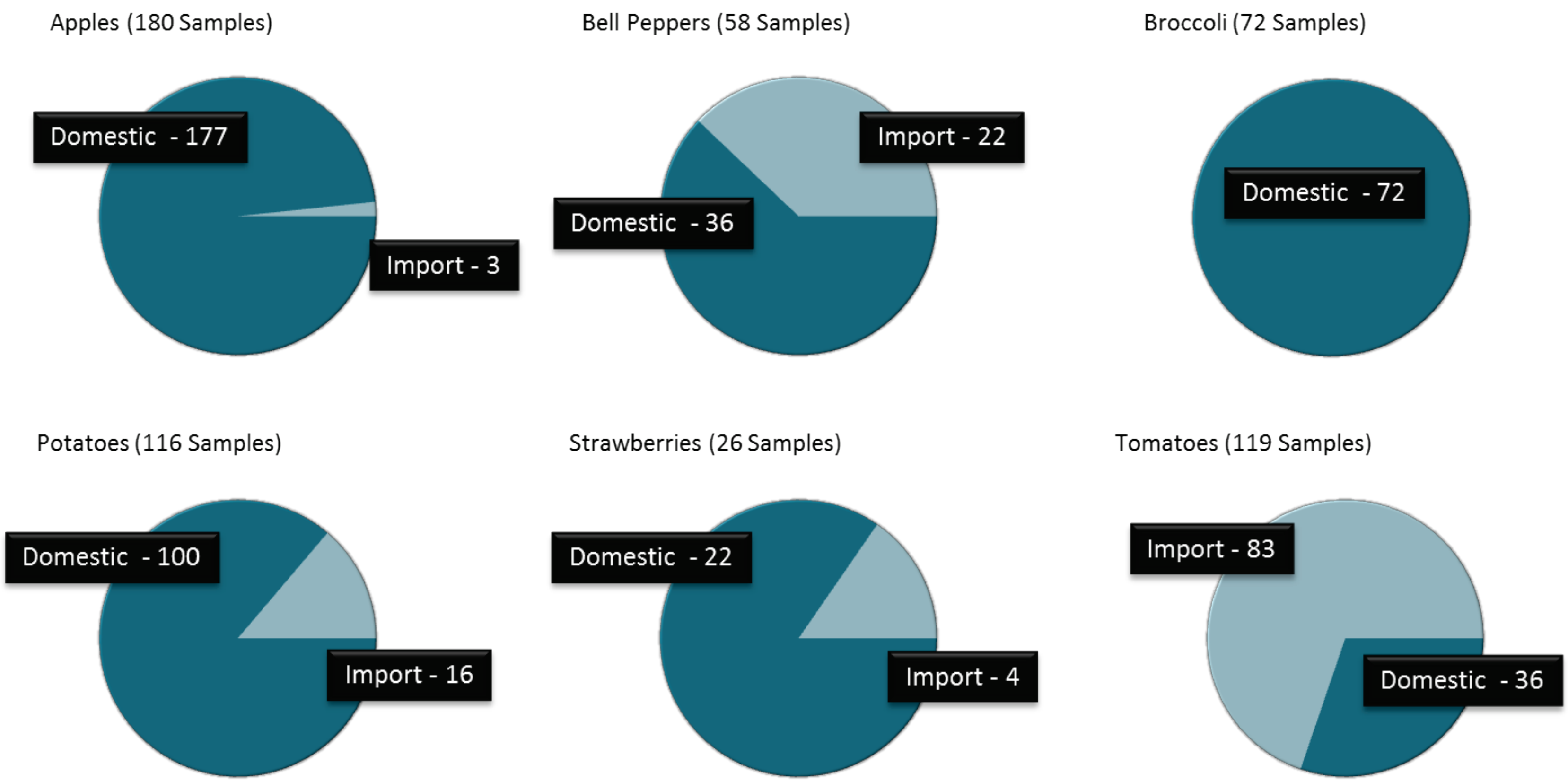

Table 1 – Production Volume in 2008 and Number of Samples by Organic Commodity

Organic Commodity	Organic Production Volume (in pounds)	Quota Sample	Samples Collected
Apples	488,194,548	175	180
Bell Peppers	12,091,200	50	58
Broccoli	54,533,600	75	72
Potatoes	227,440,600	100	116
Strawberries	42,436,800	50	26
Tomatoes	393,644,000	120	119
Total		570	571

Table 2 – The Number of Samples by Organic Commodity and Source of Production

Organic Commodity	Sample's Region of Production		Total
	Domestic	Import	
Apples	177	3	180
Bell Peppers	36	22	58
Broccoli	72	0	72
Potatoes	100	16	116
Strawberries	22	4	26
Tomatoes	36	83	119
Total	443	128	571

Table 3 – The Number of Samples and Operations by Certifying Agent and Source of Production

			Sources of Production			
			Domestic		Import	
Accredited Certifying Agent	**Samples**	**Operations**	**Samples**	**Operations**	**Samples**	**Operations**
BCS-Oeko Garantie GmbH	1	1	-	-	1	1
Guaranteed Organic Certification Agency	1	1	1	1	-	-
International Certification Service	1	1	-	-	1	1
MOFGA Certification Services	1	1	1	1	-	-
Midwest Organic Services Association	1	1	1	1	-	-
Pennsylvania Certified Organic	2	1	2	1	-	-
Global Culture	3	2	3	2	-	-
NOFA-New York Certified Organic	3	2	-	-	3	2
PrimusLabs	3	2	3	2	-	-
Organic Certifiers	4	3	3	2	1	1
Idaho State Department of Agriculture	5	2	5	2	-	-
Ohio Ecological Food and Farm Assoc.	5	1	5	1	-	-
Agricultural Services Certified Organic	8	2	8	2	-	-
Quality Certification Services	8	4	8	4	-	-
Scientific Certification Systems	8	1	4	1	4	1
Baystate Organic Certifiers	10	4	7	3	3	1
Pro-Cert Organic Systems	11	5	-	-	11	5
Indiana Certified Organic	13	2	4	1	9	2
Maryland Department of Agriculture	18	3	14	3	4	1
Colorado Department of Agriculture	23	8	16	6	7	3
Oregon Tilth Certified Organic	34	13	20	10	14	3
Washington State Dept. of Agriculture	124	20	120	19	4	1
CCOF Certification Services	125	27	107	23	18	8
Quality Assurance International	159	33	111	27	48	16
Total	**571**	**140**	**443**	**112**	**128**	**46**

Table 4 – The Number of Samples by Certifying Agent and Organic Commodity

Accredited Certifying Agent	Organic Commodity											
	Apples		Bell Peppers		Broccoli		Potatoes		Strawberries		Tomatoes	
	Domestic	Import	Domestic	Import	Domestic	Import	Domestic	Import	Domestic	Import	Domestic	Import
Agricultural Services Certified Organic	-	-	-	-	7	-	1	-	-	-	-	-
BCS-Oeko Garantie GmbH	-	1	-	-	-	-	-	-	-	-	-	-
Baystate Organic Certifiers	-	-	-	-	-	-	6	3	-	-	1	-
CCOF Certification Services	5	-	17	3	43	-	26	1	12	4	4	10
Colorado Department of Agriculture	1	-	-	-	-	-	15	-	-	-	-	7
Global Culture	2	-	-	-	-	-	-	-	1	-	-	-
Guaranteed Organic Certification Agency	-	-	-	-	-	-	-	-	1	-	-	-
Idaho State Department of Agriculture	-	-	-	-	-	-	5	-	-	-	-	-
Indiana Certified Organic	-	-	1	4	1	-	-	-	-	-	2	5
International Certification Service	-	-	-	-	-	-	-	1	-	-	-	-
MOFGA Certification Services	-	-	-	-	-	-	1	-	-	-	-	-
Maryland Department of Agriculture	8	2	4	1	1	-	1	-	-	-	-	1
Midwest Organic Services Association	-	-	-	-	-	-	1	-	-	-	-	-
NOFA-New York Certified Organic	-	-	-	1	-	-	-	-	-	-	-	2
Ohio Ecological Food and Farm Assoc.	-	-	-	-	-	-	5	-	-	-	-	-
Oregon Tilth Certified Organic	6	-	-	-	-	-	14	-	-	-	-	14
Organic Certifiers	-	-	-	-	-	-	-	-	3	-	-	1
Pennsylvania Certified Organic	-	-	-	-	2	-	-	-	-	-	-	-
PrimusLabs	-	-	3	-	-	-	-	-	-	-	-	-
Pro-Cert Organic Systems	-	-	-	-	-	-	-	11	-	-	-	-
Quality Assurance International	40	-	8	11	18	-	19	-	2	-	24	37
Quality Certification Services	-	-	-	-	-	-	-	-	3	-	5	-
Scientific Certification Systems	-	-	3	2	-	-	1	-	-	-	-	2
Washington State Dept. of Agriculture	115	-	-	-	-	-	5	-	-	-	-	4
Total	**177**	**3**	**36**	**22**	**72**	**-**	**100**	**16**	**22**	**4**	**36**	**83**
Total per Commodity	**180**		**58**		**72**		**116**		**26**		**119**	

Table 5 – The Number of Samples Analyzed and Summary of Results by Organic Commodity

Organic Commodity	Number of Samples Analyzed	Average Number of Analyses Performed on Each Sample	Number of Analyses Performed	Number of Non-Detections	Number of Detections	Number of Different Pesticides Detected
Apples	180	194	34,830	34,755	75	11
Bell Peppers	58	192	11,132	11,028	104	30
Broccoli	72	191	13,734	13,715	19	9
Potatoes	116	193	22,416	22,278	138	14
Strawberries	26	193	5,022	5,012	10	8
Tomatoes	119	194	23,056	22,989	67	19
Total	**571**		**110,190**	**109,777**	**413**	

Table 6 – The Number of Samples Analyzed and Results by Organic Commodity

Organic Commodity	Number of Samples Analyzed	Samples with Detections Exceeding EPA Tolerance (EPA Violation)		Samples with Detections Exceeding 5% EPA Tolerance (USDA Organic Violation)		Samples with Detections At Or Exceeding 0.01ppm		Samples with Detections At or Less than 0.01ppm		Samples with No Detections	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Apples	180	-	-	1	0.6	13	7.2	45	25	121	67.2
Bell Peppers	58	-	-	13	22.4	3	5.2	11	19.0	31	53.4
Broccoli	72	-	-	-	-	-	-	13	18.1	59	81.9
Potatoes	116	-	-	1	0.9	68	58.6	28	24.1	19	16.4
Strawberries	26	-	-	2	7.7	3	11.5	2	7.7	19	73.1
Tomatoes	119	-	-	4	3.4	15	12.6	22	18.5	78	65.5
Total	**571**	-	-	**21**	**3.7**	**102**	**17.9**	**121**	**21.2**	**327**	**57.3**

Appendix A

Listing of Pesticides by the Type of Pesticide

Appendix A shows the listing of pesticides by the type of pesticide.

The 571 organic produce samples in this pilot study were tested against the 195 pesticides listed in Appendix A. One-hundred-ninety (190) of the pesticides are considered single use, in that they are used to control one class of pest (e.g., insects):

Type of Pesticide	Number
Acaricide	6
Fungicide	49
Herbicide	27
Insect Growth Regulator	2
Insecticide	106
Total	**190**

The remaining five pesticides are considered dual use, in that they are used to control two classes of pests (e.g., insects and mites):

Types of Pesticide	Number
Fungicide / Growth Regulator	1
Herbicide / Growth Regulator	1
Insecticide / Acaricide	2
Insecticide / Growth Regulator	1
Total	**5**

The name and type of the 195 pesticides tested against in this pilot study:

Pesticide	Type of Pesticide
1-Naphthol	Insecticide
2,4 Dimethylphenyl formamide (DMPF)	Insecticide
3-Hydroxycarbofuran	Insecticide
4,4-Dibromobenzophenone	Acaricide
5-Hydroxythiabendazole	Fungicide
Acephate	Insecticide
Acetamiprid	Insecticide
Acetochlor	Herbicide
Aldicarb	Insecticide
Aldicarb sulfone	Insecticide
Aldicarb sulfoxide	Insecticide
Aldrin	Insecticide
Allethrin	Insecticide
Atrazine	Herbicide
Azinphos methyl	Insecticide

Pesticide	Type of Pesticide
Azoxystrobin	Fungicide
Bendiocarb	Insecticide
BHC alpha	Insecticide
Bifenazate	Acaricide
Bifenthrin	Insecticide
Biteranol	Fungicide
Boscalid	Fungicide
Bromacil	Herbicide
Buprofezin	Insecticide
Captan	Fungicide
Carbaryl	Insecticide
Carbendazim (MBC)	Fungicide
Carbofuran	Insecticide
Carfentrazone ethyl	Herbicide
Chlorantraniprole	Insecticide
Chlordane cis	Insecticide
Chlordane trans	Insecticide
Chlorfenapyr	Insecticide
Chlorothalonil	Fungicide
Chlorpropham (CIPC)	Herbicide / Growth Regulator
Chlorpyrifos	Insecticide
Chlorpyrifos methyl	Insecticide
Chlorthal (DCPA)	Herbicide
Clofentezine	Acaricide
Clothianidin	Insecticide
Coumaphos	Insecticide
Cyazofamid	Fungicide
Cycloate	Herbicide
Cyfluthrin	Insecticide
Cyhalothrin lambda	Insecticide
Cypermethrin	Insecticide
Cyprodinil	Fungicide
Cyromazine	Insect Growth Regulator
DDD o,p'	Insecticide
DDD p,p'	Insecticide
DDE o,p'	Insecticide
DDE p,p'	Insecticide
DDT p,p'	Insecticide
Deltamethrin	Insecticide
Diazinon	Insecticide
Diazinon oxygen analog	Insecticide
Dichlorvos (DDVP)	Insecticide
Dicloran	Fungicide
Dicofol o,p'	Insecticide
Dicofol p,p'	Insecticide
Dieldrin	Insecticide

Pesticide	Type of Pesticide
Difenoconazole	Fungicide
Diflubenzuron	Insecticide
Dimethoate	Insecticide
Dimethomorph	Fungicide
Dinotefuran	Insecticide
Diphenamid	Herbicide
Diphenylamine	Fungicide
Disulfoton sulfone	Insecticide
Diuron	Herbicide
Endosulfan I	Insecticide
Endosulfan II	Insecticide
Endosulfan sulfate	Insecticide
Endrin	Insecticide
Epoxiconazole	Fungicide
Esfenvalerate	Insecticide
Ethion	Insecticide
Ethoprop	Insecticide
Ethoxyquin	Fungicide / Growth Regulator
Etoxazole	Acaricide
Etridiazole	Fungicide
Famoxadone	Fungicide
Fenamidone	Fungicide
Fenamiphos	Insecticide
Fenamiphos sulfone	Insecticide
Fenamiphos sulfoxide	Insecticide
Fenarimol	Fungicide
Fenbuconazole	Fungicide
Fenhexamid	Fungicide
Fenoxaprop ethyl	Herbicide
Fenpropathrin	Insecticide
Fenpyroximate	Acaricide
Fenthion	Insecticide
Fipronil	Insecticide
Flonicamid	Insecticide
Fludioxonil	Fungicide
Fluoxastrobin	Fungicide
Fluridone	Herbicide
Flutolanil	Fungicide
Fluvalinate total	Insecticide
Folpet	Fungicide
Fonofos	Insecticide
Heptachlor	Insecticide
Heptachlor epoxide	Insecticide
Hexachlorobenzene	Fungicide
Hexaconazole	Fungicide
Hexythiazox	Insecticide

Pesticide	Type of Pesticide
Hydroprene	Insect Growth Regulator / Acaricide
Imazalil	Fungicide
Imidacloprid	Insecticide
Indoxacarb	Insecticide
Iprodione	Fungicide
Lindane	Insecticide
Linuron	Herbicide
Malathion	Insecticide
Malathion oxygen analog	Insecticide
Metalaxyl	Fungicide
Methamidophos	Insecticide
Methidathion	Insecticide
Methiocarb	Insecticide
Methomyl	Insecticide
Methoxychlor	Insecticide
Methoxyfenozide	Insecticide
Metolachlor	Herbicide
Metribuzin	Herbicide
Mevinphos total	Insecticide
MGK-264	Insecticide
Myclobutanil	Fungicide
Naled	Insecticide
Napropamide	Herbicide
Nonachlor cis	Insecticide
Nonachlor trans	Insecticide
Norflurazon	Herbicide
Norflurazon desmethyl	Herbicide
Omethoate	Insecticide
o-Phenylphenol	Fungicide
Oxadixyl	Fungicide
Oxamyl	Insecticide
Oxamyl oxime	Insecticide
Oxydemeton methyl sulfone	Insecticide
Oxyfluorfen	Herbicide
Parathion methyl	Insecticide
Pendimethalin	Herbicide
Pentachlorobenzene	Fungicide
Permethrin total	Insecticide
Phenmedipham	Herbicide
Phorate sulfone	Insecticide
Phorate sulfoxide	Insecticide
Phosalone	Insecticide
Phosmet	Insecticide
Piperonyl butoxide	Insecticide
Pirimicarb	Insecticide
Prallethrin	Insecticide

Pesticide	Type of Pesticide
Prochloraz	Fungicide
Procymidone	Fungicide
Profenofos	Insecticide
Prometryn	Herbicide
Pronamide	Herbicide
Propanil	Herbicide
Propargite	Insecticide
Propetamphos	Insecticide
Propham	Herbicide
Propiconazole	Fungicide
Pymetrozine	Insecticide
Pyraclostrobin	Fungicide
Pyridaben	Insecticide / Acaricide
Pyrimethanil	Fungicide
Pyriproxyfen	Insecticide / Growth Regulator
Quinoxyfen	Fungicide
Quintozene	Fungicide
Resmethrin total	Insecticide
Simazine	Herbicide
Spinetoram	Insecticide
Spirodiclofen	Acaricide
Spiromesifen	Insecticide
Sulfentrazone	Herbicide
Tebuconazole	Fungicide
Tebufenozide	Insecticide
Tefluthrin	Insecticide
Tetrachlorvinphos	Insecticide
Tetraconazole	Fungicide
Tetradifon	Insecticide
Tetrahydrophthalimide (THPI)	Fungicide
Tetramethrin	Insecticide
Thiabendazole	Fungicide
Thiacloprid	Insecticide
Thiamethoxam	Insecticide
Thiodicarb	Insecticide
Triadimefon	Fungicide
Triadimenol	Fungicide
Tribufos	Herbicide
Trifloxystrobin	Fungicide
Triflumizole	Fungicide
Trifluralin	Herbicide
Vinclozolin	Fungicide

Appendix B

Laboratory Procedures and Methods

Sampling Plan
A sampling plan was developed based on availability of funds for procuring and testing the samples. The USDA Agricultural Marketing Service Fruit and Vegetable Fresh Products Branch (F&V) provided 20 samplers from 20 field office locations to act as sample collectors of organic produce at retail marketplaces throughout the United States. Collectors purchased, packed, and shipped samples to the National Science Laboratory (NSL) using prepaid cartons and associated packing materials provided by the NSL. Samplers were asked to collect samples on Wednesday, Thursday, or Friday and ship them on Monday or Tuesday. NSL provided a lab procedure to the sample collection agents as a guide for collection of USDA-certified organic products for pesticide residue analysis at NSL, and boxes were sent directly to the NSL by F&V personnel for sample testing.

Since the distribution of pesticide residues is not always homogeneous in lots, multiple individual samples were taken. Furthermore, because the types and numbers of USDA certified organic produce varied from marketplace to marketplace, the sampling plan was adjusted to allow USDA inspectors to collect samples based on sample availability, up to the 571 target samples (Table B1). As long as each sample represented a different variety or commodity, multiple samples could be obtained from the same retail market. In order for a sample to be acceptable, it had to be labeled with the USDA organic seal along with the name of the certifying agent. Sampling forms and instructions for completing them were provided to the inspectors to complete for each sample. The USDA inspectors remitted invoices to NSL on a biweekly basis.

Laboratory Criteria
A multi-residue pesticide screening approach was preferable because (1) it was necessary to screen for a large number of pesticides potentially used in the 571 samples and (2) the cost and time of analysis compared to specific tests for individual residues were much less. The process for testing included the following steps: sampling, homogenization, extraction, cleanup, and chromatographic analysis. Since the project was designed to mirror compliance testing, rigorous controls were maintained over each of these steps. The method used was validated according to an internationally recognized protocol.

The method was also embedded in the NSL quality system in compliance with International Organization for Standardization/International Electrotechnical Commission ISO/IEC 17025:2005 – *General Requirements for the Competence of Testing and Calibration Laboratories*. Pesticide residue analysis at NSL is accredited according to the ISO/IEC 17025:2005 — *General Requirements for the Competence of Testing and Calibration Laboratories* through the Association for Laboratory Accreditation (A2LA). A2LA complies with the general criteria for laboratory accreditation laid down in ISO/IEC 17021:2011 — *Requirements for Bodies Providing Audit and Certification of Management Systems*. Prior to and during the project, NSL participated in recognized proficiency test programs for pesticide residue analysis.

The chromatographic pesticide residue analysis method was calibrated using certified reference material (CRM) obtained from EPA, Food Analysis Performance Assessment Scheme, or a chemical supply house. Each CRM was accompanied by documentation issued by an authoritative body providing one or more specified property values with associated uncertainties and traceability. The recoveries of pesticides were monitored in each sample set per commodity by spiking a blank sample of a commodity with known amounts of pesticides and quantifying the recovered amount via the extraction and analysis process. The amount recovered divided by the amount spiked multiplied by 100 was the percent recovery. An example of recovery data is provided in Appendix Table B2. Each sample was also spiked with a process control spike, a single compound that is monitored in each sample for its recovery.

Sample Processing

Samples were not washed, peeled, hulled, pitted or reconstituted prior to homogenization, but were prepared for analysis as they were received. Samples that were not immediately processed before homogenization were stored at 4 degrees Celsius for up to 72 hours. The entire sample as received (up to 5 pounds (~2.5 kg)) was homogenized using a Robocoupe® food processer to obtain a suitable representative portion for analysis. Homogenized samples were stored at less than -20 degrees Celsius.

Pesticide Residue Extraction

NSL used a slight modification to the AOAC Official Method of Analysis, 2007.01 Pesticide Residues in Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulfate (Quick, easy, cheap, environmentally friendly, reliable, safe—QuEChERS) for the assessment of the incidence of pesticide residues remaining on the 571 submitted samples (1). Modifications to the original method were introduced to provide better cleanup of the sample extract for gas chromatography/mass spectrometer (GC/MS) analysis. Although it is recognized that not all registered pesticides are amenable to detection using the QuEChERS method, at this time no multi-residue method is available that will analyze all registered pesticides effectively with appropriate precision and uncertainty.

Pesticide Residue Analysis

A "target" analyte list was prepared collaboratively between the USDA National Organic Program and the Laboratory Division by examination of all pesticides/metabolites/environmental contaminants that have been detected in samples analyzed for the USDA Pesticide Data Program. NSL analyzed the samples using gas chromatography (GC) and/or liquid chromatography coupled to a mass spectrometer (MS) or tandem mass spectrometers (MS/MS). See Table B2 for an example of quality assurance/quality control (QA/QC) data. NSL evaluated 195 pesticide residues in the 571 samples.

Quality Assurance

Quantitative analysis of residues was performed using calibration standards of pesticide reference materials prepared at known concentrations. The most accurate quantitative results were obtained with matrix matched calibration standards prepared using blank matrix extracts. Qualitative analysis was performed by comparing mass spectral ion abundances of known standards to ion abundances of presumptive incurred residues in order to confirm the identity of observed residues in samples. Reference materials and the instrument recoveries were generated and monitored for trends. The final data package underwent three reviews, and the results of those reviews were documented. The results from the analyses were reported in parts per million (ppm). Measurement uncertainty is inherent in the analytic process and needs to be considered when the analytic results are examined (2).

Data Analysis

Data recorded for each sample included product description, collection date, name of the certifier, collection site city, collection site State, source of production, country of origin, and operation name.

Quality Control Samples. Test items/materials were processed in batches of 20 or fewer samples, typically including at least 1 quality control sample (QCS) per batch. Acceptance criteria for QCS were based on an absolute value recovery range of 50 to 150 percent. When multiple commodities were tested per set, a commodity-specific QCS would also be analyzed per commodity. Out of 195 different residues analyzed, there appears to have been an overall recovery range of 80 to 113 percent. Examples of recoveries exceeding 150 percent include 3-Hydroxycarbofuran, boscalid, captan, carbaryl, chlorantraniprole, clothianidin, DDT, and dletamethrin. Examples of recoveries at less than 50 percent include naphthol, captan, chlorothalonil, and DDD.

Control of Nonconforming Work. Each batch of test items processed underwent a 3-tiered review, including two technical reviews and one quality evaluation. The NSL quality manual was used as a guide for the control of nonconforming work. Policies and control processes covered include addressing customer needs, obtaining feedback, confidentiality, complaints, errors and remedial action, corrections, corrective action, prevention, reporting test results, sensitive information, audits, quality practices, management review and others. Corrective action logs indicating no significant actions were required to address issues within the testing processes applied to National Organic Program test materials. However, several remedial actions were taken to address minor issues such as shortage of clean matrices for QCS, long-term use of intermediate reference materials, or simple error handling practices. No actions were taken against the recovery results being outside the range requirement, because the laboratory applied additional criteria to the analysis of results. There were a few residues that demonstrated unusual recovery patterns (e.g., tridimenol, pyridaben, tetramethrin, and tetrahydrophthalimide), but no cause for this pattern could be determined.

Handling of Test Items/Materials. Receipt of test items was managed according to a variety of provisions necessary to protect the integrity of test items and to satisfy the National Organic Program and NSL. These included but were not limited to determining the temperature, container condition upon arrival, damage, and placement of security seals. A total of 571 test items were analyzed; 22 samples were not analyzed due to some form of spoilage. Examples of common indicators of spoilage, which led to the sample not being tested, included the appearance of rot or mold, or foul odors implying rot. There was no indication that test items were compromised by poor handling practices during shipment. Compromised cooling may have contributed to those identified as spoiled. Arrangements were not made for USDA inspectors to replace spoiled samples. Test items/materials were retained a minimum of 10 working days following completion of all analyses and reporting of results. This includes any remaining sample or reserve portions required to insure a usable amount is available for re-extraction, re- testing, etc. Some samples required additional testing and will be stored up to 1 to 2 years or longer.

Ensuring the Quality of Test Results. Activities associated with the quality management system and the laboratory's scopes of accreditation were audited according to a predetermined monthly schedule. In addition to the recovery range criteria (i.e., 50 to 150 percent), the laboratory chose to take action only when evidence indicated that greater than 30 percent of the residues analyzed had been adversely affected; statistical process control charts and summary spreadsheets indicate that only 1 to 8 percent of the total residues analyzed were adversely affected. This gave analysts confidence that there wasn't a need to pursue every questionable recovery result. Proficiency testing through external and internal programs was required to maintain the laboratory's accreditation to the ISO/IEC 17025 standard. Recoveries ranged between 60 and 120 percent, with broccoli demonstrating a lower-than-expected range of 40 to 70 percent.

Control of Records

The laboratory adheres to the Science and Technology Program record retention and disposition plan where all analytical records are archived onsite 3 years following the close of the fiscal year in which the records were generated. Ancillary data about the type of pesticide was subsequently incorporated into each sample's data record.

References

1. Lehotay, Steven J., Determination of Pesticide Residues in Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulfate: Collaborative Study, J AOAC INT Vol. 90, No. 2, 2007, p 485-520.

2. Paul De Bièvre and Helmut Günzler, eds., *Measurement Uncertainty in Chemical Analysis* (Berlin: Springer Verlag, 2003).

Table B1 – Optimized Sample Size

Primary Food Commodities of Plant Origin All fresh fruits and vegetables				
1	**Small sized products** units generally less than 25 g	Strawberries	Whole units, or packages, or units taken with sampling device	2-3 packages (up to 2.5 lbs) or what is available in the store.
2	**Medium sized products** units generally 25 - 250 g	Bell Peppers	Whole units, or units taken with sampling device	5 peppers or what is available loose or in a package at the store.
3	**Medium sized products** units generally 25 - 250 g	Tomatoes	Whole units, or units taken with sampling device	5-10 full sized tomatoes, 2-3 packages of smaller sized tomatoes or what is available at the store
4	**Medium sized products** units generally 25 - 250 g	Potatoes	Whole units, or units taken with sampling device	3-5 lbs or what is available in a package. If less is available collect the amount available.
5	**Medium sized products** units generally 25 - 250 g	Apples	Whole units, or units taken with sampling device	3-5 lbs or what is available in a package. If less is available collect the amount available.
6	**Large sized products** units generally greater than 250 g	Broccoli	Whole units, units taken with sampling device	2-3 bunches (up to 2.5 lbs) or what is available in the store.

Appendix C

Distribution of Pesticide Residues in Organic Commodities

Appendix C shows pesticide residue detections for the pesticide/commodity pairs of samples having pesticide residue detected. The following data is presented for each pesticide detected in the study, per commodity:

- EPA tolerance level
- 5 percent of EPA tolerance level
- Samples with detections exceeding EPA tolerance (EPA violation)
- Samples with detections exceeding 5 percent EPA tolerance (USDA Organic Violation)
- Samples with detections exceeding 0.01 ppm
- Samples with detections at or less than 0.01 ppm
- Range of detected values (ppm)

The EPA tolerances cited in this study apply to 2010 and not to the current year. There may be instances where tolerances may have been recently set or revoked that would have an effect on whether a residue exceeds the tolerance or not.

Instead of EPA tolerance levels, some pesticides have Action Levels (AL) established by the U.S. Food and Drug Administration (FDA). In these cases, the USDA National Organic Program has established an action threshold that constitutes a violation of the USDA organic regulations: 0.01 parts per million (ppm). These pesticides are labeled accordingly in Appendix C.

Some pesticides have no tolerance levels established by EPA or FDA. NT denotes pesticide/commodity pairs having no tolerance levels established by EPA or FDA. In these cases, the USDA National Organic Program has established an action threshold that constitutes a violation of the USDA organic regulations: 0.01 parts per million (ppm). These pesticides are labeled accordingly in Appendix C.

Table C1 – Apples, Distribution of Results for Each Detected Pesticide

Pesticide	EPA Tolerance Level (ppm)	5% of EPA Tolerance Level (ppm)	Samples with Detections Exceeding EPA Tolerance (EPA Violation)		Samples with Detections Exceeding 5% EPA Tolerance (USDA Organic Violation)		Samples with Detections Exceeding 0.01ppm		Samples with Detections At or Less than 0.01ppm		Range of Detected Values (ppm)	Range of Limit of Detection (ppm)
			Number	%	Number	%	Number	%	Number	%		
Bifenthrin	0.05	0.0025	-	-	-	-	-	-	1	0.6	0.002	0.002
Chlorpyrifos	0.1	0.005	-	-	-	-	-	-	3	1.7	0.001	0.001
Cyhalothrin lambda	0.3	0.015	-	-	-	-	-	-	2	1.1	0.001	0.001
DDE p,p'	0.1 AL*	0.01***	-	-	-	-	-	-	1	0.6	0.004	0.002
Diphenylamine	10.0	0.5	-	-	-	-	9	5	11	6.1	0.006 - 0.021	0.005 - 0.011
Endosulfan II	1.0	0.05	-	-	-	-	-	-	1	0.6	0.001	0.001
Endosulfan sulfate	1.0	0.05	-	-	-	-	-	-	2	1.1	0.001	-
Imidacloprid	0.5	0.025	-	-	-	-	-	-	1	0.6	0.006	0.001
Pendimethalin	0.1	0.005	-	-	-	-	-	-	1	0.6	0.002	0.002
Spirodiclofen	0.8	0.04	-	-	-	-	-	-	7	3.9	0.001 – 0.003	0.004
Thiabendazole	5.0	0.25	-	-	1	0.6	5	2.8	30	16.7	0.001 - 0.028	0.001

*FDA action level; this pesticide is no longer registered by EPA.
**Tolerance level not established by EPA.
***Action threshold established by the USDA National Organic Program to constitute a USDA organic violation.

No residues of the 184 other pesticides were detected in the 180 apple samples.

Table C2 – Bell Peppers, Distribution of Results for Each Detected Pesticide

Pesticide	EPA Tolerance Level (ppm)	5% of EPA Tolerance Level (ppm)	Samples with Detections Exceeding EPA Tolerance (EPA Violation)		Samples with Detections Exceeding 5% EPA Tolerance (USDA Organic Violation)		Samples with Detections Exceeding 0.01ppm		Samples with Detections At or Less than 0.01ppm		Range of Detected Values (ppm)	Range of Limit of Detection (ppm)
			Number	%	Number	%	Number	%	Number	%		
Acephate	4.00	0.2	-	-	-	-	-	-	1	1.7	0.045	0.01
Azoxystrobin	2.0	0.1	-	-	-	-	-	-	5	8.6	0.001 - 0.004	0.001
Bifenthrin	0.50	0.025	-	-	-	-	-	-	2	3.4	0.007 - 0.008	0.005
Boscalid	1.2	0.06	-	-	1	1.7	1	1.7	-	-	0.02 - 0.072	0.02
Carbendazim	NT**	0.01***	-	-	1	1.7	-	-			0.07	0.005
Carfentrazone ethyl	1.0	0.05	-	-	2	3.4	2	3.4	-	-	0.043 - 0.095	0.003
Chlorpyrifos	1.00	0.05	-	-	-	-	2	3.4	5	8.6	0.001 - 0.041	0.003
Chlothianidin	0.25	0.0125	-	-	-	-	3	5.2	8	13.8	0.002 - .026	0.001
Cyfluthrin	0.5	0.025	-	-	-	-	2	3.4	-	-	0.018 - 0.021	0.004
Cyhalothrin lambda	0.2	0.01	-	-	1	1.7	2	3.4	-	-	0.002 - 0.012	0.001
Cypermethrin	0.2	0.01	-	-	1	1.7	-	-	-	-	0.022	0.004
Endosulfan I	2.0	0.1	-	-	-	-	2	3.4	7	2.1	0.001 - 0.077	0.001
Endosulfan II	2.0	0.1	-	-	-	-	3	5.2	3	5.2	0.003 - 0.063	0.001
Endosulfan sulfate	2.0	0.1	-	-	-	-	1	1.7	4	6.9	0.005 - 0.051	0.001
Esfenvalerate	0.50	0.025	-	-	-	-	-	-	2	3.4	0.002 - 0.007	0.005
Famoxadone	4.0	0.2	-	-	-	-	1	1.7	-	-	0.184	0.05
Fenhexamid	2.0	0.1	-	-	-	-	1	1.7	1	1.7	0.006 - 0.019	0.003
Fenpropathrin	1.0	0.05	-	-	-	-	1	1.7	-	-	0.012	0.008
Flonicamid	0.4	0.02	-	-	1	1.7	-	-	-	-	0.04	0.008
Imidacloprid	1.0	0.05	-	-	1	1.7	3	5.2	5	8.6	0.002 - 0.078	0.001
Metalaxyl	1.0	0.05	-	-	-	-	1	1.7	3	5.2	0.006 - 0.016	0.002
Methamidophos	1.0	0.05	-	-	-	-	1	1.7	-	-	0.024	0.004
Methoxyfenozide	2.0	0.1	-	-	-	-	-	-	3	5.2	0.003 - 0.004	0.002
Myclobutanil	4.00	0.2	-	-	-	-	4	6.9	1	1.7	0.007 - 0.053	0.005
Oxamyl oxime	2.00	0.1	-	-	1	1.7	2	3.4	-	-	0.033 - 0.158	0.025
Propanil	NT**	0.01***	-	-	3	5.2	-	-	-	-	0.034 - 0.045	0.03

Pesticide	EPA Tolerance Level (ppm)	5% of EPA Tolerance Level (ppm)	Samples with Detections Exceeding EPA Tolerance (EPA Violation)		Samples with Detections Exceeding 5% EPA Tolerance (USDA Organic Violation)		Samples with Detections Exceeding 0.01ppm		Samples with Detections At or Less than 0.01ppm		Range of Detected Values (ppm)	Range of Limit of Detection (ppm)
			Number	%	Number	%	Number	%	Number	%		
Quinoxyfen	0.35	0.0175	-	-	1	1.7	-	-	-	-	0.084	0.02
Tebufenozide	1.0	0.05	-	-	-	-	1	1.7	-	-	0.034	0.005
Thiamethoxam	0.25	0.0125	-	-	1	1.7	-	-	5	8.6	0.004 - 0.020	0.001
Trifloxystrobin	0.5	0.025	-	-	-	-	-	-	2	3.4	0.002 - 0.010	0.002

*FDA action level; this pesticide is no longer registered by EPA.
**Tolerance level not established by EPA.
***Action threshold established by the USDA National Organic Program to constitute a USDA organic violation.

No residues of the 155 other pesticides were detected in the 58 bell pepper samples.

Table C3 – Broccoli, Distribution of Results for Each Detected Pesticide

Pesticide	EPA Tolerance Level (ppm)	5% of EPA Tolerance Level (ppm)	Samples with Detections Exceeding EPA Tolerance (EPA Violation)		Samples with Detections Exceeding 5% EPA Tolerance (USDA Organic Violation)		Samples with Detections Exceeding 0.01ppm		Samples with Detections At or Less than 0.01ppm		Range of Detected Values (ppm)	Range of Limit of Detection (ppm)
			Number	%	Number	%	Number	%	Number	%		
Chlorpyrifos	1.0	0.05	-	-	-	-	-	-	6	8.3	0.001	0.001
Chlorthal (DCPA)	5.0	0.25	-	-	-	-	-	-	2	2.8	0.004 - 0.005	0.004
Cyhalothrin lambda	0.4	0.02	-	-	-	-	-	-	1	1.4	0.001	0.001
DDE p,p'	0.5 AL*	0.01***	-	-	-	-	-	-	2	2.8	0.003 - 0.008	0.002
Esfenvalerate	1.0	0.05	-	-	-	-	-	-	2	2.8	0.002	0.002
Imidacloprid	3.5	0.175	-	-	-	-	-	-	1	1.4	0.003	0.005
Iprodione	25.0	1.25	-	-	-	-	-	-	1	1.4	0.005	0.01
Pendimethalin	0.1	0.005	-	-	-	-	-	-	2	2.8	0.002	0.002
Trifluralin	0.05	0.0025	-	-	-	-	-	-	2	2.8	0.001	0.001

*FDA action level; this pesticide is no longer registered by EPA.
**Tolerance level not established by EPA.
***Action threshold established by the USDA National Organic Program to constitute a USDA organic violation.

No residues of the 186 other pesticides were detected in the 72 broccoli samples.

Table C4 – Potatoes, Distribution of Results for Each Detected Pesticide

Pesticide	EPA Tolerance Level (ppm)	5% of EPA Tolerance Level (ppm)	Samples with Detections Exceeding EPA Tolerance (EPA Violation)		Samples with Detections Exceeding 5% EPA Tolerance (USDA Organic Violation)		Samples with Detections At Or Exceeding 0.01ppm		Samples with Detections At or Less than 0.01ppm		Range of Detected Values (ppm)	Range of Limit of Detection (ppm)
			Number	%	Number	%	Number	%	Number	%		
Azoxystrobin	0.03	0.0015	-	-	-	-	-	-	4	3.4	0.001 - 0.003	0.001
Carfentrazone ethyl	0.1	0.005	-	-	-	-	-	-	1	0.9	0.001	0.001
Chlorpropham (CIPC)	30.0	1.5	-	-	-	-	67	57.8	-	-	0.030 - 0.368	0.05
DDE p,p'	0.1 AL*	0.01***	-	-	-	-	-	-	39	33.6	0.002 - 0.010	0.002
Dieldrin	0.5 AL*	0.01***	-	-	-	-	-	-	2	1.7	0.002	0.002
Endosulfan sulfate	0.2	0.01	-	-	-	-	-	-	14	12.1	0.001	0.001
Esfenvalerate	0.02	0.001	-	-	-	-	-	-	1	0.9	0.002	0.002
Fenpropathrin	NT**	0.01***	-	-	-	-	-	-	1	0.9	0.005	0.008
Heptachlor epoxide	0.1 AL*	0.01***	-	-	-	-	-	-	1	0.9	0.003	0.003
Imidacloprid	0.4	0.02	-	-	1	0.9	-	-	-	-	0.03	0.001
Iprodione	0.5	0.025	-	-	-	-	1	0.9	-	-	0.014	0.01
Spirodiclofen	NT**	0.01***	-	-	-	-	-	-	1	0.9	0.001	0.001
Tetradifon	NT**	0.01***	-	-	-	-	-	-	1	0.9	0.001	0.001
Thiabendazole	10.0	0.5	-	-	-	-	1	0.9	2	1.7	0.004 - 0.331	0.001

*FDA action level; this pesticide is no longer registered by EPA.
**Tolerance level not established by EPA
***Action threshold established by the USDA National Organic Program to constitute a USDA organic violation.

No residues of the 181 other pesticides were detected in the 116 potato samples.

Table C5 – Strawberries, Distribution of Results for Each Detected Pesticide

Pesticide	EPA Tolerance Level (ppm)	5% of EPA Tolerance Level (ppm)	Samples with Detections Exceeding EPA Tolerance (EPA Violation)		Samples with Detections Exceeding 5% EPA Tolerance (USDA Organic Violation)		Samples with Detections At Or Exceeding 0.01ppm		Samples with Detections At or Less than 0.01ppm		Range of Detected Values (ppm)	Range of Limit of Detection (ppm)
			Number	%	Number	%	Number	%	Number	%		
Azoxystrobin	10.00	0.5	-	-	-	-	-	-	1	3.8	0.002	0.001
Endosulfan I	2.0	0.1	-	-	-	-	-	-	1	3.8	0.001	0.001
Endosulfan II	2.0	0.1	-	-	-	-	-	-	1	3.8	0.005	0.001
Endosulfan sulfate	2.0	0.1	-	-	-	-	1	3.8	-	-	0.015	0.001
Etoxazole	0.5	0.025	-	-	1	3.8	-	-	-	-	0.117	0.001
Etridiazole	NT**	0.01***	-	-	1	3.8	-	-	-	-	0.013	0.01
Piperonyl butoxide	10.0	0.5	-	-	-	-	3	11.5	-	-	0.092 - 0.200	0.05
Pyrimethanil	3.0	0.15	-	-	-	-	-	-	1	3.8	0.01	0.003

*FDA action level; this pesticide is no longer registered by EPA.
**Tolerance level not established by EPA.
***Action threshold established by the USDA National Organic Program to constitute a USDA organic violation.

No residues of the 187 other pesticides were detected in the 26 strawberry samples.

Table C6 – Tomatoes, Distribution of Results for Each Detected Pesticide

Pesticide	EPA Tolerance Level (ppm)	5% of EPA Tolerance Level (ppm)	Samples with Detections Exceeding EPA Tolerance (EPA Violation)		Samples with Detections Exceeding 5% EPA Tolerance (USDA Organic Violation)		Samples with Detections At Or Exceeding 0.01ppm		Samples with Detections At or Less than 0.01ppm		Range of Detected Values (ppm)	Range of Limit of Detection (ppm)
			Number	%	Number	%	Number	%	Number	%		
Acetamiprid	0.2	0.01	-	-	-	-	-	-	1	0.8	0.005	0.004
Azoxystrobin	0.20	0.01	-	-	1	0.8	-	-	3	2.5	0.003 - 0.015	0.001
Bifenthrin	0.15	0.0075	-	-	-	-	-	-	1	0.8	0.001	0.001
Carfentrazone ethyl	1.0	0.05	-	-	-	-	-	-	4	3.4	0.001	0.001
Chlorpyrifos	NT**	0.01***	-	-	-	-	-	-	5	4.2	0.001	0.001-0.003
Chlothianidin	0.25	0.0125	-	-	1	0.8	-	-	1	0.8	0.008 - 0.015	0.001
Cypermethrin	0.2	0.01	-	-	-	-	-	-	2	1.7	0.006 - 0.007	0.004
Dicofol p,p'	2.0	0.1	-	-	-	-	-	-	1	0.8	0.002	0.002
Endosulfan I	1.0	0.05	-	-	-	-	-	-	1	0.8	0.003	0.003
Endosulfan II	1.0	0.05	-	-	-	-	-	-	1	0.8	0.004	0.001
Endosulfan sulfate	1.0	0.05	-	-	-	-	-	-	2	1.7	0.001 - 0.003	0.001
Fenarimol	NT**	0.01***	-	-	-	-	-	-	1	0.8	0.005	0.005
Flonicamid	0.4	0.02	-	-	2	1.7	-	-	-	-	0.033 - 0.048	0.008
Imidacloprid	1.0	0.05	-	-	1	0.8	8	6.7	17	14.3	0.001 - 0.059	0.001
Pendimethalin	0.10	0.005	-	-	-	-	-	-	2	1.7	0.004	0.003
Piperonyl butoxide	10.0	0.5	-	-	-	-	7	9.3	-	-	0.054 - 0.480	0.05
Quintozene	0.1	0.005	-	-	-	-	-	-	1	0.8	0.001	0.001
Spiromesifen	0.45	0.0225	-	-	-	-	2	1.7	-	-	0.016	0.01
Thiamethoxam	0.25	0.0125	-	-	-	-	1	0.8	1	0.8	0.009 - 0.011	0.004

*FDA action level; this pesticide is no longer registered by EPA.
**Tolerance level not established by EPA.
***Action threshold established by the USDA National Organic Program to constitute a USDA organic violation.

No residues of the 176 other pesticides were detected in the 119 tomato samples.