Agricultural Chemical Use – Fruit Methodology and Quality Measures

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Fruit Chemical Use Survey: Methodology and Chemical Usage Statistics

Scope and Purpose: The National Agricultural Statistics Service (NASS) Fruit Chemical Use Survey (FCUS) collects entire farm level chemical use data from growers of select fruits in program states. The fruit and vegetable chemical surveys have been conducted in alternating years since 1990 with data collected on fruits in odd numbered years and vegetables in even numbered years. The states involved and the commodities surveyed are selected based on NASS acres planted and evaluated each cycle to ensure maximum coverage.

The states involved (referred to as "program states") and the commodities surveyed are selected based on NASS acres planted and evaluated each cycle to ensure maximum coverage. NASS aims to cover at a minimum 80 percent of targeted fruit crop acres in the United States. Farm level data are combined during summary and, pending compliance with disclosure rules, published at state and national levels. Data are published for 22 targeted fruit crops in 12 states.

Survey Timeline: Data collection begins on September 1 and lasts until mid-January of the following year to ensure completion of the crop year. NASS Regional Field Offices (RFOs) along with NASS Headquarters (HQ) spend the next several months reviewing reported data for reasonableness and conduct producer follow-ups, as necessary. The estimates are released to the NASS Quick Stats 2.0 system during the fourth week in July.

Sampling: The target population for the FCUS is all agricultural establishments with more than $1,000 in agricultural sales (or potential sales). NASS uses a dual frame approach, consisting of list frame and area frame components, to provide complete coverage of this target population.

NASS maintains a list of farm and ranch operators. NASS is constantly seeking new operations from outside list sources confirmed to be qualifying farms before being added to the list. A profile, known as control data, of each operation is maintained which indicates what the farm has historically produced and a general indication of size. This information allows NASS to define sampling populations that are specific to each survey and employ advanced and more efficient sample designs.

The FCUS list sample is selected based on a calculated Farm Value of Sales (FVS). All farms on the list frame with an estimated FVS of $1,000 or more are eligible. The value of sales control data need not be exact as it is used to stratify similar list operations into homogeneous groups.

Sampling Frames and Methods: The sample for the FCUS is selected from the NASS List Sampling Frame. The population of interest is fruit growers having positive list frame acreage for one or more of the target fruit crops. The sample will use the Multivariate Probability Proportional to Size (MPPS) design, in which each reporting unit's probability of selection depends on its total acres of the target crops. The reporting unit is one farm associated with the selected operator. Sampled units that were known to have multiple farms had one farm randomly selected as the reporting unit.

The 2017 FCUS consists of a single data collection phase. The sample size for the FCUS is 6,162.

Data Collection and Editing: All federal data collections require approval by the Office of Management and Budget (OMB). NASS must document the public need for the data, show the design applies sound statistical practice, ensure the data do not already exist elsewhere, and show that the public is not excessively burdened. The fruit chemical use questionnaires must display an active OMB number that gives NASS the authority to conduct the survey, a statement of the survey purpose and the use of the collected data, a response burden statement that estimates the time required to complete the form, a confidentiality statement that the respondent's information will be protected from disclosure, and a statement that response to the survey is voluntary and not required by law.

Using these questionnaires, chemical use and pest management data are collected only by personal visit from an enumerator. Postcards are mailed to producers prior to field contact stating the importance of cooperation and that contact will be made in the coming weeks. Once contact is made by the field enumerator, an appointment will be set up to collect data when the farm operator indicates no further chemical applications are remaining. The field enumerator returns the questionnaires to the NASS RFO for editing and data entry. Questionnaire responses are captured and edited for consistency using automated systems, and a report of questionnaires with errors is generated. NASS statisticians will correct the errors on the report or comment to their validity if the data are deemed to be correct.

Analysis Tools: Chemical use data are processed through an interactive data analysis tool which displays data for all reports by product or commodity. This application tool provides various scatter plots, graphs, tables, charts, and listing tools that allow the analyst to compare an individual record to other similar records within a program state. Outliers and unusual data relationships are investigated by RFO and HQ statisticians to determine validity. Suspect data found to be in error are corrected, while data found to be correct are kept.

Nonsampling Errors: Nonsampling errors are present in any survey process. These errors include reporting, recording, editing, and imputation errors. Steps are taken to minimize the impact of these errors, such as comprehensive interviewer training, validation and verification of processing systems, detailed computer edits, and the analysis tool. Re-contact with respondents is conducted on an as needed basis.

Nonresponse Adjustment: Response to the FCUS is voluntary. Some producers refuse to participate in the survey, others cannot be located during the data collection period, and some submit incomplete reports. These nonrespondents must be accounted for if accurate estimates of total chemical usage are to be made. For this survey, item level nonresponse is accounted for by imputing data where there are missing values. Imputed rates of application for chemicals are calculated through an automated imputation system that calculates an unweighted mean for an imputation group based on commodity, state, and product. When a group lacks sufficient responses, groups are collapsed to preserve as much of the homogeneity as possible.

Calibration: Calibration is a weighting technique used in survey sampling to adjust the survey weights for sampled elements so that the weighted sum of a set of benchmark variables equals a pre-determined set of values for the population. The input to the calibration algorithm is the weights generated from the sampling procedures. Sampling weights are calculated based on numerous factors so that the sample allocations are representative of the entire population of farms at the state level for the target fruit crop(s) in that state. Due to survey nonresponse, weights are adjusted through a calibration algorithm. Calibration adjusts the sampling weights so the expanded data will match planted acreage totals from the June Noncitrus Fruits and Nuts report and the August Citrus Fruits Summary. This ensures that the chemical data collected will accurately represent the chemical usage for all target fruit crops for the entire target population.

Estimators: The FCUS utilizes direct expansions and/or ratio expansions for all survey indications. Direct expansions are calculated by summing the reported or imputed chemical data values by the calibrated weights. Similarly, ratios are calculated by applying calibrated weights and nonresponse adjustments to data when both the numerator and denominator are reported. Variance estimates are computed for all expansions.

Outliers: NASS conducts a review of outliers found in the chemical use data by reviewing application rates for all records for the same product and commodity combinations. The RFO and HQ statisticians work together to ensure the data are as accurate as possible. The RFO statisticians review outliers within their program states, and the HQ statistician examines outliers across all program states for the published categories. A determination is made as to whether an adjustment to the application data is required. Most outliers trace back to unique situations that do not exist in the target population as much as the survey weight would indicate.

Estimation: HQ statisticians execute a summary that generates state level and national level indications. RFO statisticians are responsible for performing a detailed review of their survey results and providing comments that justify their survey results. HQ statisticians conduct a final review of survey results from all states. Any irregularities revealed by the summary must be investigated and, if necessary, resolved. After final review, national level summary results are adopted as official national estimates except in cases where strong justification supports deviating from survey totals.

For this survey there are two main types of data that NASS estimates - pesticide application and pest management data. For the application data, NASS collects information about pesticides applied during the crop year. For pesticides, these applications are

collected at the product level, generally per application. These product level data are converted to pounds of active ingredient, summarized, and published. If there are not a sufficient number of reports, the data are suppressed from publication, along with any needed complementary suppression.

For the pesticide application data, NASS estimates area applied (percent acres treated), number of applications, rate per application (pounds of active ingredient or acid equivalent per acre), rate per crop year (number of applications multiplied by rate per application), and total amount applied. In order to publish data for an active ingredient, there must be a minimum number of reports for the specific active ingredient at the summary level (by crop, by state, or all program states). If there are not a sufficient number of reports, the data is suppressed from publication, along with any needed complementary suppression

The standard deviation for each active ingredient is calculated to determine data distribution for each crop. Chemical distribution rates are given by active ingredient for the Percent of Acres Treated, Number of Applications, Rate per Application, and Rate per Crop Year. The distribution tables include the coefficient of variation (CV) for an active ingredient when at least 30 farm operators report applying it on the specified crop.

The pest management data are generally a series of yes/no questions pertaining to specific pest management practices. Pest management data are collected for the entire operation. From these data, NASS releases the percent of operations using the practice as well as the percent of acreage. The percent of acreage assumes that, if the operation uses the practice on one acre, it is used on all acres. This also means that the pest management data are not crop specific; they are distributed across all fruit acres.

Selected Terms and Definitions

Active Ingredient: The specific pesticide ingredient which kills or controls the target pest(s) or other target material(s), or otherwise results in the pesticide effect(s). All pesticide-use estimates in the report are published per active ingredient (rather than per product); one or more active ingredients are present in known amounts in the pesticide products reported in the survey.

Rate and *Total Applied* estimates were reported in a single unit of equivalence, per active ingredient. For salt, ester, or amine active ingredients, estimates were published in the parent acid equivalents. For example, the acid derivatives glyphosate isopropylamine salt and 2, 4-D, 2-EHE were published in the glyphosate and 2, 4-D equivalents, respectively. For copper compounds, estimates were published in the metallic copper equivalent.

Active Ingredient Code: A unique code assigned to each active ingredient upon registration with the Environmental Protection Agency's Office of Pesticide Programs to facilitate pesticide regulation.

Area Applied, Percent: Percent of total Percent of acres which received one or more applications of a specific fertilizer, nutrient, or pesticide active ingredient. (*In Quick Stats: Treated, Measured as Percent of Area Percent of*)

Avoidance: A strategy in which the detrimental effects of pests on crops are mitigated or eliminated solely through various cultural practices. Avoidance is one of four classes of pest-management practices for which data are included in the report.

Beneficial Insects: Insects (small invertebrate animals, mostly of arthropod classes Insecta and Arachnida), which are collected and introduced onto crop acres because of their value in biological control as predators on harmful insects and parasites.

Chemigation: Application of agricultural chemicals, including pesticide products, by injection into irrigation water.

Crop Year: The period starting immediately after harvest of the previous year's crop and ending at harvest of the current year's crop.

Farm: Any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold during the year. Government payments are included in sales.

Fertilizer: A soil-enriching agricultural input which contains one or more plant nutrients. Data for three primary macronutrients, nitrogen (N), phosphate (P_2O_5), and potash (K_20), and the secondary macronutrient sulfur (S) are included in the report.

Fungi: Various organisms of the kingdom Fungi, which obtain nutrients by decomposing plant or other organic life. This pest group includes mushrooms, molds, mildews, smuts, rusts, and yeasts. Fungal infestations have the potential to reduce crop production and/or lower the grade quality of the host crop.

Mechanism of Action (MOA): The method or biological pathway by which the pesticide or active ingredient kills or controls the target pest(s) or other target material(s).

Minimum or Reduced Tillage: Tillage practices prior to planting which result in a minimum of 30 percent or more of crop residue being retained on the surface following planting.

Monitoring: A strategy involving the observance or detection of pests through systematic sampling, counting, or other forms of scouting. Monitoring may include prediction of pest population levels through the observance of environmental factors such as weather or soil and crop quality. Monitoring is one of four classes of pest-management practices for which data are included in the report.

Nematodes: Unsegmented, parasitic worms of the phylum nematoda. Prominent animal pest of field crops with the potential to be highly destructive, lowering crop production and grade quality significantly.

Number of Applications: The average number of times a treated acre received a specific fertilizer nutrient or pesticide active ingredient. (*In Quick Stats: Applications, Measure in Number)*

Pesticide: Defined by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as "(1) any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and (3) any nitrogen stabilizer…" (*Title 7, U.S. Code, 136)*. Under FIFRA, pesticides are registered and regulated through the Environmental Protection Agency's Office of Pesticide Programs. Four classes of pesticides are included in the report: (1) herbicides targeting weeds, (2) insecticides targeting insects (3) fungicides targeting fungi, and (4) other chemicals targeting all other pests or other materials (including extraneous crop foliage).

Pheromone: A chemical substance produced by an insect which serves as a stimulus to other individuals of the same species for one or more behavioral responses.

Prevention: A strategy in which a pest population is kept from infesting a crop or field by taking various preceding actions. Prevention is one of four classes of pest-management practices for which data are included in the report.

Rate per Application: Ratio indicating pounds (lbs) of a fertilizer primary nutrient or pesticide active ingredient (or associated acid or metallic equivalent) applied, counting all applications per crop year, per Percent of acre. (*In Quick Stats: Applications, Measured in Lb/Acre/Year)*

Suppression: A strategy which involves the control or reduction of existing pest populations in order to mitigate crop damage. May include physical or biological controls, or management of resistance build-up through pesticide rotation. Suppression is one of four classes of pest-management practices for which data are included in the report.

Quality Metrics for Agricultural Chemical Use

Purpose and Definitions: Under the guidance of the Statistical Policy Office of the Office of Management and Budget (OMB), NASS provides data users with quality metrics for its published data series. The metrics tables below describe the performance data for the survey contributing to the publication. The accuracy of data products may be evaluated through sampling and non-sampling error. The measurement of error due to sampling in the current period is evaluated by the coefficient of variation for each estimated item. Non-sampling error is evaluated by response rates and the percent of the estimate from respondents.

Sample Size is the number of observations selected from the population that are used to be representative of the entire population.

Response rates measure the proportion of the sample that is represented by the responding units in the survey.

Coefficient of Variation provides a measure of the size for the standard error relative to the point estimate and is used to measure the precision of the results of a survey estimator.

Fruit Chemical Usage, Sample Size and Response Rate – Program States: 2017

State	Sample size	Response rate
	(number)	(percent)
California	2,175	68.4
Florida	489	35.2
Georgia	184	60.9
Michigan	590	54.6
New Jersey	149	53.0
New York	392	50.0
North Carolina	187	63.1
Oregon	602	52.0
Pennsylvania	234	60.7
South Carolina	66	45.5
Texas	301	51.8
Washington	793	50.1
Program States	6,162	57.2

Apples Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
2;4-D; dimethylamine salt	14	8	14	20
Carfentrazone-ethyl	21	11	11	14
Diuron	53	19	12	28
Glufosinate-ammonium	23	18	12	28
Glyphosate isopropylamine salt	21	6	9	13
Glyphosate potassium salt	31	8	23	27
Paraquat	24	11	7	14
Pendimethalin	25	2	12	12
Pyraflufen-ethyl	50	10	7	16
Rimsulfuron	20	4	8	11
Insecticides				
Abamectin	12	3	4	4
Acetamiprid	28	11	5	10
Beta-cyfluthrin	44	6	15	15
Bifenazate	53	21	6	15
Carbaryl	20	8	8	10
Chlorantraniliprole	18	5	11	28
Chlorpyrifos	11	7	5	9
Clothianidin	9	6	3	7
Cyflumetofen	62	2	1	1
Diazinon	33	7	11	14
Emamectin benzoate	26	11	7	9
Esfenvalerate	15	11	4	13
Ethyl (2E;4Z) - decadienoate	29	17	40	50
Fenpropathrin	24	8	9	12
Fenpyroximate	22	8	16	18
Flupyradifurone	22	5	6	8
Imidacloprid	17	8	6	12
Indoxacarb	19	16	18	16
Kaolin	42	7	11	7
Lambda-cyhalothrin	15	11	5	12
Methoxyfenozide	55	25	10	34
Novaluron	84	27	1	26
Phosmet	16	7	10	8
Pyriproxyfen	18	5	4	5
Spinetoram	20	4	4	6
Spinosad	24	6	6	9
Spirotetramat	57	9	3	7
Thiamethoxam	8	6	4	6
Zeta-cypermethrin	18	13	9	15

Apples Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Fungicides				
Basic copper sulfate	10	9	7	9
Benzovindiflupyr	16	8	4	8
Boscalid	34	4	6	6
Calcium polysulfide	19	19	10	13
Captan	3	3	3	4
Copper chloride hydroxide	14	8	15	14
Copper hydroxide	16	15	13	10
Copper oxide	42	9	9	12
Copper sulfate	19	43	35	24
Cyprodinil	7	4	3	4
Difenoconazole	7	5	4	5
Dodine	19	10	14	9
Fenbuconazole	13	6	10	12
Fluopyram	26	9	3	7
Fluxapyroxad	14	7	4	7
Kasugamycin	46	8	3	10
Kresoxim-methyl	22	20	27	24
Mancozeb	7	7	4	8
Mono-potassium salt	15	10	13	16
Myclobutanil	15	10	3	11
Oxytetracycline hydrochloride	31	28	63	70
Penthiopyrad	25	7	4	7
Pyraclostrobin	17	7	5	7
Pyrimethanil	14	6	4	5
Streptomycin sulfate	9	10	31	32
Sulfur	17	11	8	18
Thiophanate-methyl	10	8	11	10
Trifloxystrobin	30	10	5	7
Triflumizole	34	26	11	34
Ziram	36	18	11	10
Other Chemicals				
Acibenzolar-s-methyl	36	9	20	28
Aureobasidium pullulans	34	22	(N/A)	(N/A)
Benzyladenine	12	5	6	10
Butenoic acid hydrochloride	17	9	5	11
Chlorophacinone	94	62	14	68
Cytokinins	31	19	6	14
Dodecadien-1-ol	12	13	20	20
Dodecano	21	17	7	16
Ethephon	30	5	16	13
Flutriafol	26	18	6	21
Gibberellins A4A7	30	9	10	10
Indaziflam	30	8	9	7
Mineral oil	10	9	6	7
NAA	26	7	13	11
NAA; Potassium salt	24	11	4	11
NAA; Sodium	22	11	19	24
NAD	24	10	9	12
Oxytetracycline hydrochloride	41	4	12	13
Prohexadione calcium	26	7	22	22
Spirodiclofen	72	7	5	7
Tetradecanol	21	17	7	16

(NA) Not available.

Apricot Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Other Chemicals				
Mineral oil	43	9	19	25

Avocados Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glufosinate-ammonium	43	17	8	13
Glyphosate isopropylamine salt	26	15	17	13
Insecticides				
Abamectin	9	12	4	15
Other Chemicals				
Mineral oil	7	11	7	8

Blackberries Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Fungicides				
Calcium polysulfide	40	6	11	12

Blueberries Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Clethodim	22	15	2	17
Diuron	37	16	31	24
Flumioxazin	20	7	18	14
Glufosinate-ammonium	21	20	9	21
Glyphosate isopropylamine salt	14	33	24	20
Mesotrione	27	9	11	13
Norflurazon	19	3	10	11
Oryzalin	29	10	19	25
Paraquat	24	15	20	18
Pendimethalin	11	12	11	14
Simazine	22	10	8	17
Terbacil	24	5	11	15
Insecticides				
Acetamiprid	17	39	1	38
Bifenthrin	18	14	8	15
Diazinon	33	22	36	32
Esfenvalerate	13	5	6	8
Fenpropathrin	29	10	4	14
Imidacloprid	20	17	12	28
Malathion	14	17	7	12
Methoxyfenozide	18	6	5	5
Phosmet	12	6	3	6
Spinetoram	7	10	2	10
Malathion	27	11	7	13
Zeta-cypermethrin	13	15	1	15
Fungicides				
Azoxystrobin	15	15	12	25
Boscalid	30	8	2	9
Calcium polysulfide	17	15	13	21
Captan	11	21	6	18
Copper hydroxide	22	15	39	36
Cyprodinil	22	15	3	13
Fenbuconazole	9	7	6	9
Fenhexamid	58	6	8	8
Fludioxonil	24	18	4	16
Metconazole	12	16	2	16
Mono-potassium salt	28	14	8	15
Propiconazole	16	34	5	30
Pyraclostrobin	30	8	2	9
Ziram	22	8	4	11

Cherries, Sweet Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
2;4-D; dimethylamine salt	41	4	30	32
Carfentrazone-ethyl	49	6	8	11
Glufosinate-ammonium	26	6	10	12
Glyphosate isopropylamine salt	14	6	10	10
Glyphosate potassium salt	55	22	59	81
Oxyfluorfen	18	11	21	26
Paraquat	33	14	4	15
Pendimethalin	41	5	9	11
Pyraflufen-ethyl	30	18	5	21
Rimsulfuron	18	4	4	4
Insecticides				
Abamectin	22	8	7	10
Acetamiprid	32	9	8	16
Bifenazate	23	3	2	4
Buprofezin	38	6	2	7
Carbaryl	25	9	3	9
Chlorantraniliprole	29	7	7	10
Chlorpyrifos	23	3	2	3
Esfenvalerate	30	11	12	9
Fenpropathrin	14	5	2	4
Imidacloprid	18	7	61	55
Lambda-cyhalothrin	11	19	1	20
Malathion	21	6	2	6
Methoxyfenozide	24	7	5	4
Pyriproxyfen	32	4	1	4
Spinetoram	10	4	1	4
Spinosad	10	6	7	5
Thiamethoxam	27	9	7	14
Zeta-cypermethrin	20	6	7	9

Cherries, Sweet Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Fungicides				
Basic copper sulfate	28	6	7	7
Boscalid	16	6	3	8
Calcium polysulfide	31	6	68	65
Captan	15	17	3	16
Chlorothalonil	8	5	5	6
Copper hydroxide	33	8	4	10
Copper oxide	35	6	5	8
Fenbuconazole	13	12	3	13
Fluopyram	11	7	5	8
Fluxapyroxad	21	6	2	5
Iprodione	10	5	4	8
Myclobutanil	18	5	4	8
Penthiopyrad	13	3	3	5
Potassium biocarbonate	43	7	3	5
Propiconazole	32	53	1	54
Pyraclostrobin	12	3	2	5
Quinoline	15	6	1	6
Sulfur	17	5	4	5
Tebuconazole	22	8	6	10
Trifloxystrobin	10	7	4	8
Triflumizole	12	6	3	8
Ziram	12	9	4	11
Other Chemicals				
Butenoic acid hydrochloride	19	15	13	19
Cyanamid	13	6	9	10
Cytokinins	26	7	4	10
Ethephon	10	3	8	10
Flutriafol	37	10	10	17
Gibberellic acid	10	11	19	16
Gibberellins A4A7	43	12	9	8
Indaziflam	22	3	22	23
Mineral oil	14	7	5	5
Prohexadione calcium	47	12	6	14
Spirodiclofen	30	4	(Z)	4

(Z) Less than half of the unit shown.

Cherries, Tart Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glyphosate isopropylamine salt	34	30	8	33
Insecticides				
Chlorpyrifos	35	13	16	6
Imidacloprid	40	9	10	11
Lambda-cyhalothrin	7	24	5	22
Phosmet	4	7	5	7
Thiamethoxam	17	5	4	6
Zeta-cypermethrin	24	11	6	17
Fungicides				
Captan	2	12	4	12
Chlorothalonil	5	6	3	9
Dodine	21	9	16	11
Fenbuconazole	19	11	6	12
Fluopyram	18	15	5	10
Fluxapyroxad	21	16	20	8
Myclobutanil	21	8	5	10
Pyraclostrobin	18	16	18	7
Sulfur	9	16	22	14
Tebuconazole	46	13	6	18
Trifloxystrobin	7	16	6	11
Other Chemicals				
Ethephon	4	2	6	6
Gibberellic acid	5	14	29	25

Grapefruit Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glyphosate isopropylamine salt	26	14	18	29
Chlorpyrifos	44	21	5	22
Imidacloprid	36	24	12	34
Insecticides				
Abamectin	69	5	28	27
Chlorpyrifos	249	57	33	89
Diflubenzuron	22	13	13	13
Fenbutatin-oxide	45	16	6	20
Fenpropathrin	37	19	7	23
Imidacloprid	102	36	69	79
Spinetoram	49	10	6	8
Spirotetramat	28	7	9	12
Sulfur	102	53	9	48
Thiafloxystrobin	41	9	9	14
Fungicides				
Azoxystrobin	286	131	18	149
Copper hydroxide	75	67	9	61
Fenbuconazole	47	22	9	28
Pyraclostrobin	43	24	5	25
Trifloxystrobin	44	12	8	18
Other Chemicals				
Indaziflam	21	18	10	17
Mineral oil	30	27	4	26
Spirodiclofen	105	57	25	82

Grapes, All Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Carfentrazone-ethyl	22	13	5	14
Flumioxazin	18	5	7	9
Glufosinate-ammonium	13	10	6	7
Glyphosate isopropylamine salt	10	9	5	10
Glyphosate potassium salt	13	34	18	18
Oryzalin	39	8	8	13
Oxyfluorfen	17	6	10	10
Paraquat	20	13	7	12
Pendimethalin	19	17	8	16
Pyraflufen-ethyl	28	10	11	15
Rimsulfuron	17	4	8	8
Simazine	23	10	13	15
Insecticides				
Abamectin	17	7	2	8
Acetamiprid	36	3	5	6
Beta-cyfluthrin	42	7	3	8
Bifenazate	36	6	3	4
Bifenthrin	22	6	5	7
Buprofezin	23	9	2	9
Chlorantraniliprole	29	16	4	18
Chlorpyrifos	33	23	10	13
Cyflumetofen	31	13	1	13
Etoxazole	16	6	3	8
Fenpropathrin	36	14	10	12
Fenpyroximate	22	2	3	4
Imidacloprid	13	8	8	8
Methoxyfenozide	13	9	3	11
Spinetoram	25	7	3	6
Spinosad	35	10	8	17
Spirotetramat	10	19	3	17
Thiamethoxam	34	34	2	36

Grapes, All Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Fungicides				
Azoxystrobin	31	7	9	14
Basic copper sulfate	30	16	29	42
Boscalid	12	21	7	27
Calcium polysulfide	20	5	24	22
Captan	14	18	8	20
Copper chloride hydroxide	23	9	51	58
Copper hydroxide	14	6	29	28
Copper oxide	33	20	3	20
Cyflufenamid	17	6	(Z)	6
Cyprodinil	18	12	3	12
Difenoconazole	21	13	3	14
Fenbexamid	24	9	(Z)	9
Fludioxonil	28	15	1	15
Fluopyram	15	11	2	11
Kresoxim-methyl	14	5	4	8
Mancozeb	15	22	6	26
Mandipropamide technical	7	48	1	49
Mono-potassium salt	34	36	18	25
Myclobutanil	10	5	2	5
Polyoxin D zinc salt	23	6	36	35
Potassium bicarbonate	21	20	5	19
Pyraclostrobin	12	21	8	27
Pyrimethanil	40	2	9	8
Quinoline	9	15	2	16
Sulfur	6	7	5	10
Tebuconazole	11	14	2	14
Tetraconazole	21	6	3	5
Thiophanate-methyl	31	2	17	17
Trifloxystrobin	13	13	5	14
Triflumizole	17	9	2	8
Ziram	17	6	5	7
Other Chemicals				
Cyanamid	28	5	2	6
Ethephon	12	3	14	15
Flutriafol	41	3	(Z)	3
Gibberellic acid	9	13	11	19
Indaziflam	27	4	8	9
Metrafenone	17	22	2	24
Mineral oil	18	44	18	60

(Z) Less than half of the unit shown.

Grapes, Raisin Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glufosinate-ammonium	41	23	19	9
Glyphosate potassium salt	27	4	21	21
Insecticides				
Abamectin	23	16	2	16
Imidacloprid	22	7	14	17
Spirotetramat	13	22	4	21
Fungicides				
Copper hydroxide	16	8	111	106
Myclobutanil	21	6	3	7
Quinoline	25	8	2	7
Sulfur	5	16	6	20
Tebuconazole	29	23	2	24
Other Chemicals				
Gibberellic acid	19	14	10	22

Grapes, Table Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glufosinate-ammonium	28	12	15	16
Insecticides				
Buprofezin	24	4	3	4
Imidacloprid	33	4	9	8
Spinetoram	29	7	4	6
Spirotetramat	14	7	3	7
Fungicides				
Boscalid	20	9	8	20
Copper hydroxide	25	14	10	15
Myclobutanil	21	7	5	10
Pyraclostrobin	20	9	8	11
Quinoline	19	9	8	14
Sulfur	2	12	14	25
Other Chemicals				
Ethephon	13	2	14	15
Gibberellic acid	5	17	14	25

Grapes, Wine Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Carfentrazone-ethyl	25	15	6	17
Flumioxazin	21	4	8	11
Glufosinate-ammonium	15	14	7	10
Glyphosate isopropylamine salt	16	12	8	15
Glyphosate potassium salt	12	42	20	23
Oxyfluorfen	16	8	12	12
Paraquat	32	18	7	19
Pendimethalin	23	31	7	27
Pyraflufen-ethyl	36	6	8	9
Rimsulfuron	17	4	8	10
Insecticides				
Abamectin	20	12	2	13
Bifenazate	43	7	3	5
Buprofezin	31	5	8	11
Imidacloprid	15	12	14	10
Methoxyfenozide	15	12	4	13
Spirotetramat	13	24	4	22
Fungicides				
Azoxystrobin	20	11	6	12
Boscalid	16	27	9	35
Copper hydroxide	18	10	6	13
Cyflufenamid	19	6	1	6
Cyprodinil	17	9	4	10
Difenoconazole	15	18	2	18
Fenbexamid	29	10	1	11
Fluopyram	13	13	2	12
Kresoxim-methyl	21	8	9	16
Myclobutanil	17	8	3	8
Potassium bicarbonate	22	24	6	22
Pyraclostrobin	16	27	9	35
Quinoline	9	21	2	22
Sulfur	9	11	5	12
Tebuconazole	12	18	2	19
Tetraconazole	23	9	3	7
Trifloxystrobin	15	19	4	21
Triflumizole	21	10	3	8
Other Chemicals				
Indaziflam	20	5	10	12
Metrafenone	18	30	1	31
Mineral oil	20	47	18	64

Lemons Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glyphosate isopropylamine salt	34	13	17	13
Glyphosate potassium salt	36	16	8	19
Insecticides				
Abamectin	13	13	16	9
Chlorpyrifos	111	6	103	109
Imidacloprid	59	21	7	16
Pyriproxyfen	26	2	6	6
Spinetoram	31	9	6	6
Spirotetramat	37	3	2	4
Thiamethoxam	26	6	13	17
Fungicides				
Basic copper sulfate	30	10	5	11
Copper hydroxide	43	12	19	16
Other Chemicals				
Gibberellic acid	35	5	19	22
Metaldehyde	26	7	28	27
Mineral oil	22	13	9	11

Nectarines Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glufosinate-ammonium	83	93	60	45
Glyphosate isopropylamine salt	77	119	276	161
Oxyfluorfen	108	14	209	198
Rimsulfuron	82	19	43	27
Insecticides				
Abamectin	157	58	24	82
Chlorantraniliprole	79	74	10	64
Esfenvalrate	25	35	84	115
Spinetoram	94	97	4	94
Fungicides				
Propiconazole	28	79	3	76
Sulfur	120	29	12	21
Ziram	67	13	17	12
Other Chemicals				
Mineral oil	36	221	114	107

Olives Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Insecticides				
Spinosad	34	14	6	18
Fungicides				
Copper hydroxide	19	11	22	16

Oranges Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
2;4-D; isopropylamine salt	38	44	25	36
Diuron	28	9	10	13
Glufosinate-ammonium	39	19	11	15
Glyphosate isopropylamine salt	23	26	12	21
Glyphosate potassium salt	28	42	25	36
Paraquat	40	7	12	13
Rimsulfuron	18	69	3	71
Saflufenacil	51	66	21	84
Simazine	41	3	6	5
Insecticides				
Abamectin	15	15	12	20
Acetamiprid	16	10	7	12
Beta-cyfluthrin	25	25	6	21
Buprofezin	35	27	(Z)	28
Chlorantraniliprole	42	14	30	43
Chlorpyrifos	27	49	9	56
Cyantraniliprole	27	15	28	41
Diflubenzuron	21	17	21	23
Fenpropathrin	23	8	5	9
Imidacloprid	24	44	21	50
Pyriproxyfen	24	44	(Z)	44
Spinetoram	22	22	2	23
Spirotetramat	10	20	6	21
Thiamethoxam	25	58	11	59
Zeta-cypermethrin	13	28	13	34
Fungicides				
Azoxystrobin	31	10	4	11
Basic copper sulfate	22	50	23	66
Copper hydroxide	24	11	19	23
Pyraclostrobin	20	26	2	26
Other Chemicals				
2;4-D; dimethylamine salt	11	78	8	70
Gibberellic acid	13	62	8	56
Indaziflam	23	34	4	35
Metrafenone	37	69	28	96
Mineral oil	17	33	9	40
Spirodiclofen	52	51	4	54

(Z) Less than half of the unit shown.

Peaches Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
2;4-D; dimethylamine salt	89	42	15	20
Glufosinate-ammonium	196	90	39	14
Glyphosate isopropylamine salt	97	115	183	28
Glyphosate potassium salt	200	19	14	28
Oxyfluorfen	31	45	262	13
Paraquat	95	164	132	27
Pendimethalin	177	23	51	14
Rimsulfuron	125	41	47	12
Insecticides				
Abamectin	111	98	49	146
Acetamiprid	128	14	20	29
Beta-cyfluthrin	79	11	15	13
Bifenazate	55	173	4	176
Carbaryl	27	15	13	11
.				
Chlorantraniliprole	180	82	6	77
Chlorpyrifos	100	36	50	58
Esfenvalerate	32	67	67	133
Fenpropathrin	41	6	3	6
Imidacloprid	45	21	11	25
Indoxacarb	63	7	3	5
Lambda-cyhalothrin	71	31	17	33
Methomyl	111	75	49	29
Methoxyfenozide	297	47	6	52
Permethrin	65	36	15	23
Phosmet	23	11	10	19
Pyriproxyfen	85	10	9	9
Spinetoram	91	78	2	78
Thiamethoxam	101	25	43	61
Zeta-cypermethrin	84	24	7	31
Fungicides				
Basic copper sulfate	122	15	114	113
Boscalid	203	86	13	73
Captan	46	16	8	14
Chlorothalonil	61	34	9	33
Copper chloride hydroxide	145	36	42	15
Copper hydroxide	38	52	102	56
Cyprodinil	51	30	7	32
Fenbuconazole	49	23	25	39
Fluxapyroxad	71	55	3	55
Iprodione	159	45	48	6
Myclobutanil	163	96	33	66
Oxytetracycline calcium	185	64	6	59
Propiconazole	59	64	7	64
Pyraclostrobin	123	122	4	123
Sulfur	103	59	124	182
Tebuconazole	223	117	27	114
Thiophanate-methyl	85	37	26	51
Trifloxystrobin	52	38	15	28
Ziram	32	41	15	27
Other Chemicals				
E-8-Dodecenyl acetate	43	34	43	13
Indaziflam	44	33	34	12
Mineral oil	4	32	23	12
Z-8-Dodecanol	34	22	14	11
Z-8-Dodecen acetate	22	25	25	8

Pears Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
2;4-D; dimethylamine salt	22	3	7	7
Glyphosate isopropylamine salt	16	5	8	9
Insecticides				
Abamectin	8	7	2	8
Acetamiprid	20	13	4	15
Azadirachtin	11	9	5	11
Bifenazate	23	3	5	8
Buprofezin	21	9	6	12
.				
Chlorantraniliprole	21	13	4	13
Chlorpyrifos	20	3	3	4
Cyflumetofen	31	10	1	10
Esfenvalerate	25	11	8	10
Etoxazole	22	5	1	5
Fenpyroximate	26	4	6	7
Imidacloprid	20	14	6	19
Kaolin	15	5	4	7
Lambda-cyhalothrin	14	12	1	12
Novaluron	17	9	1	10
Piperonyl butoxide	17	8	8	11
Pyridaben	13	4	6	8
Pyriproxyfen	8	6	2	5
Spinetoram	14	9	1	9
Spirotetramat	7	3	2	4
Thiamethoxam	24	7	3	7
Fungicides				
Basic copper sulfate	11	7	4	8
Boscalid	13	5	1	4
Calcium polysulfide	15	8	13	14
Copper hydroxide	16	23	29	10
Cyprodinil	37	22	1	22
Difenoconazole	38	9	14	15
Fluopyram	18	4	3	5
Kasugamycin	16	7	3	8
Mancozeb	8	22	4	22
Oxytetracycline calcium	19	23	15	22
Penthiopyrad	13	9	2	10
Pyraclostrobin	13	5	1	4
Streptomycin sulfate	11	45	24	33
Sulfur	10	7	4	8
Thiophanate-methyl	22	2	1	1
Trifloxystrobin	12	3	3	5
Triflumizole	11	6	5	8
Other Chemicals				
Dodecadien-1-ol	18	9	14	16
Dodecanol	19	8	8	14
Mineral oil	4	6	13	14
NAA; Potassium salt	12	6	5	9
Oxytetracycline hydrochloride	9	19	10	17
Spirodiclofen	25	7	2	7
Tetradecanol	19	8	8	13

Plums Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glyphosate isopropylamine salt	32	23	10	20
Oxyfluorfen	26	9	28	46
Rimsulfuron	34	23	19	40
Insecticides				
Esfenvalerate	34	51	23	31
Fungicides				
Propiconazole	19	14	2	14
Other Chemicals				
Mineral oil	21	50	20	62

Prunes Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glyphosate isopropylamine salt	12	55	34	27
Glyphosate potassium salt	24	11	10	15
Oxyfluorfen	23	8	16	17
Insecticides				
Esfenvalerate	12	5	5	9
Fungicides				
Chlorothalonil	14	6	6	9
Propiconazole	13	9	2	8
Other Chemicals				
Indaziflam	32	2	7	9
Mineral oil	20	7	10	13

Raspberries Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Fungicides				
Captan….	4	10	12	21

Tangerines Pesticide Usage Coefficient of Variation – Program States: 2017

Active ingredient	Percent of acres treated	Number of applications	Rate per Application	Rate per crop Year
	(CV percent)	(CV percent)	(CV percent)	(CV percent)
Herbicides				
Glyphosate isopropylamine salt	31	31	17	45
Glyphosate potassium salt	21	77	11	85
Rimsulfuron	28	57	4	60
Saflufenacil	38	17	26	35
Insecticides				
Abamectin	27	48	5	52
Beta-cyfluthrin	22	66	5	62
Chlorpyrifos	25	47	21	68
Imidacloprid	12	37	8	37
Pyriproxyfen	21	63	1	64
Spinetoram	13	27	6	28
Spirotetramat	19	30	1	30
Thiamethoxam	40	45	20	31
Zeta-cypermethrin	57	29	13	22
Fungicides				
Basic copper sulfate	17	76	7	83
Other Chemicals				
2;4-D; isopropyl ester	17	72	5	69
Gibberellic acid	27	47	21	66
Indaziflam	24	42	5	46
Mineral oil	15	60	8	62

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