Agricultural Chemical Usage – Fruit Methodology and Quality Measures

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Fruit Chemical Usage 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 21 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 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 2021 FCUS consists of a single data collection phase. The sample size for the FCUS is 6,071.

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 by an enumerator using the mobile computer assisted personal interview web instrument. Postcards are mailed to producers prior to contact stating the importance of cooperation and that contact will be made in the coming weeks. Once contact is made by the enumerator, an appointment is made to collect data. The 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 May Noncitrus Fruits and Nuts report and the September 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 Usage

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: 2021

State	Sample size	Response rate
	(number)	(percent)
California	2,426	46.7
Florida	523	12.2
Georgia	192	28.6
Michigan	622	42.9
New Jersey	141	35.5
New York	203	28.6
North Carolina	90	74.4
Oregon	511	47.9
Pennsylvania	260	26.9
South Carolina	64	23.4
Texas	97	47.4
Washington	942	31.0
Program States	6,071	38.9

Apples Pesticide Usage Coefficient of Variation – Program States: 2021

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	21	8	13	17
Carfentrazone-ethyl	22	1	16	16
Glufosinate-ammonium	21	5	3	7
Glyphosate isopropylamine salt	27	5	9	10
Glyphosate potassium salt	26	7	13	18
Oxyfluorfen	28	9	18	10
Paraquat	39	9	11	8
Pendimethalin	33	6	7	11
Pyraflufen-ethyl	40	6	4	9
Rimsulfuron	30	7	7	13
Insecticides				
Abamectin	15	2	5	5
Acetamiprid	13	6	3	8
Bifenazate	45	2	1	2
Carbaryl	24	3	5	5
Chlorantraniliprole	22	7	3	6
Chlorpyrifos	24	8	4	7
Clothianidin	14	8	4	9
Cyflumetofen	74	18	1	18
Diazinon	51	9	18	11
Emamectin benzoate	21	6	3	7
Ethyl (2E;4Z) - decadienoate	29	17	27	43
Imidacloprid	22	12	5	12
Indoxacarb	23	12	9	13
Kaolin	99	10	49	56
Lambda-cyhalothrin	6	7	3	7
Methoxyfenozide	26	8	4	8
Phosmet	15	14	8	12
Pyriproxyfen	30	3	2	4
Spinetoram	14	4	2	3
Spinosad	45	13	8	11
Spirotetramat	40	15	1	14
Thiamethoxam	16	6	3	6

Apples Pesticide Usage Coefficient of Variation – Program States: 2021

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	21	7	6	7
Benzovindiflupyr	18	8	4	7
Boscalid	38	9	5	8
Calcium oxytetracycline	23	11	55	61
Calcium polysulfide	22	13	10	22
Captan	6	5	3	5
Copper chloride hydroxide	21	14	13	16
Copper hydroxide	12	11	16	20
Copper sulfate	43	19	21	26
Cyprodinil	9	8	2	9
Difenoconazole	10	9	2	9
Dodine	17	38	17	22
Fenbuconazole	17	12	7	11
Fluopyram	34	10	2	10
Fluxapyroxad	14	9	4	7
Kasugamycin	29	4	(Z)	4
Mancozeb	8	6	2	6
Myclobutanil	20	15	6	12
Penthiopyrad	28	5	3	6
Polyoxin D zinc salt	43	2	25	24
Potassium bicarbonate	51	28	10	18
Pydiflumetofen	18	12	3	12
Pyraclostrobin	14	9	4	7
Streptomycin sulfate	16	10	17	18
Sulfur	23	10	6	13
Thiophanate-methyl	14	10	14	16
Trifloxystrobin	27	9	46	45
Triflumizole	44	5	7	7
Ziram	17	16	16	10
Other Chemicals				
Acibenzolar-s-methyl	16	10	2	10
Aureobasidium pullulans	40	13	9	6
Benzyladenine	24	5	11	9
Butenoic acid hydrochloride	20	6	9	8
Cytokinins	56	13	14	16
Dodecadien-1-ol	16	3	13	13
Dodecano	16	3	6	6
Ethephon	14	4	12	12
Flutriafol	17	5	2	6
Gibberellins A4A7	39	6	13	17
Indaziflam	51	2	8	9
Mineral oil	9	24	22	7
NAA	19	23	33	18
NAA; Potassium salt	31	3	22	20
NAA; Sodium	24	10	31	36
NAD	26	2	7	8
Oxytetracycline hydrochloride	19	8	16	23
Prohexadione calcium	21	8	9	6
Reynoutria sachaline	32	14	23	29
Spirodiclofen	25	4	3	2
Tetradecanol	16	3	6	6
Zinc phosphide	18	3	8	9

(Z) Less than half of the unit shown.

Avocados Pesticide Usage Coefficient of Variation – Program States: 2021

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	28	38	33	17
Glyphosate potassium salt	18	27	14	23
Insecticides				
Abamectin	17	11	3	11
Other Chemicals				
Gibberellic acid	21	15	1	15
Mineral oil	10	9	6	12

Blueberries Pesticide Usage Coefficient of Variation – Program States: 2021

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	50	18	13	29
Diuron	26	9	19	17
Flumioxazin	28	54	46	12
Glufosinate-ammonium	37	28	11	36
Glyphosate isopropylamine salt	36	16	22	30
Mesotrione	24	5	6	8
Simazine	58	51	39	18
Insecticides				
Bifenthrin	15	8	3	8
Diazinon	20	22	7	15
Esfenvalerate	37	6	2	6
Imidacloprid	29	9	12	12
Malathion	19	8	8	12
Methomyl	32	12	11	9
Phosmet	21	11	2	12
Zeta-cypermethrin	13	9	1	9
Fungicides				
Azoxystrobin	22	12	5	14
Boscalid	27	10	3	9
Calcium polysulfide	25	8	14	21
Captan	13	15	6	12
Chlorothalonil	49	34	24	11
Cyprodinil	29	10	4	9
Fenbuconazole	18	9	14	16
Fludioxonil	29	11	3	11
Fluopyram	36	9	2	10
Metconazole	21	12	1	11
Propiconazole	32	10	5	10
Pyraclostrobin	27	10	3	9
Pyrimethanil	39	10	2	11

Cherries, Sweet Pesticide Usage Coefficient of Variation – Program States: 2021

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	47	15	13	7
Glufosinate-ammonium	30	9	3	8
Glyphosate isopropylamine salt	20	7	9	8
Glyphosate potassium salt	24	13	10	19
Oxyfluorfen	21	5	11	11
Paraquat	32	20	6	24
Pendimethalin	27	3	11	10
Pyraflufen-ethyl	27	10	2	10
Rimsulfuron	20	12	5	12
Insecticides				
Abamectin	20	11	2	11
Acetamiprid	35	5	6	6
Bifenazate	17	10	3	11
Buprofezin	16	34	(Z)	34
Chlorantraniliprole	47	44	7	51
Fenpropathrin	18	9	3	8
Imidacloprid	17	29	3	30
Lambda-cyhalothrin	11	5	1	6
Malathion	27	12	1	12
Methoxyfenozide	22	10	6	12
Pyriproxyfen	57	4	1	4
Spinetoram	18	29	2	30
Spinosad	18	14	12	14
Thiamethoxam	16	20	4	22

Cherries, Sweet Pesticide Usage Coefficient of Variation – Program States: 2021

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				
Boscalid	22	4	3	4
Calcium polysulfide	67	5	20	23
Copper hydroxide	21	39	4	38
Fluopyram	13	10	4	13
Flutianil	22	3	1	2
Fluxapyroxad	16	7	1	6
Iprodione	22	10	5	12
Myclobutanil	16	5	2	5
Penthiopyrad	19	6	2	6
Polyoxin D zinc salt	52	18	32	39
Propiconazole	40	42	2	39
Pyraclostrobin	15	3	2	6
Quinoline	19	8	(Z)	5
Sulfur	24	10	4	15
Tebuconazole	25	12	6	15
Trifloxystrobin	14	12	4	9
Triflumizole	30	8	2	5
Other Chemicals				
Cyanamid	22	3	7	7
Cytokinins	29	15	9	11
Flutriafol	37	8	1	7
Gibberellic acid	10	6	10	11
Gibberellins A4A7	29	28	25	53
Harpin a B protein	65	13	3	15
Indaziflam	30	4	8	6
Metrafenone	34	5	1	5
Mineral oil	16	21	13	13
Prohexadione calcium	35	14	2	14
Spirodiclofen	38	5	2	6

(Z) Less than half of the unit shown.

Cherries, Tart Pesticide Usage Coefficient of Variation – Program States: 2021

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	11	10	20
Insecticides				
Imidacloprid	39	13	16	23
Lambda-cyhalothrin	26	11	4	14
Phosmet	27	10	5	8
Thiamethoxam	24	10	7	15
Zeta-cypermethrin	36	22	8	15
Fungicides				
Captan	13	12	30	40
Chlorothalonil	8	40	24	17
Copper chloride hydroxide	86	40	17	56
Copper hydroxide	58	17	129	118
Dodine	48	13	46	38
Fenbuconazole	13	11	29	23
Pyraclostrobin	30	22	10	30
Sulfur	66	55	55	109
Tebuconazole	74	8	39	35
Trifloxystrobin	55	28	6	34
Other Chemicals				
Ethephon	28	14	10	16
Gibberellic acid	15	15	29	39

Grapefruit Pesticide Usage Coefficient of Variation – Program States: 2021

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				
Abamectin	25	46	11	36
Cyantraniliprole	27	29	3	30
Imidacloprid	81	36	10	32
Spirotetramat	18	36	1	36
Fungicides				
Copper hydroxide	93	60	21	58
Other Chemicals				
Indaziflam	262	101	20	119
Mineral oil	42	68	11	72

Grapes, All Pesticide Usage Coefficient of Variation – Program States: 2021

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	21	11	11	9
Flumioxazin	19	33	8	26
Glufosinate-ammonium	7	10	4	10
Glyphosate isopropylamine salt	30	21	7	25
Glyphosate potassium salt	13	21	5	21
Oxyfluorfen	13	11	12	11
Pendimethalin	13	14	9	19
Pyraflufen-ethyl	21	12	8	11
Rimsulfuron	15	13	11	16
Insecticides				
Abamectin	19	26	2	28
Imidacloprid	14	20	14	30
Methoxyfenozide	15	21	7	27
Spirotetramat	11	7	4	9
Sulfoxaflor	30	8	4	8
Thiamethoxam	58	35	3	37
Fungicides				
Boscalid	12	16	4	17
Calcium polysulfide	18	7	24	21
Copper chloride hydroxide	24	11	19	29
Copper hydroxide	10	23	18	34
Cyflufenamid	21	17	4	16
Cyprodinil	21	22	11	29
Difenoconazole	36	30	5	30
Fenbexamid	13	5	20	22
Fluopyram	16	11	2	12
Myclobutanil	16	17	11	24
Potassium bicarbonate	12	15	33	33
Pyraclostrobin	10	16	4	17
Pyriofenone	22	30	1	30
Quinoline	8	24	4	22
Sulfur	3	20	8	25
Tebuconazole	11	11	2	12
Tetraconazole	16	38	4	41
Trifloxystrobin	21	12	1	12
Other Chemicals				
Flutriafol	28	13	1	14
Gibberellic acid	12	16	12	23
Indaziflam	17	13	10	15
Metrafenone	26	22	2	21
Mineral oil	22	11	5	11

Grapes, Raisin Pesticide Usage Coefficient of Variation – Program States: 2021

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				
Sulfur	9	66	5	68
Other Chemicals				
Gibberellic acid	29	10	37	41

Grapes, Table Pesticide Usage Coefficient of Variation – Program States: 2021

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				
Sulfur	2	12	7	14

Grapes, Wine Pesticide Usage Coefficient of Variation – Program States: 2021

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	21	12	11	10
Flumioxazin	21	38	8	31
Glufosinate-ammonium	9	15	4	14
Glyphosate isopropylamine salt	33	25	5	27
Glyphosate potassium salt	16	26	7	27
Oxyfluorfen	20	14	12	11
Pendimethalin	24	12	5	13
Pyraflufen-ethyl	18	14	10	14
Rimsulfuron	17	15	11	11
Insecticides				
Abamectin	29	30	2	32
Imidacloprid	23	22	11	25
Methoxyfenozide	18	22	3	24
Spirotetramat	10	8	3	8
Thiamethoxam	58	35	3	37
Fungicides				
Copper chloride hydroxide	48	12	31	30
Copper hydroxide	14	33	9	30
Cyflufenamid	32	23	5	21
Cyprodinil	26	31	5	28
Difenoconazole	41	33	3	32
Fluopyram	26	12	2	12
Myclobutanil	25	26	5	29
Quinoline	9	29	5	25
Sulfur	4	24	12	33
Tebuconazole	14	12	2	12
Tetraconazole	20	21	9	26
Trifloxystrobin	34	7	2	8
Other Chemicals				
Flutriafol	26	13	1	14
Indaziflam	15	15	11	18
Metrafenone	33	26	2	25
Mineral oil	27	13	9	14

Lemons Pesticide Usage Coefficient of Variation – Program States: 2021

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	21	12	20	14
Glyphosate isopropylamine salt	33	22	29	32
Glyphosate potassium salt	23	33	54	25
Rimsulfuron	26	20	9	27
Saflufenacil	34	26	26	45
Insecticides				
Abamectin	20	14	5	16
Beta-cyfluthrin	20	15	9	19
Cyantraniliprole	32	11	11	18
Flupyradifurone	22	7	5	6
Imidacloprid	39	14	7	14
Pyriproxyfen	18	9	3	9
Spinetoram	44	22	1	22
Thiamethoxam	31	10	3	13
Fungicides				
Basic copper sulfate	21	9	6	11
Other Chemicals				
2,4-D, isopropyl ester	22	18	4	18
Gibberellic acid	16	11	15	19
Indaziflam	17	16	6	15
Mineral oil	3	14	11	18

Nectarines Pesticide Usage Coefficient of Variation – Program States: 2021

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	5	6	7	12

Olives Pesticide Usage Coefficient of Variation – Program States: 2021

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	20	19	29	33

Oranges Pesticide Usage Coefficient of Variation – Program States: 2021

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	56	21	16	29
Glyphosate isopropylamine salt	17	6	13	12
Glyphosate potassium salt	47	9	21	19
Rimsulfuron	21	32	3	33
Saflufenacil	34	9	13	7
Insecticides				
Abamectin	16	20	3	20
Acetamiprid	28	32	14	19
Beta-cyfluthrin	14	24	3	23
Buprofezin	31	34	2	33
Chlorantraniliprole	20	20	2	20
Cyflumetofen	22	22	4	22
Cyfluthrin	23	6	3	6
Diflubenzuron	44	28	8	34
Fenpropathrin	18	41	4	44
Fenpyroximate	40	45	3	44
Flupyradifurone	41	9	11	20
Formetanate hydrochloride	33	24	2	23
Imidacloprid	22	23	25	45
Pyriproxyfen	18	12	2	12
Spinetoram	19	27	1	28
Spirotetramat	42	13	4	17
Thiamethoxam	36	27	5	23
Fungicides				
Azoxystrobin	32	23	7	20
Basic copper sulfate	13	37	8	44
Copper hydroxide	63	11	8	14
Difenoconazole	38	19	19	29
Oxathiapiprolin	28	21	9	16
Pyraclostrobin	44	37	3	37
(3S,6R)-3-Methyl-6-isopropenyl-9-decen-1-yl acetate	36	24	(Z)	24
Other Chemicals				
2,4-D, isopropyl ester	14	30	7	25
Gibberellic acid	14	19	40	45
Indaziflam	47	16	4	19
Metaldehyde	24	22	14	28
Mineral oil	29	21	5	19

(Z) Less than half of the unit shown.

Peaches Pesticide Usage Coefficient of Variation – Program States: 2021

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	35	12	11	11
Glyphosate isopropylamine salt	45	42	19	47
Glyphosate potassium salt	107	12	17	28
Oxyfluorfen	33	10	20	20
Insecticides				
Abamectin	18	8	15	23
Acetamiprid	57	27	12	35
Chlorantraniliprole	16	9	4	9
Esfenvalerate	11	6	4	7
Fenpropathrin	40	14	11	17
Imidacloprid	26	15	21	27
Lambda-cyhalothrin	23	10	3	11
Phosmet	141	72	14	62
Spinetoram	40	26	8	18
Thiamethoxam	33	14	34	34
Fungicides				
Boscalid	108	15	12	6
Captan	27	17	7	17
Chlorothalonil	17	32	7	28
Copper hydroxide	48	14	24	30
Cyprodinil	18	8	1	9
Fenbuconazole	32	17	16	17
Fluxapyroxad	69	12	3	12
Iprodione	27	9	10	18
Myclobutanil	75	24	10	21
Propiconazole	19	12	2	12
Pyraclostrobin	58	10	9	11
Sulfur	19	50	3	51
Ziram	26	7	14	20
Other Chemicals				
E-8-Dodecenyl acetate	30	23	48	36
Mineral oil	32	9	24	18
Z-8-Dodecanol	30	23	50	38
Z-8-Dodecen acetate	30	23	42	31

Pears Pesticide Usage Coefficient of Variation – Program States: 2021

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	14	8	15
Insecticides				
Abamectin	13	7	3	7
Azadirachtin	28	9	9	17
Bifenazate	48	8	3	9
Chlorantraniliprole	24	12	4	9
Etoxazole	40	4	(Z)	3
Kaolin	39	8	7	12
Lambda-cyhalothrin	47	6	3	5
Pyridaben	34	25	7	21
Pyriproxyfen	23	14	1	15
Spinetoram	18	12	2	11
Spirotetramat	14	13	1	13
Tolfenpyrad	17	9	2	8
Fungicides				
Calcium polysulfide	24	8	18	17
Copper hydroxide	20	19	33	17
Fluopyram	34	25	(Z)	25
Kasugamycin	31	3	(Z)	3
Mancozeb	20	17	9	15
Streptomycin sulfate	26	45	32	20
Sulfur	19	13	9	19
Trifloxystrobin	34	25	(Z)	25
Triflumizole	33	10	5	7
Other Chemicals				
Dodecadien-1-ol	20	8	32	27
Mineral oil	19	7	10	14
NAA; Potassium salt	26	8	7	12
Oxytetracycline hydrochloride	28	21	3	20
Spirodiclofen	20	5	1	5

(Z) Less than half of the unit shown.

Plums Pesticide Usage Coefficient of Variation – Program States: 2021

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	17	12	10	16

Prunes Pesticide Usage Coefficient of Variation – Program States: 2021

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	17	15	3	16
Insecticides				
Esfenvalerate	20	10	5	9

Strawberries Pesticide Usage Coefficient of Variation – Program States: 2021

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				
Bifenazate	70	19	1	19
Novaluron	60	15	3	13
Spinetoram	67	30	3	28
Fungicides				
Captan	57	19	5	21
Cyprodinil	66	16	2	15
Fludioxonil	66	22	3	19
Other Chemicals				
Chloropicrin	41	8	43	36

Tangerines Pesticide Usage Coefficient of Variation – Program States: 2021

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	39	46	21	66
Glyphosate isopropylamine salt	54	24	13	36
Glyphosate potassium salt	20	58	15	73
Rimsulfuron	44	40	9	38
Insecticides				
Abamectin	12	35	5	31
Beta-cyfluthrin	50	30	7	23
Cyantraniliprole	20	28	2	29
Diflubenzuron	35	48	17	32
Fenpyroximate	38	36	5	40
Flupyradifurone	54	25	11	31
Imidacloprid	28	78	2	79
Pyriproxyfen	62	14	1	14
Spinetoram	44	11	(Z)	11
Spirotetramat	34	33	1	33
Thiamethoxam	64	22	3	25
Fungicides				
Azoxystrobin	49	30	9	24
Basic copper sulfate	44	18	8	24
Copper hydroxide	51	61	11	57
Difenoconazole	42	27	8	21
Pyraclostrobin	25	50	3	52
(3S,6R)-3-Methyl-6-isopropenyl-9-decen-1-yl acetate	41	68	(Z)	68
Other Chemicals				
2,4-D; isopropyl ester	45	43	5	39
Indaziflam	22	83	8	84
Metaldehyde	44	25	4	28
Mineral oil	14	28	9	27

(Z) Less than half of the unit shown.

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