



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 (P₂O₅), and potash (K₂O), 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 (number)	Response rate (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
Metalddehyde.....	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-Dodecanyl 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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