Nitrogen Management Plan Summary Report Analysis

2016 Crop Year

East San Joaquin
WATER QUALITY COALITION

Prepared For
Central Valley Regional Water Quality Control Board

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LIST OF ACRONYMS

A	Total available nitrogen applied per acre
APN	Assessor Parcel Number
A/Y	Total Available Nitrogen Applied over Yield per acres
BW	Box and Whisker plots
ESJWQC	East San Joaquin Water Quality Coalition
HVA	High Vulnerability Area
MPEP	Management Practices Evaluation Program
MU	Management Unit
NMP	Nitrogen Management Plan
SR	Summary Report
NR	Not Reported (crop or crop age)
R	Nitrogen removed at harvest
T-R	Township-Range
Y	Yield per acre

LIST OF TERMS

ArcGIS – Geographic Information Systems mapping software

Central Valley or Valley – California Central Valley

Coalition – East San Joaquin Water Quality Coalition

Coalition/ESJWQC region – The region within the Central Valley that is monitored by the East San Joaquin Water Quality Coalition

NMP Management Unit – Reporting unit in the NMP Summary Report

N Removal Factor – Pounds of nitrogen per pound of yield used to calculate N removed at harvest

Regional Water Board – Central Valley Regional Water Quality Control Board

NMP SUMMARY REPORT ANALYSIS

INTRODUCTION

The East San Joaquin Water Quality Coalition (Coalition or ESJWQC) is required to submit a summary of reported nitrogen applied and removed data as a component of the Coalition's Annual Report. The WDR (Order R5-2012-0116-r3) requires that the Coalition submit "At a minimum, the statistical summary of nitrogen consumption ratios by crop or other equivalent reporting units and the estimated nitrogen consumed for the different crop types and soil conditions will describe the range, percentiles (10th, 25th, 50th, 75th, 90th), and any outliers. A Box and Whisker plot or equivalent tabular or graphical presentation of the data approved by the Executive Officer may be used." Outliers are defined by the Regional Water Board as any Management Unit in which the amount of nitrogen applied per unit of yield (A/Y) falls in the upper 10% of the distribution of Management Units growing the same crop within a T-R.

All Coalition members are required to prepare and implement a Nitrogen Management Plan (NMP) for their farms by March 1 of each year. Growers in groundwater high vulnerability areas (HVA) are required to have their NMP Worksheets certified, either by a nitrogen specialist, a crop specialist, or self-certified if the member passes the NMP self-certification course. Members in groundwater HVAs with large farming operations (more than 60 acres) are required to submit to the Coalition a Summary Report (SR) of their previous year NMP. The NMP SR is submitted annually by March 1, using the template survey approved on December 23, 2015.

On the NMP Summary Report (NMP SR), growers report their nitrogen use by Management Unit (MU). An NMP Management Unit (NMP MU) is a field, a parcel, or a group of parcels that grow the same crop and that are managed the same way with respect to nitrogen applications. Each NMP MU can correspond to a single parcel or include more than one parcel. The NMP SRs include the total available nitrogen applied (A) in pounds per acre, and the ratio of total available nitrogen applied to yield per acre (A/Y). Growers may also provide their yield per acre (Y), though this information is not required. A/Y is an indicator of the proportion of nitrogen removed from the field at harvest.

The Coalition is required to analyze data from members' NMP SRs and submit an NMP SR Analysis to the Regional Board annually with the May 1 Annual Monitoring Report. On March 22, 2017, the Coalition submitted a request to the Regional Board for an extension on the submission of the 2016 NMP SR Analysis from May 1, 2017 to July 1, 2017 (approved April 5, 2017). Additional time was required to process the data, follow-up with growers regarding potentially inaccurate responses, flag incorrect entries, and complete Quality Assurance (see section 'Data Quality Control') and control checks to ensure a more robust and accurate NMP SR analysis. This report satisfies that requirement and provides the 2016 NMP SR Analysis.

This NMP SR Analysis includes a reporting of A/Y values by Crop type and by T-R, including a summary of ranges and percentiles (10th, 25th, 50th, 75th and 90th) and identification of outliers. When possible, the Coalition converts the yield to the amount of nitrogen removed (R) from the field at harvest, and

evaluates A/R and A-R. All methods and calculations are explained in the section 'NMP Summary Report Analysis Methods'.

Once the data are analyzed, the Coalition provides a Nitrogen Use Evaluation report to each member. The Nitrogen Use Evaluation reports provide an estimate of the nitrogen removed per acre for each the members MUs, and provides summary statistics that place their nitrogen use and nitrogen removal performance in the context of other growers of the same crop. These efforts are explained in the 'Outreach and Education' section.

AVAILABLE DATA

The Coalition mailed 1,226 SRs in November 2016 to members in HVA with large farming operations. In addition, 1,593 SRs were mailed to growers in HVA whose farms were designated as small farming operations. These growers are not required to turn in NMP information until 2018, but were given the opportunity to volunteer their NMP information this year. Surveys received from these growers were utilized in this analysis in addition to those with large farming operations. The Coalition received 1,043 required NMP SRs, and an additional 754 NMP SRs from growers with small farms, totaling 1,797 returned SRs.

To ensure the highest percentage of returned surveys, the Coalition sent late reminder emails and postcards to members who have not yet submitted their NMP SR. The Coalition sent out reminder notices to members with outstanding NMP requirements on March 31, 2017. A final notice was sent on May 25, 2017. The Coalition continues to receive reports from members, though no NMP Summary Reports received after June 7, 2017 are included in this report.

Of the 1,797 returned surveys, 267 were determined to have missing or unlikely data, and were flagged for follow-up with the member. After the quality control and follow-up efforts made by the Coalition, 61 of these surveys were included in the analysis. The remaining 206 NMP SRs for which the Coalition was unable to obtain updated information were omitted from the analysis (see section 'Data Quality Control'). Many of the incomplete NMP SRs, however, were partially analyzed, as members could have reported both flagged and un-flagged data. For example, if a grower reported two MUs, but one MU was reported correctly and the other was not, this member would be counted as both complete and incomplete in Table 1.

Table 1. Summary of members and acreages associated with returned NMP Summary Reports.

NMP Summary Reports Status	Included in Analysis	Count of Members	Sum of Acreage
Not Received	No	182	48,465
Received - Not Required	Yes	738	20,265
Received - Complete	Yes	984	361,536
Received - Incomplete[1]	No	206	34,689
Total Received		**1,797**	**416,490**

[1]108 members did not correctly report on 235 MUs, consisting of 435 APNs and 20,486 acres (Table 3). 110 NMP SRs had 323 APNs totaling 14,203 acres that were not reported on. Both groups were considered incomplete, for a total of 206 members over 34,689 acres.

The most abundant crop in the region is almonds. Half the acreage reported was from almond fields (Figure 1). Other important crops in the region are grapes, pistachios, walnuts, and alfalfa (Figure 1). Table 2 includes a summary of the acreage associated with each crop type for returned and complete NMP SRs.

Figure 1. Major crops reported in the Coalition NMP Summary Reports.
"All Other" crops are listed in Table 2.

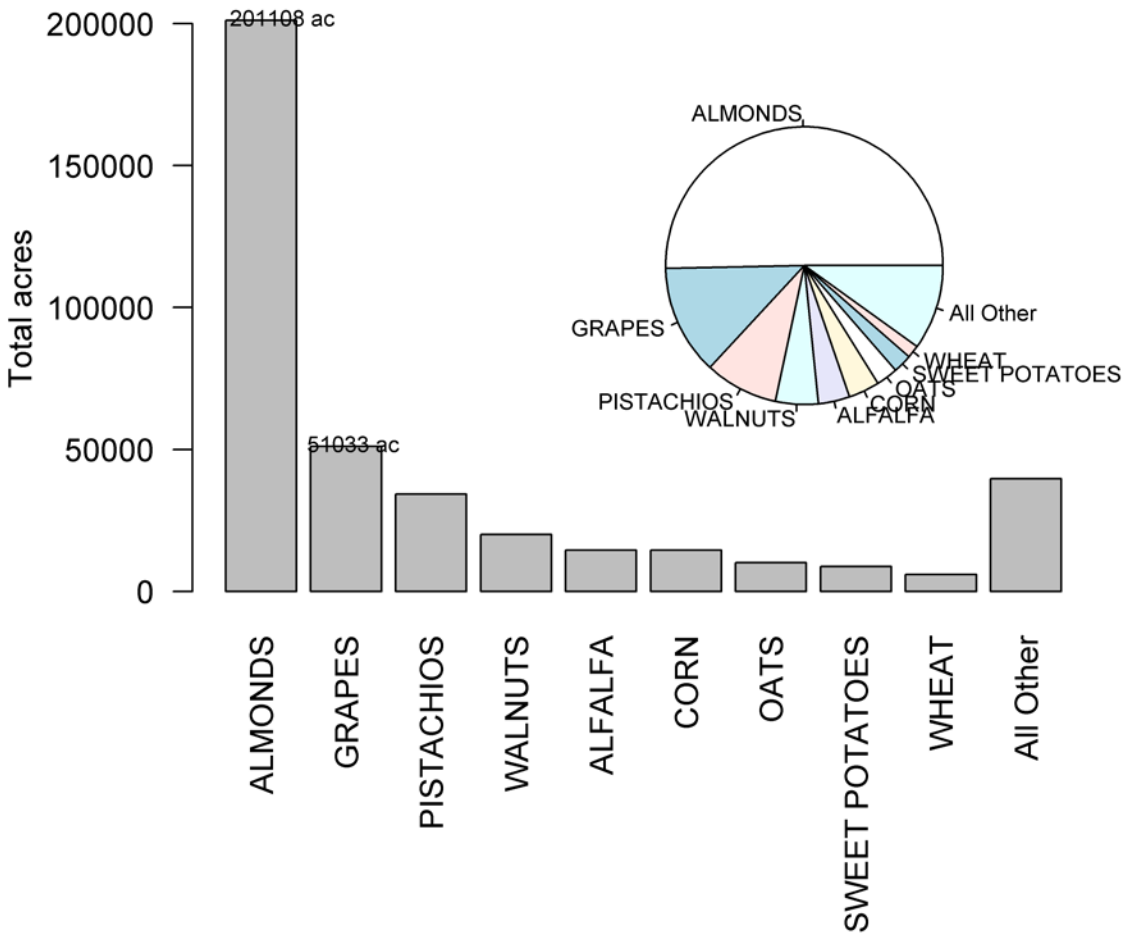


Table 2. Summary of crops reported in the ESJWQC, including the acreage and number of members reporting.

CROP	COUNT OF MEMBERS	ACREAGE
ALMONDS	1275	201,108
GRAPES	191	51,033
PISTACHIOS	101	34,217
WALNUTS	275	20,023
ALFALFA	130	14,539
CORN	127	14,469
OATS	103	10,108
SWEET POTATOES	55	8,724
WHEAT	46	5,939
CITRUS	10	5,582
TOMATOES	17	5,225
PEACHES	69	4,436
COTTON	14	3,737
FORAGE GRASS	26	2,586
SMALL GRAIN (EXCL WHEAT AND OATS)	22	2,564
FIGS	13	1,961
PRUNES	8	1,764
SORGHUM/SUDAN	16	1,676
CHERRY	20	961
BEANS	14	728
OLIVES	9	684
POMEGRANATES	9	662
CARROT	2	617
SAFFLOWER	1	570
APPLES	4	526
GARLIC	2	499
RADICCHIO	3	421
LETTUCE	1	386
ONIONS	5	361
POTATOES	3	339
TREE	5	311
CABBAGE	1	239
PECANS	6	211
STRAWBERRIES	3	189
CILANTRO	1	179
MUSTARD	1	148
BASIL	2	141
PARSLEY	2	141
BOK CHOY	2	136
CHARD	1	130
GREENS	1	128
KALE	1	123
PEARS	1	119
BEETS	1	115
BERRY	4	104
PLUMS	6	97
HERBS	2	76
MELONS	3	68
SPINACH	1	65
APRICOTS	2	65
PUMPKINS	2	63

Crop	Count of Members	Acreage
NECTARINES	5	61
TURNIPS	1	56
LEEKS	1	53
DILL	1	49
PEPPERS	1	44
PERSIMMONS	6	32
KOHLRABI	1	31
SQUASH	3	29
KIWIFRUIT	2	29
CELERY ROOT	1	23
DANDELION	1	22
DAIKON	1	20
ESCAROLE	1	15
ENDIVE	1	14
CHESTNUTS	1	14
FENNEL	1	9
Total Acreage		**399,790** [1]

[1] Total Acreage does not include 16,700 acres reported on not farmed parcels, cover crops, nurseries, pastures, or rice (See Data Quality Control Section below).

DATA QUALITY CONTROL

Completeness

The hardcopy of all received NMP SRs were reviewed for completeness. Any data that were considered incomplete were flagged for follow-up. A SR was considered incomplete and required follow-up with the grower if:

1. Not all APNs designated as high vulnerability to groundwater were reported.
2. A crop was not provided. For example, a grower may have reported "row crops" and therefore the Coalition could not determine the specific crop type grown on the field.
3. Acreage of APNs was not provided and/or could not be determined through enrolled acreage.
4. NMP MU data could not be associated with a specific APN.
5. The SR was missing any of the requisite NMP data, including amount nitrogen applied per acre, A/Y ratio, or a production unit for the yield.

Complete data were further reviewed for consistency by ensuring that all reported APNs were associated with the correct membership ID and were within the ESJWQC boundary. Duplicated entries based on APN or MU were removed.

Data Verification and Corrections

The Coalition reviewed the yield per acre (Y) and the nitrogen applied per acre (A) to determine if the reported data appeared reasonable. Yields varied by multiple orders of magnitude between all crops, ranging from 0 pounds per acre to more than 100,000 lbs/acre for some crops. Yields reported at higher than 250,000 lbs/acre and nitrogen application rates higher than 1,000 lbs/acre were determined likely to represent errors in the reporting and were flagged for review and follow up.

The range of A and Y values also varied considerably among crops (Figure 2). The median yield of crops ranged from a few thousand pounds per acre (1-3 tons) for dry crops like almonds or cotton, to about 100,000 pounds (over 50 tons) for tomatoes. The median A for each crop also varied among crop types, but not as dramatically as yield. Some crops, like grapes, often received very little nitrogen, while others such as tomatoes or corn were heavily fertilized. Other crops, like almonds, had great variability in the application rates (Figure 2).

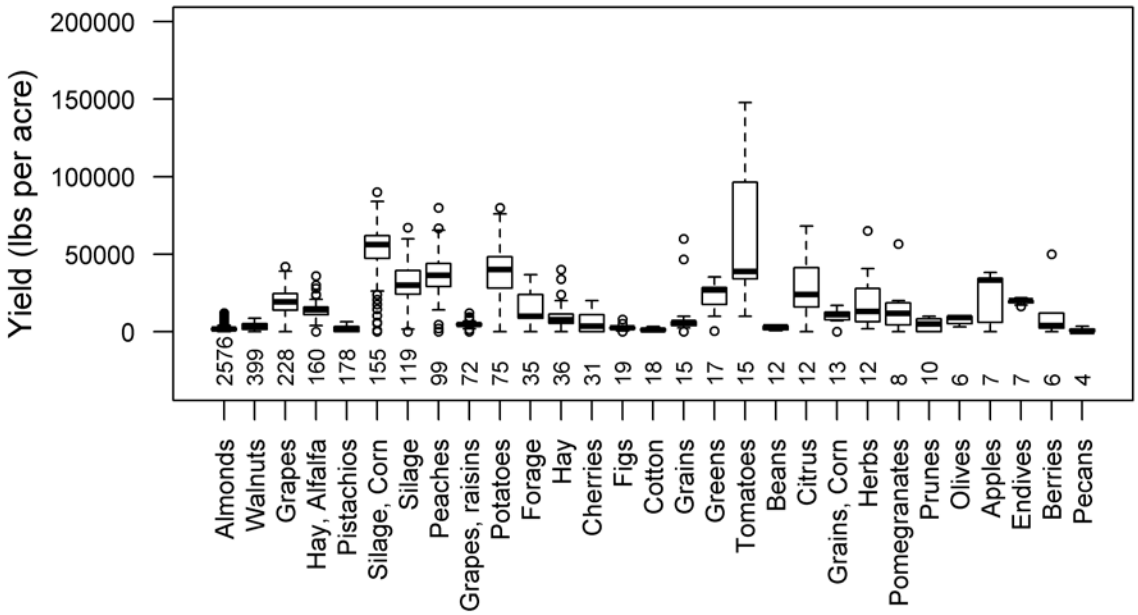
The Coalition identified MUs with data quality concerns by comparing reported A and Y values to the distribution of values per crop shown in Figure 2. The Coalition estimates that any datum with an A or Y value that was twice the 75th percentile of all other data for the same crop was most likely reported incorrectly. The MUs identified as having an unlikely A or Y were flagged for review and follow-up.

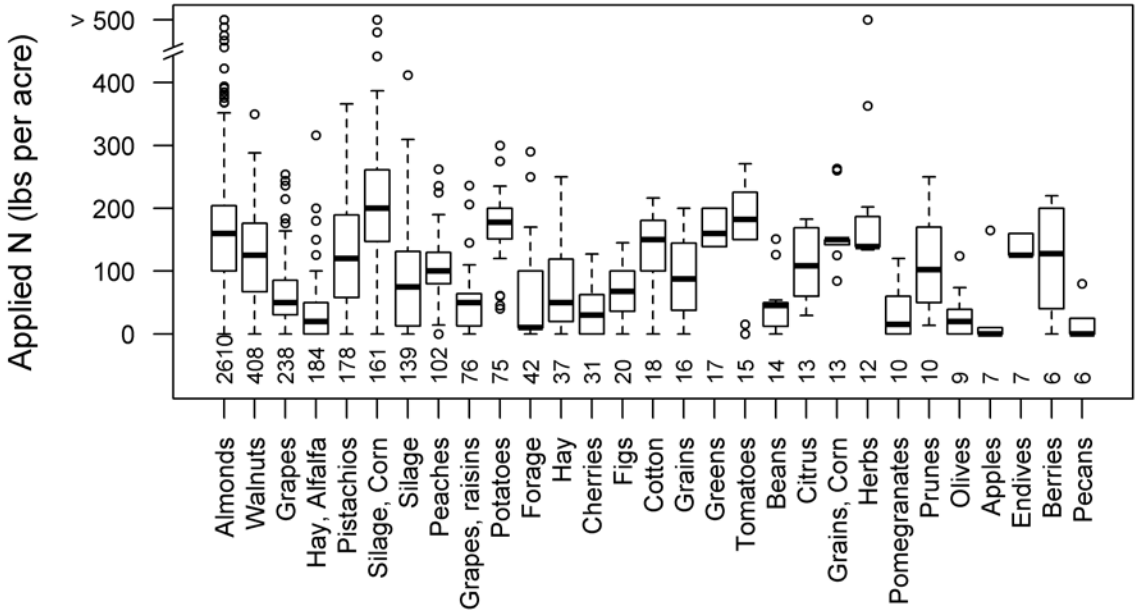
All data flagged for follow-up due to incompleteness, inconsistencies, or unlikely yield or nitrogen applications were addressed as follows:

1. The Coalition reviewed the original submission to ensure these values were not the result of data-entry errors.
2. The Coalition contacted members to verify or correct the reported values.
3. In addition, 25% of NMP SRs were selected at random and reviewed for data entry accuracy.

Figure 2. Box and Whisker plots showing the yield (Y) and nitrogen applied (A) per acre for the most common crop groups in the region.

Reporting yield in the NMP SR is optional when there are no N applications, as a result there are MUs that have no Yield values and there are fewer MUs in the yield plots.





Data Excluded from the Analysis

Several complete APNs were not included in the analysis because they were not farmed or they reported crops for which an NMP SR was not required. These parcels did not always include NMP SR data. The APNs excluded from the analyses include:

1. APNs that were reported as not farmed (fallow, open).
2. Cover crops, as these receive no N applications and have no yield.
3. Rice field MUs, as these are reported by the California Rice Commission.
4. Nurseries and grass sod, as they have no yield in the traditional sense.
5. Pastures have no yield in the traditional sense, but farmers can estimate yields using available tools. Currently growers are not required to report NMP on their pasture APNs if fertilizers are not applied. The Coalition excluded pastures most of the time, but included some forage MUs where the growers reported A and Y.

The NMP MUs with incomplete data or data flagged with other quality concerns (that had not been addressed through follow-up by the time this report was prepared) were also excluded from the analysis. The number of NMP MUs and acreage excluded due to quality concerns are listed in Table 3. In total, 235 NMP MUs were excluded from the analysis due to data quality issues.

Table 3. Number of reported MUs and associated acreage excluded from the analysis due to incomplete data or unverified yields or nitrogen applications.

Crop	Count of MUs	Total Acres
ALMONDS	84	11,360
APPLES	2	40
BEANS	1	11
STRAWBERRIES	1	15
CHERRY	1	1
CITRUS	4	177
COTTON	1	622
FIGS	4	64
FORAGE GRASS	1	2
CORN	2	70
GRAPES	30	1666
GRAPES	19	2163
ALFALFA	4	163
NECTARINES	1	1
SMALL GRAIN (EXCL WHEAT AND OATS)	1	152
WHEAT	1	60
OLIVES	1	69
PEACHES	8	238
PERSIMMONS	1	1
PISTACHIOS	7	572
PLUMS	3	89
POMEGRANATES	1	40
POTATOES	5	231
SWEET POTATOES	12	499
OATS	9	221
SORGHUM/SUDAN	2	36
CORN	5	204
SQUASH	1	6

Crop	Count of MUs	Total Acres
TOMATOES	4	1053
WALNUTS	19	661
Total	**235**	**20,486**

After follow-ups and exclusions, the Coalition was able to use complete NMP SR data from 1,718 members farming 379,303 irrigated acres and 67 crops.

NMP SUMMARY REPORT ANALYSIS METHODS

Yield Estimation and Units

Growers are not required to report their yields in their SR. In cases where yield was not provided, the Coalition used nitrogen applied and the A/Y ratio values submitted in the NMP SR to estimate the yield per acre. If the crop yield was reported in a production unit other than pounds, the Coalition converted the yield to pounds using the conversion values in Table 4

Table 4. Conversion factor for production units different from pounds.

Production Unit	Lbs Conversion	Production Unit	Lbs Conversion
1/2-bushel carton (28 lbs)	28	Carton (18 lbs)	18
1/2-bushel carton (30 lbs)	30	Carton (20 lbs)	20
12, 1/2-pint baskets (6 lbs)	6	Carton (23 lbs)	23
12, 1-pint (12 lbs)	12	Carton (25 lbs)	25
15, 1/2-inch wirebound crate (50-53 lbs)	52	Carton (30 lbs)	30
		Carton (33 lbs)	33
2 Layer Carton (22 lbs)	22	Carton (38 lbs)	38
2 layer tray pack (20-25 lbs)	22	Carton (40 lbs)	40
2/3 Carton (30 lbs)	30	Carton (50 lbs)	50
4/5 Bushel Crate (20 lbs)	20	Carton (55 lbs)	55
5-Dozen Bunches (20-25 lbs)	22	Carton (60 lbs)	60
Bag (100 lbs)	100	Carton (85 lbs)	85
Bag (25 lbs)	25	Carton of 30 (11-12 lbs)	12
Bag (50 lbs)	50	Carton or Lug (22 lbs)	22
Bale (200 lbs)	200	Carton/25 Bunches (8 lbs)	8
Bale (500 lbs)	500	Crate (30 lbs)	30
Bin (1050 lbs)	1050	Crate (38 lbs)	38
Bin (800 lbs)	800	Crate (40 lbs)	40
Bin (850 lbs)	850	Crate (50 lbs)	50
Bin (900 lbs)	900	Crate (50-60 lbs)	55
Box (12 lbs)	12	Crate (60 lbs)	60
Bundle (6 lbs)	6	Cwt (100 lbs)	100
Bushel (25 lbs)	25	Flat (4-6 lbs)	5
Bushel (28-32 lbs)	30	Flat (6 lbs)	6
Bushel (30 lbs)	30	Flat of 12 pots (10 lbs)	10
Bushel (32 lbs)	32	Lug Box (112 lbs)	112
Bushel (40 lbs)	40	Lug Box (12-15 lbs)	14
Bushel (48 lbs)	48	Lug Box (18 lbs)	18
Bushel (56 lbs)	56	Lug Box (24 lbs)	24
Bushel (60 lbs)	60	Lug Box (25-30 lbs)	28
Bushel (70 lbs)	70	Lug Box (28 lbs)	28
Bushel Basket (40 lbs)	40	Pounds	1
Carton (100 lbs)	100	Sack (25 lbs)	25
Carton (13 lbs)	13	Sack (50 lbs)	50

Production Unit	Lbs Conversion
Sack (60 lbs)	60
Sacks (100 lbs)	100
Sacks of 8, 5-pound bags (40 lbs)	40
SX (100 lbs)	100
Tons (2000 lbs)	2000
Units	1

Crop Classification

The Order requires the Coalition to report statistical summaries for parcels grouped by township, and "similar crops in that township". In fact, the analysis and the identification of outliers are strongly dependent on comparing NMP data to similar crops, necessitating an accurate classification of crops. In addition to the crop species (e.g., corn, alfalfa), many of the crops grown in the region can be harvested in very different ways (e.g., alfalfa hay vs. alfalfa haylage/silage) or from different varieties (e.g. corn grain vs. sweet corn). Some of these differences in harvest types and varieties have important implications for the analysis.

In field crops, different harvest types result in very different yields per acre. For example, field crops harvested as hay have lower humidity content (usually around 12% moisture) than the same crop harvested as silage (usually around 70% moisture). Hence, the yields per acre reported for hay harvests are lower than the yields reported for silage harvests even if both harvests remove the same dry matter and nitrogen content from the field. As a result, A/Y of hay harvests are generally higher than A/Y of silage harvests, and the two cannot be compared to each other. Different types of harvest also remove different amounts of N per pound of yield. For example, crops harvested as grain have a higher N content than the same crop harvested as silage. Hence, field crops need a different N Removal Factor depending on the harvest type, and the Coalition needs to know the harvest type to correctly calculate A/R and A-R.

Some fruit crops are grown and harvested for different purposes (e.g., wine grapes vs. table grapes; or processing tomatoes vs. market tomatoes). These fruit varieties may differ in moisture content and N concentration, making the distinction important for the correct analysis of A/Y and identification of outliers. Current N Removal Factors and preliminary analysis of the yields suggest that these differences are not as large as the differences seen among field crop harvest types. However, as the quality of the data improves over time, some distinctions may become more apparent. Tree crops also have smaller yields per acre for younger trees that have not reached full maturity. Therefore, the summary statistics in Appendix I include an analysis of outliers by T-R based on the crop group and additional summary statistics based on crop age for the following crops: almonds, apples, apricots, berries, cherries, chestnuts, citrus, figs, grapes, raisin grapes, kiwis, nectarines, olives, peaches, persimmons, pistachios, plums, pomegranates, prunes, and walnuts.

To account for those crop differences that could influence the analysis of A/Y, the calculation of A/R, and the correct identification of outliers, the Coalition classifies crops using a specific crop type that includes the harvest type and crop age, when applicable. For example, corn specific crop types are "corn, silage", "corn, grain", and "corn, sweet"; and grapes can be "grapes, wine", "grapes, table", or "grapes, raisins". The Coalition has been improving the list of specific crop types to best represent the growing practices in the region and the nitrogen management information required by the Regional Board. This is an ongoing process, and as a result, some of the crop classifications used in this report are slightly different from the ones used in the NMP Analysis of the 2015 crop year.

In the current reporting season, the Coalition improved the handling of MUs that could not be clearly classified to a specific crop type from the NMP SR (e.g., the grower reported corn, but did not indicate if

it was silage, grain, or sweet). When growers report their MUs this way, the Coalition cannot correctly compare those MUs to other with similar A/Y. Ambiguous harvest types or crop names were flagged as crop "Not Reported" (e.g. Corn, NR or Grapes, NR). In future years, the Coalition will include these ambiguous crops to the follow-up list in the QC checks. However, the turnaround period between the receipt of NMP SRs and the preparation of this report was not long enough to follow up with growers to obtain more specific crop types for this report.

When a grower provided an ambiguous crop name for crops that could have very large differences in yields or N content depending on the harvest type, the Coalition excluded these MUs from the analysis. Conversely, when the grower reported ambiguous crop names for crops that are less variable (e.g., tomatoes or peaches), the Coalition included them in the analysis. The Coalition expects that crop classification will become more accurate over time.

The Coalition also created a category that grouped sets of similar crops together. These crop groups could include different crop species that had similar harvest types and yields (e.g., hay from different small grains or from grass), or that had very similar N Removal Factors (e.g., different bean types (garbanzo, lima, and black-eyed) or different citrus fruits (oranges, mandarins, and tangerines). Crop groups were used for the analysis by T-R and for the display of box and whisker plots in Appendix I. Table 5 provides a complete list of specific crop types reported by growers in the ESJWQC, including crops groups used in this analysis.

Table 5. List of crop groups used in the Appendix I and Specific Crop Types (not including tree age) reported by growers in the Coalition region.
Additional information includes the total number of MUs reported, total nitrogen applied, yield, and acreage for each Specific Crop Type.

Crop Group	Specific Crop Type[1]	Number of MUs	Total N Applied (lbs)	Total Yield Harvested (lbs)	Total Acres
Almonds	ALMONDS	2249	32,103,917	365,262,561	170,245
Apples	APPLES	6	13,418	14,998,768	484
Apricots	APRICOTS	1	125	8,013	1
Beans	BEANS, DRY	2	0	660,000	349
Beans	BEANS, DRY, BLACK-EYED	11	9,412	682,548	318
Beans	BEANS, DRY, GARBANZO	1	7,550	125,000	50
Beets	BEETS	1	15,927	3,723,850	115
Berries	BERRY, BLUEBERRY	4	6,980	504,846	104
Berries	STRAWBERRIES	2	34,026	7,885,103	174
Bok Choy	BOK CHOY	2	10,249	2,527,000	66
Bok Choy	BOK CHOY, BABY	1	11,125	2,085,900	70
Cabbage	CABBAGE	4	47,736	10,055,840	239
Carrots	CARROT	2	87,361	44,083,240	617
Celery	CELERY ROOT	1	4,658	1,455,625	23
Cherries	CHERRY	22	49,391	7,772,918	826
Chestnuts	CHESTNUTS	1	0	20,650	14
Citrus	CITRUS, MANDARINS	9	423,642	37,591,207	2,721
Citrus	CITRUS, ORANGES	2	237,549	53,702,737	2,243
Citrus	CITRUS, TANGELO	1	71,994	7,447,684	431
Cotton	COTTON	13	411,946	4,018,603	2,500

Crop Group	Specific Crop Type[1]	Number of MUs	Total N Applied (lbs)	Total Yield Harvested (lbs)	Total Acres
Cotton	COTTON, PIMA	3	37,197	151,140	211
Cotton	COTTON, UPLAND	2	23,237	462,066	300
Endives	ENDIVE	1	2,312	315,993	14
Endives	ESCAROLE	1	2,339	238,598	15
Endives	RADICCHIO	5	52,720	8,409,126	421
Fennel	FENNEL	1	1,205	37,142	9
Figs	FIGS	18	139,872	5,777,220	1,787
Forage	FORAGE GRASS, FORAGE	29	57,968	20,372,438	2,083
Forage	OATS, FORAGE	7	25,150	3,516,390	151
Forage	SMALL GRAINS (OTHER), FORAGE	1	0	n.a.	14
Forage	SORGHUM/SUDAN, FORAGE	1	0	n.a.	17
Forage	WHEAT, FORAGE	2	1,747	516,099	80
Garlic	GARLIC	3	107,808	7,753,200	499
Grains	OATS, GRAIN	2	21,728	647,328	193
Grains	SMALL GRAINS (OTHER), GRAIN	5	690	5,783,120	1,033
Grains	WHEAT, GRAIN	9	115,931	6,206,359	1,043
Grains, Corn	CORN, GRAIN	13	113,854	7,447,282	738
Grapes	GRAPES, NR	5	8,282	493,586	142
Grapes	GRAPES, TABLE	32	124,864	29,833,863	2,230
Grapes	GRAPES, WINE	192	2,591,032	762,219,266	34,152
Grapes, raisins	GRAPES, RAISINS	75	668,314	64,056,225	9,983
Greenchop	WHEAT, GREENCHOP	1	36,112	9,973,680	287
Greens	CHARD	3	18,077	3,706,425	130
Greens	GREENS, COLLARD	1	25,636	4,518,345	128
Greens	KALE	4	24,582	3,134,501	123
Greens	LETTUCE	4	60,505	7,967,690	386
Greens	MUSTARD, GREENS	2	23,691	4,804,537	148
Greens	ONIONS, GREEN	2	2,750	170,500	18
Greens	SPINACH	1	9,050	906,331	65
Hay	FORAGE GRASS, HAY	11	8,981	3,420,597	336
Hay	OATS, HAY	6	28,692	2,933,284	329
Hay	SMALL GRAINS (OTHER), HAY	13	71,430	12,865,772	821
Hay	WHEAT, HAY	7	108,776	6,341,517	797
Hay, Alfalfa	ALFALFA, HAY	181	538,689	188,146,505	13,717
Herbs	BASIL	2	23,080	3,020,890	141
Herbs	CILANTRO	1	24,906	2,418,930	179
Herbs	DANDELION	1	3,119	639,540	22
Herbs	DILL	1	6,758	1,331,702	49
Herbs	HERBS, FRESH CUT	4	20,206	872,376	76
Herbs	PARSLEY	3	27,366	2,907,083	141
Kiwis	KIWIFRUIT	1	1,480	117,235	19
Kohlrabi	KOHLRABI	1	4,880	963,424	31
Leeks	LEEKS	1	10,506	1,575,900	53
Melons	MELONS, NR	1	90	12,000	6
Melons	MELONS, WATERMELON	2	8,268	6,685,120	62
Nectarines	NECTARINES	4	5,824	975,817	60
Olives	OLIVES	9	27,307	2,913,774	615
Onions	ONIONS, BULB	1	75,600	8,398,215	315
Onions	ONIONS, NR	2	3,573	7,845	28
Peaches	PEACHES, FRESH MARKET	18	58,015	23,335,277	597

Crop Group	Specific Crop Type[1]	Number of MUs	Total N Applied (lbs)	Total Yield Harvested (lbs)	Total Acres
Peaches	PEACHES, NR	5	18,581	8,333,745	159
Peaches	PEACHES, PROCESSING	69	290,624	102,180,543	3,003
Pecans	PECANS	3	160	7,200	13
Peppers	PEPPERS, BELL	1	9,328	3,886,652	44
Persimmons	PERSIMMONS	4	2,224	347,145	30
Pistachios	PISTACHIOS	120	3,790,867	63,233,557	23,595
Plums	PLUMS	2	560	209,776	7
Pomegranates	POMEGRANATES	9	32,247	6,716,092	595
Potatoes	POTATOES	3	20,793	55,326	107
Potatoes	SWEET POTATOES	72	1,854,304	402,987,356	8,224
Prunes	PRUNES	7	264,294	10,141,727	1,597
Pumpkins	PUMPKINS	2	650	2,404,000	63
Radish	DAIKON	1	3,156	1,820,700	20
Rice	RICE	11	119,393	8,660,900	982
Safflower	SAFFLOWER	1	47,310	889,200	570
Silage	FORAGE GRASS, SILAGE	2	9,910	4,387,542	147
Silage	OATS, SILAGE	112	794,417	244,337,409	8,404
Silage	SMALL GRAINS (OTHER), SILAGE	1	2,277	495,000	9
Silage	SORGHUM/SUDAN, SILAGE	15	170,402	37,397,363	1,556
Silage	WHEAT, SILAGE	8	13,924	9,242,497	484
Silage, Alfalfa	ALFALFA, HAYLAGE	2	25,690	6,735,700	293
Silage, Corn	CORN, SILAGE	161	2,583,954	673,988,686	12,802
Squash	SQUASH, SUMMER	1	150	4,000	1
Squash	SQUASH, WINTER	1	880	572,000	22
Tomatoes	TOMATOES, FRESH MARKET	6	473,039	148,807,572	2,087
Tomatoes	TOMATOES, NR	3	41,619	22,537,470	191
Tomatoes	TOMATOES, PROCESSING	6	171,996	142,822,570	1,894
Turnips	TURNIPS	1	8,752	1,262,250	56
Walnuts	WALNUTS	343	2,352,805	68,613,239	16,592
Ambiguous Crop types [2]	CORN, NR	15	111,531	29,408,556	655
	OATS, NR	19	42,422	7,405,028	747
	SMALL GRAINS (OTHER), NR	4	45,914	1,823,609	315
	SORGHUM/SUDAN, NR	3	1,210	151,065	67
	TREE, FRUIT NR	3	953	40,440	113
	WHEAT, NR	27	465,134	56,405,685	3,188
NB [3]	NON-BEARING	494	1,664,402	0	31,663
NY [3]	NO YIELD	60	199,206	0	3,610

n.a. – Value not available.
NR – Crop or crop age not reported.
[1]Additional age categories are reported in Appendix I for the following crops: almonds, apples, apricots, berries, cherries, chestnuts, citrus, figs, grapes, raisin grapes, kiwis, nectarines, olives, peaches, persimmons, pistachios, plums, pomegranates, prunes, and walnuts.
[2] Not included in the analysis because the harvest type is necessary to compare data appropriately.
[3] Not included in the analysis because these MUs have no A/Y.

N Removal Calculations

All N Removal Factors were obtained from Dr. Daniel Geisseler's 2016 report[1] (with the single exception of berries). In his report, Geisseler performed an extensive literature review to obtain nitrogen concentrations for a wide variety of crops. Geisseler summarized all data from the different studies identified in the review, and provided an average N removal per crop. In addition, Geisseler provided a coefficient of variation to assess the variability of the data around each mean, and an assessment of the quality, completeness, and relevance of the dataset. By the author's own assessment, many of the values are poor or unreliable estimates for the Central Valley.

For this analysis, the Coalition used the average N Removal Factors reported in Geisseler (2016), with the forewarning that many of the values are poor estimates and will change in the future. After further review, the Coalition also considers that the coefficient of variation provided by Geisseler is not a proper statistic to estimate variability. Instead, to assess variability, the Coalition used the range of values from all studies reviewed by Geisseler for each crop. A summary of Geisseler's mean N Removal Factors, the range of values, and both Geisseler's and the Coalition's quality assessments, are provided in Table 6. The Coalition plans on updating and improving these values over time, as more, higher quality data become available.

In some cases, the crop types reported by Geisseler were more specific than those used by the Coalition. For example, while the Coalition reports on wheat as a single crop type, Geisseler has two separate (albeit similar) values for durum and common grain wheat. In such cases, the Coalition calculated an average of the multiple values provided by Geisseler. Averages calculated by the Coalition are presented in Table 7.

In some cases where the Coalition calculated average N Removal Factors for groups of similar crops, the Coalition's quality assessment of the average differed from Geisseler's assessment of the more specific crops used to calculate the average. For example, Geisseler considers that there is insufficient data for black-eyed and garbanzo beans from the Central Valley, and it is not possible to determine if the average he provides is a good estimate for the region. However, the Coalition observed that those values overlap substantially with values from lima beans, which are considered by Geisseler to be reasonable estimates for the region. Given the strong overlap in means and ranges, the Coalition considers that the average for dry beans is likely also a reasonable estimate for the region. The same group quality assessment was made for citrus based on their general overlap with each other and oranges from California, for market tomatoes based its overlap with processing tomatoes from California, and for oats grain based on its overlap with other small grains from California (Table 6).

[1] Geisseler, Daniel. 2016. Nitrogen concentrations in harvested plant parts – A literature overview. Prepared for the Central Valley ILRP Water Quality Coalitions.

Table 6. Nitrogen Removal Factors reported by Geisseler (2016) with their range and quality assessment.

Commodity	N Removal Factor			Units	Quality assessment	
	Mean	Min	Max		Coalition	Geisseler Report (2016)
Alfalfa - Hay	0.03115	0.02465	0.04125	lbs N/lbs @ 12% moisture	Good	The dataset used for this report can be considered a very good estimate for alfalfa hay produced in California. However, the range probably includes sites outside the Central Valley.
Alfalfa - Haylage	0.012	0.00925	0.0138	lbs N/lbs @ 65% moisture	Good	The estimate can be considered a very good estimate of alfalfa silage produce in California. However, the dataset is small and more samples are needed.
Almonds	0.068	0.051	0.087	lbs N/lbs of marketable kernels	Good	The value is a good estimate for N removed from almond orchards in the Central Valley.
Apples	0.00054	0.0003	0.001615	lbs N/lbs of fruits	Poor	The value is only a rough estimate.
Apricots	0.00278	0.00224	0.00282	lbs N/lbs of fruits	Poor	The value is only a rough estimate.
Barley - Grain	0.0168	0.0098	0.02435	lbs N/lbs of grain @ 12% moisture	Reasonable	Even though the average value reported here may be an acceptable estimate, it needs to be confirmed with a larger set of samples.
Beans, dry - Blackeye	0.0365	0.02815	0.0403	lbs N/lbs of mature dry beans @ 12% moisture	Poor	It is not possible to determine the degree to which the average value is representative. Needs a more representative sample from the Central Valley. However, values overlap substantially with lima beans from California.
Beans, dry - Garbanzo	0.0336	0.0234	0.04785	lbs N/lbs of mature dry beans @ 12% moisture	Poor	It is not possible to determine the degree to which the average value is representative. Needs a more representative sample from the Central Valley. However, values overlap substantially with lima beans from California.
Beans, dry - Lima	0.03615	0.03165	0.045	lbs N/lbs of mature dry beans @ 12% moisture	Reasonable	The value in the table may be a reasonable estimate of N in lima beans harvested in California.
Carrots	0.001645	0.000855	0.003675	lbs N/lbs of carrot root	Poor	No recent values are available from California. It is not possible to determine the degree to which the value is representative of the Central Valley.
Cherries	0.00221	0.00135	0.003335	lbs N/lbs of fruits	Poor	The value is only a rough estimate.
Corn - Grain	0.012	0.003	0.0268	lbs N/lbs of grain @ 15.5% moisture	Poor	More corn grain samples from Central Valley fields are necessary to determine whether the value is a good estimate for the region.
Corn - Silage	0.00378	0.0025	0.0052	lbs N/lbs @ 70% moisture	Good	This value can be considered a very good estimate of Central Valley corn silage.
Cotton	0.02185	0.01165	0.0316	lbs N/lbs lint & seed	Good	The value can be considered a very good estimate of the N concentration in cotton from the Central Valley.
Fescue, Tall - Hay	0.0254	0.01685	0.03505	lbs N/lbs @ 12% moisture	Poor	The value may overestimate the N concentrations in the Central Valley. The results may not fully capture the variability of hay produced in the Central Valley.
Figs	0.00127	0.0012	0.002105	lbs N/lbs of fruits	Poor	It cannot be determined how well the average value in the table represents figs from California.
Garlic	0.00755	0.004705	0.01024	lbs N/lbs of bulb weight	Poor	The variability within and among studies is high. With no recent values from California, it is not possible to determine how well the values in the table represent N concentrations in garlic harvested in California.

Commodity	N Removal Factor			Units	Quality assessment	
Grapefruit	0.00148	0.0008	0.00162	lbs N/lbs of fruits	Reasonable	The dataset is a reasonable estimate of N removed with grapefruits. However, more recent data from the Central Valley is needed.
Grapes - Raisins	0.00505	0.00394	0.00625	lbs N/lbs of grapes @ 15% moisture	Reasonable	The value is a good estimate of N removed with 'Thompson Seedless' grapes from California vineyards. However, it likely underestimates the variability of grape N concentrations in commercial vineyards.
Grapes - Table	0.00113	0.00089	0.001405	lbs N/lbs of grapes	Reasonable	The value is a good estimate of N removed with 'Thompson Seedless' grapes from California vineyards. However, it likely underestimates the variability of grape N concentrations in commercial vineyards.
Grapes - Wine	0.0018	0.00098	0.0026	lbs N/lbs of grapes	Poor	It cannot be determined if value is representative for wine grapes from California.
Lemons	0.00129	0.00115	0.001935	lbs N/lbs of fruits	Reasonable	The dataset is a reasonable estimate of N removed with lemons. However, more recent data from the Central Valley is needed.
Lettuce - Iceberg	0.001315	0.000875	0.00237	lbs N/lbs of fresh weight	Reasonable	The value is likely a good estimate of N concentrations in the Central Valley, even though most of the data are from the Salinas Valley.
Lettuce - Romaine	0.00181	0.001135	0.00256	lbs N/lbs of fresh weight	Reasonable	The value is likely a good estimate of N concentrations in the Central Valley, even though most of the data are from the Salinas Valley.
Melons, Water	0.000695	0.000475	0.00102	lbs N/lbs of melons	Poor	With no recent data from California, it is not possible to determine if the value is a good estimate of watermelon harvested from the Central Valley.
Nectarines	0.00182	0.000825	0.002775	lbs N/lbs of fruits	Reasonable	The value may be a reasonable estimate of N in nectarines form the Central Valley. However, the dataset may not fully capture the variability.
Oat - Grain	0.01885	0.01325	0.02535	lbs N/lbs of grain @ 12% moisture	Poor	With no oat grain data from California, values may not be representative of oats grown in California. However, means and ranges overlap substantially, with other small grains from the Central Valley.
Oat - Hay	0.01085	0.0073	0.01465	lbs N/lbs @ 12% moisture	Good	The value is a good estimate of the average N concentration in oat hay produced in the Central Valley.
Olives	0.00314	0.002	0.00555	lbs N/lbs of olives	Reasonable	The dataset may provide a reasonable estimate of N removed with olives. However, the dataset needs more samples from orchards in the Central Valley.
Onions	0.00197	0.0008	0.0031445	lbs N/lbs of bulb weight	Poor	The value may not be representative of N concentrations in onions harvested in the Central Valley.
Oranges	0.00148	0.001175	0.00243	lbs N/lbs of fruits	Reasonable	The dataset is a reasonable estimate of N removed with oranges. However, needs more recent data from the Central Valley.
Orchard Grass - Hay	0.02725	0.019	0.03815	lbs N/lbs @ 12% moisture	Poor	The value may overestimate the N concentrations in the Central Valley. The results may not fully capture the variability of hay produced in the Central Valley.
Peaches	0.00113	0.00069	0.001845	lbs N/lbs of fruits	Reasonable	The average N concentration may be a reasonable estimate of N in California peaches. However, needs more data from the Central Valley.
Pears	0.000645	0.00035	0.00105	lbs N/lbs of fruits	Poor	The value is only a rough estimate.
Pepper - Bell	0.001655	0.00109	0.003065	lbs N/lbs of fresh weight	Poor	It is not possible to determine whether the value is a good estimate of bell peppers grown in the Central Valley.

Commodity	N Removal Factor			Units	Quality assessment	
Pistachios	0.02805	0.02705	0.0288	lbs N/lbs dry yield (CPC)	Good	The value is a good estimate for N removed from pistachio orchards in the Central Valley.
Plums	0.001415	0.0012	0.00165	lbs N/lbs of fruits	Poor	It is not possible to determine how well the dataset represents N concentrations in the Central Valley.
Pomegranate	0.0076	0.00605	0.00935	lbs N/lbs of fruits	Poor	It is not possible to determine the degree to which the value is representative of pomegranates harvested in the Central Valley.
Potatoes	0.00312	0.00204	0.00461	lbs N/lbs of fresh weight	Poor	It is not possible to determine how well the dataset represents N concentrations in potatoes harvested in the Central Valley.
Prunes	0.0056	0.00445	0.009	lbs N/lbs of dried fruits	Good	The value is likely a good estimate of the N concentration from Central Valley.
Pumpkin	0.00368	0.002135	0.00453	lbs N/lbs of fresh weight	Poor	The value is likely not representative of N concentration of pumpkins in the Central Valley.
Ryegrass, Perennial - Hay	0.02745	0.0181	0.0379	lbs N/lbs @ 12% moisture	Poor	The value may overestimate the N concentrations in the Central Valley. The results may not fully capture the variability of hay produced in the Central Valley.
Safflower	0.0284	0.0169	0.05465	lbs N/lbs of seed @ 8% moisture	Poor	The variability within and among studies was uncharacteristically large. With only one study from California, the average may not be representative of N concentrations from California.
Sorghum - Silage	0.00367	0.00195	0.00595	lbs N/lbs @ 65% moisture	Reasonable	The value provides a good estimate of N concentrations in sorghum silage produced in the Central Valley. However, the data may not fully capture the variability.
Squash	0.001835	0.00032	0.0032	lbs N/lbs of fresh weight	Poor	Some N concentrations refer to the edible part of the fruit, and may not represent the N removed with the whole fruit.
Sweet potatoes	0.00237	0.001715	0.003185	lbs N/lbs of fresh weight	Good	The value is a good estimate for N removed with sweet potatoes from Central Valley fields.
Tangerines	0.00127	0.00101	0.00153	lbs N/lbs of fruits	Poor	It is not possible to determine how well the values represent tangerines grown in the Central Valley. Samples need to be collected from different orchards in the Central Valley.
Tomatoes - Fresh market	0.001305	0.000945	0.001695	lbs N/lbs of fresh weight	Poor	It is not possible to determine the degree to which the dataset is representative of tomatoes harvested in the Central Valley. However, means and ranges overlap substantially, with processing tomatoes from the Central Valley.
Tomatoes - Processing	0.001365	0.00095	0.0018	lbs N/lbs of fresh weight	Good	The average value can be considered a very good estimate for the Central Valley.
Triticale - Grain	0.0202	0.01475	0.02545	lbs N/lbs of grain @ 12% moisture	Good	The results are a good estimate of triticale grown in the Central Valley.
Triticale - Silage	0.004515	0.0037	0.00575	lbs N/lbs @ 70% moisture	Reasonable	The value provides a good estimate of the average N concentration in triticale silage produced in the Central Valley. However, the data may not capture the full variability.

Commodity	N Removal Factor			Units	Quality assessment	
Walnuts	0.01595	0.012	0.0232	lbs N/lbs with shells	Reasonable	The value can be considered a good estimate of N removed with walnuts in the Central Valley. However, the data range may not fully capture the variability.
Wheat - Silage	0.00525	0.00335	0.00725	lbs N/lbs @ 70% moisture	Reasonable	The dataset likely provides a good estimate of the average N concentration in wheat silage produced in the Central Valley. However, the data may not fully capture the variability.
Wheat, common - Grain	0.0215	0.01605	0.02635	lbs N/lbs of grain @ 12% moisture	Good	The results are highly representative for the Central Valley.
Wheat, durum - Grain	0.02105	0.01685	0.027	lbs N/lbs of grain @ 12% moisture	Good	The results are highly representative for the Central Valley.

Table 7. Nitrogen Removal Factors calculated by the Coalition by averaging Factors from similar crops evaluated separately by Geisseler (2016).

Commodity	N Removal Factor			Units	Description and Quality Assessment	
	Mean	Min	Max			
Beans, dry - average	0.03542	0.0234	0.04785	lbs N/lbs of mature dry beans @ 12% moisture	Reasonable	This is an average of black-eyed, garbanzo and lima beans. As means and ranges overlap substantially for the different beans, and some values were obtained in California, this is likely a reasonable estimate for the Central Valley. The Coalition applied this value to cases when the growers did not specify the type of bean reported.
Small grains - Grain, average	0.01968	0.0098	0.0270	lbs N/lbs of grain @ 12% moisture	Reasonable	This is an average of barley, triticale, oats, common wheat and durum wheat. The Coalition applied this value to cases when the grower did not specify the kind of small grain reported. As means and ranges overlap substantially among the different small grains, this is likely a reasonable estimate of N Removal with small grains grain in the Central Valley.
Wheat - Grain, average	0.02128	0.01605	0.027	lbs N/lbs of grain @ 12% moisture	Good	Geisseler evaluated grains from common wheat and durum wheat separately. Coalition growers did not differentiate between the two types of wheat. The Coalition applied this average to all wheat reported by the growers. Both values overlap substantially and results are highly representative of wheat grown in Central Valley.
Forage grass - Hay, average	0.02670	0.01685	0.03815	lbs N/lbs @ 12% moisture	Poor	Geisseler evaluated tall fescue, orchard grass and ryegrass separately. The Coalition created a forage grass average N Removal Factor and applied that to cases when the grower did not specify the kind of grass hay reported. Means and ranges for the different grass N Removal Factors overlap substantially. However, they are all from the same trial, and may overestimate the N concentrations in the Central Valley.

Commodity	N Removal Factor			Units	Description and Quality Assessment	
Small grains - Silage, average	0.00488	0.00335	0.00725	lbs N/lbs @ 70% moisture	**Reasonable**	This is an average of triticale and wheat. The Coalition applied this value to all other small grains, and to cases when the grower did not specify the kind of small grain reported. As means and ranges overlap substantially among the two small grains, this is likely a reasonable estimate of N Removal with small grains silage in the Central Valley.
Citrus, average	0.00138	0.0008	0.0024	lbs N/lbs of fruits	**Reasonable**	This value is an average of grapefruit, lemons, oranges, and tangerines. Means and ranges for the different citrus overlap substantially. The Coalition used this citrus average N Removal Factor in cases when the grower reported other citrus fruits not included in that list. As means and ranges overlap substantially, this average can be considered a reasonable estimate for citrus.
Grapes - average	0.00147	0.0009	0.0026	lbs N/lbs of grapes	**Reasonable**	This value is an average of wine and table grapes. Although N removal might be higher in wine grapes, there is substantial overlap, and this mean value may be reasonable for grapes in the Central Valley. The Coalition applied this value to cases when the grower did not specify the kind of grapes reported.
Lettuce - average	0.00156	0.0009	0.0026	lbs N/lbs of fresh weight	**Reasonable**	Geisseler evaluated iceberg and romaine lettuce separately. Means and ranges for the two N Removal Factors overlap substantially. The Coalition created a lettuce average N Removal Factor and applied that to all salad greens reported by the growers. Geisseler believes the value is likely a reasonable estimate of N concentrations in the Central Valley, even though most of the data are from the Salinas Valley.
Tomatoes - average	0.00134	0.0009	0.0018	lbs N/lbs of fresh weight	**Reasonable**	Geisseler evaluated market and processing tomatoes separately. Means and ranges for the two N Removal Factors overlap substantially. The Coalition created a tomato average N Removal Factor and applied that to cases when the grower did not specify the kind of tomato reported. As values overlap substantially, and there is good representation for processing tomatoes in the Central Valley, this is likely a reasonable estimate for tomato N removal in the region.

The specific N Removal Factors that were applied to each specific crop type reported by Coalition growers are shown in Table 8. Crops with available N Removal Factor in this report cover 367,712 acres, 97% of the available data (based on the total number of received and complete reports).

Even when N Removal Factors are considered good estimates for the region by Geisseler or by the Coalition, the calculation of R can be in error. Errors can occur if the yield is reported by the grower in a different way from the yield used in the N Removal Factor. The Coalition has identified the following specific issues:

- Almonds can be reported as kernel weight or as kernels + hulls + shells (KHS). The growers do not always differentiate these two types of yield in their NMP SRs. The N Removal Factor is based on kernel weight and cannot be applied to yield reported as KHS. The Coalition identified and corrected yields reported as KHS when possible (See Appendix I), but may not have identified all cases correctly.
- Cotton can be reported as lint weight or as lint + seed weight. The growers do not differentiate these two types of yield in the reports. The N Removal Factor is based on lint + seed yields and cannot be applied to MUs reporting only lint yield. The Coalition does not have enough information to identify the type of yield reported and make corrections. Hence some R values for cotton could be in error.
- The N Removal Factors of forage field crops, specifically hay and silage, are calculated based on typical moisture contents. The growers do not often report the moisture content of their yields. If the moisture content of the reported yield differs from the one used to calculate the N Removal Factor, the R obtained will be inaccurate.
- Some growers reporting raisin grapes may have provided fresh weight of the grapes. The N Removal Factor is based on the dry weight. The Coalition corrected the fresh weight yields when sufficient information was provided in the SR, but may not have identified all cases correctly.

Table 8. N Removal Factors applied to each of the Specific Crop Types used by the Coalition.

Some of the values used are not good estimates. The quality assessment of N Removal Factors sourced from Geisseler (2016) is provided in Table 6. Coalition averages and their quality assessment are explained in Table 7.

Coalition Specific Crop type	N Removal Commodity	N Removal Source	Quality Assessment	N Removal Factor	Units
ALFALFA, HAY	Alfalfa - Hay	Geisseler (2016)	Good	0.0312	lbs N/lbs @ 12% moisture
ALFALFA, HAYLAGE	Alfalfa - Haylage	Geisseler (2016)	Good	0.0120	lbs N/lbs @ 65% moisture
ALMONDS	Almonds	Geisseler (2016)	Good	0.0680	lbs N/lbs of marketable kernels
APPLES	Apples	Geisseler (2016)	Poor	0.0005	lbs N/lbs of fruits
APRICOTS	Apricots	Geisseler (2016)	Poor	0.0028	lbs N/lbs of fruits
BEANS, DRY	Beans, dry - average	Coalition average	Reasonable	0.0354	lbs N/lbs of mature dry beans @ 12% moisture
BEANS, DRY, BLACK-EYED	Beans, dry - Blackeye	Geisseler (2016)	Poor	0.0365	lbs N/lbs of mature dry beans @ 12% moisture
BEANS, DRY, GARBANZO	Beans, dry - Garbanzo	Geisseler (2016)	Poor	0.0336	lbs N/lbs of mature dry beans @ 12% moisture
BERRY, BLUEBERRY	Strawberries	CDFA FREP[1]	--	0.0013	lbs N/lbs of fruit
CARROT	Carrots	Geisseler (2016)	Poor	0.0016	lbs N/lbs of carrot root
CHARD	Lettuce - average	Coalition average	Reasonable	0.0016	lbs N/lbs of fresh weight
CHERRY	Cherries	Geisseler (2016)	Poor	0.0022	lbs N/lbs of fruits
CITRUS, MANDARINS	Citrus, average	Coalition average	Reasonable	0.0014	lbs N/lbs of fruits
CITRUS, ORANGES	Oranges	Geisseler (2016)	Reasonable	0.0015	lbs N/lbs of fruits
CITRUS, TANGELO	Citrus, average	Coalition average	Reasonable	0.0014	lbs N/lbs of fruits
CORN, GRAIN	Corn - Grain	Geisseler (2016)	Poor	0.0120	lbs N/lbs of grain @ 15.5% moisture
CORN, SILAGE	Corn - Silage	Geisseler (2016)	Good	0.0038	lbs N/lbs @ 70% moisture
COTTON	Cotton	Geisseler (2016)	Good	0.0219	lbs N/lbs lint & seed
COTTON, PIMA	Cotton	Geisseler (2016)	Good	0.0219	lbs N/lbs lint & seed
COTTON, UPLAND	Cotton	Geisseler (2016)	Good	0.0219	lbs N/lbs lint & seed
FIGS	Figs	Geisseler (2016)	Poor	0.0013	lbs N/lbs of fruits
FORAGE GRASS, HAY	Forage grass - Hay, average	Coalition average	Poor	0.0267	lbs N/lbs @ 12% moisture
GARLIC	Garlic	Geisseler (2016)	Poor	0.0076	lbs N/lbs of bulb weight
GRAPES, NR	Grapes - average	Coalition average	Reasonable	0.0015	lbs N/lbs of grapes
GRAPES, RAISINS	Grapes - Raisins	Geisseler (2016)	Reasonable	0.0051	lbs N/lbs of grapes @ 15% moisture

Coalition Specific Crop type	N Removal Commodity	N Removal Source	Quality Assessment	N Removal Factor	Units
GRAPES, TABLE	Grapes - Table	Geisseler (2016)	Reasonable	0.0011	lbs N/lbs of grapes
GRAPES, WINE	Grapes - Wine	Geisseler (2016)	Poor	0.0018	lbs N/lbs of grapes
GREENS, COLLARD	Lettuce - average	Coalition average	Reasonable	0.0016	lbs N/lbs of fresh weight
KALE	Lettuce - average	Coalition average	Reasonable	0.0016	lbs N/lbs of fresh weight
LETTUCE	Lettuce - average	Coalition average	Reasonable	0.0016	lbs N/lbs of fresh weight
MELONS, WATERMELON	Melons, Water	Geisseler (2016)	Poor	0.0007	lbs N/lbs of melons
MUSTARD, GREENS	Lettuce - average	Coalition average	Reasonable	0.0016	lbs N/lbs of fresh weight
NECTARINES	Nectarines	Geisseler (2016)	Reasonable	0.0018	lbs N/lbs of fruits
OATS, GRAIN	Oat - Grain	Geisseler (2016)	Poor	0.0189	lbs N/lbs of grain @ 12% moisture
OATS, HAY	Oat - Hay	Geisseler (2016)	Good	0.0109	lbs N/lbs @ 12% moisture
OATS, SILAGE	Small grains - Silage, average	Coalition average	Reasonable	0.0049	lbs N/lbs @ 70% moisture
OLIVES	Olives	Geisseler (2016)	Reasonable	0.0031	lbs N/lbs of olives
ONIONS, BULB	Onions	Geisseler (2016)	Poor	0.0020	lbs N/lbs of bulb weight
PEACHES, FRESH MARKET	Peaches	Geisseler (2016)	Reasonable	0.0011	lbs N/lbs of fruits
PEACHES, NR	Peaches	Geisseler (2016)	Reasonable	0.0011	lbs N/lbs of fruits
PEACHES, PROCESSING	Peaches	Geisseler (2016)	Reasonable	0.0011	lbs N/lbs of fruits
PEARS	Pears	Geisseler (2016)	Poor	0.0006	lbs N/lbs of fruits
PECANS	Walnuts	Geisseler (2016)	Reasonable	0.0160	lbs N/lbs with shells
PEPPERS, BELL	Pepper - Bell	Geisseler (2016)	Poor	0.0017	lbs N/lbs of fresh weight
PISTACHIOS	Pistachios	Geisseler (2016)	Good	0.0281	lbs N/lbs dry yield (CPC)
PLUMS	Plums	Geisseler (2016)	Poor	0.0014	lbs N/lbs of fruits
POMEGRANATES	Pomegranate	Geisseler (2016)	Poor	0.0076	lbs N/lbs of fruits
POTATOES	Potatoes	Geisseler (2016)	Poor	0.0031	lbs N/lbs of fresh weight
PRUNES	Prunes	Geisseler (2016)	Good	0.0056	lbs N/lbs of dried fruits
PUMPKINS	Pumpkin	Geisseler (2016)	Poor	0.0037	lbs N/lbs of fresh weight
SAFFLOWER	Safflower	Geisseler (2016)	Poor	0.0284	lbs N/lbs of seed @ 8% moisture
SMALL GRAIN (EXCL WHEAT AND OATS), GRAIN	Small grains - Grain, average	Coalition average	Reasonable	0.0197	lbs N/lbs of grain @ 12% moisture

Coalition Specific Crop type	N Removal Commodity	N Removal Source	Quality Assessment	N Removal Factor	Units
SMALL GRAIN (EXCL WHEAT AND OATS), SILAGE	Small grains - Silage, average	Coalition average	Reasonable	0.0049	lbs N/lbs @ 70% moisture
SORGHUM/SUDAN, SILAGE	Sorghum - Silage	Geisseler (2016)	Reasonable	0.0037	lbs N/lbs @ 65% moisture
SPINACH	Lettuce - average	Coalition average	Reasonable	0.0016	lbs N/lbs of fresh weight
SQUASH, SUMMER	Squash	Geisseler (2016)	Poor	0.0018	lbs N/lbs of fresh weight
SQUASH, WINTER	Squash	Geisseler (2016)	Poor	0.0018	lbs N/lbs of fresh weight
STRAWBERRIES	Strawberries	CDFA FREP [1]	--	0.0013	lbs N/lbs of fruit
SWEET POTATOES	Sweet potatoes	Geisseler (2016)	Good	0.0024	lbs N/lbs of fresh weight
TOMATOES, FRESH MARKET	Tomatoes - Fresh market	Geisseler (2016)	Poor	0.0013	lbs N/lbs of fresh weight
TOMATOES, NR	Tomatoes - average	Coalition average	Reasonable	0.0013	lbs N/lbs of fresh weight
TOMATOES, PROCESSING	Tomatoes - Processing	Geisseler (2016)	Good	0.0014	lbs N/lbs of fresh weight
WALNUTS	Walnuts	Geisseler (2016)	Reasonable	0.0160	lbs N/lbs with shells
WHEAT, GRAIN	Wheat - Grain, average	Coalition average	Good	0.0213	lbs N/lbs of grain @ 12% moisture
WHEAT, SILAGE	Wheat - Silage	Geisseler (2016)	Reasonable	0.0053	lbs N/lbs @ 70% moisture

[1] CDFA FREP values were obtained from http://apps.cdfa.ca.gov/frep/docs/N_Strawberry.html. No data quality assessment exists for this value.

Statistical Methods

All analyses were performed using R software for statistical computing[2]. The Coalition calculated summary statistics on the NMP SR values by crop. Summary statistics included the minimum, the maximum, and the 10th, 25th, 50th, 75th, and 90th percentiles of A/Y, A-R, and A/R (if the N Removal Factor was known). Percentiles were calculated using the R function "quantile" per the default method in R. This is a quantile method for continuous variables, where the quantiles are obtained by linear interpolation between data points. For example, if only two data points were available, the median is interpolated half way between them, and the 90th percentile is one ninth of the way from the highest value. All data points (NMP MUs) with A/Y values > the 90th percentile within each group were flagged as outliers.

Summary statistics were also calculated by T-R to comply with the Order requirements. Each T-R represents 36 sections (23,040 acres). The NMP data were associated with a T-R location using ArcGIS by overlaying the TRS layer with county the parcel layers. There were 71 MUs associated with APNs that could not be associated to a T-R. These were labeled as T-R unknown and treated as a single T-R in the analysis. Some NMP MUs were associated with more than one T-R because different parcels or parts of a parcel overlapped with multiple T-Rs. To avoid having the MUs duplicated in the T-R outlier analysis, these NMP MUs were assigned to the T-R that included most of the MU area.

As indicated in the Order, the Coalition used standard Box and Whisker plots (BW plots) to visualize data grouped by crop and T-R (Appendix I). In the BW plots, the "boxes" indicate the 25th, 50th, and 75th percentiles, and "whiskers" the data range. The default BW plot method in R calculates the percentiles as described above for the quantile calculation. The data range are the most extreme data point, which are no more than 1.5 times the length of the box away from the box. In addition to the BW plots, the Coalition generated standard scatter plots of A vs. Y to visualize the range of nitrogen applications and Yields for each crop (Appendix I).

The Regional Board also requested that the Coalition evaluate and provide an analysis of nitrogen applied relative to recommended fertilizer application rates. Fertilizer recommendations vary depending on factors such as age of crop, target yield, soil type, and irrigation method. The Coalition plotted a number of possible fertilizer recommendations as part of the scatter plots in Appendix I. Recommendations were obtained from the CDFA FREP (https://www.cdfa.ca.gov/is/ffldrs/frep/) and from the UC Cooperative Extension cost analysis (http://coststudies.ucdavis.edu/current/). Data from UC Davis are not recommendations but estimates of the amount of fertilizer used in a typical operation. The Coalition reviewed all available data from these two sources and, when possible, selected values from studies conducted in counties within the ESJWQC. A table explaining the source and applicability of each of the fertilizer recommendations for each crop is provided next to the corresponding scatter plot. It is important to note that this is not a comprehensive review of recommended application rates and should not be used to draw any conclusions regarding their accuracy or applicability to specific fields.

[2] R Core Team 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

RESULTS

Summary Statistics and Outliers by T-R

The analysis was performed at the level of NMP MUs, which represents field level management of nitrogen by Coalition members. After QC, there were 4,616 NMP MUs with complete data (Table 5). Of these, 554 MUs from non-yield (NY) or nonbearing (NB) crops have no A/Y due to zero yield. The NY/NB crops cover 35,273 acres and reported applications of 1,863,600 lbs of nitrogen (Table 5). In addition, there were 71 MUs (5,085 acres, Table 5) that had ambiguous crop types. This occurred when members did not utilize the specific crop type list supplied by the Coalition when filling out their NMP SRs. While MUs with ambiguous crop types had valid A/Y values, the Coalition determined that these could not be used to reliably calculate summary statistics and estimate outliers (See Crop Classification Section). With the exclusion of MUs with NY/NB crops or with ambiguous crop types, this analysis reflects the A/Y values of 3,991 NMP MUs.

The Order requires the Coalition to report statistical summaries for parcels grouped by township, and "any outliers for similar soil conditions and similar crops in that township". In this analysis, the Coalition provides summary statistics and a count of outliers by similar crops and by T-R. However, further aggregation of the data by soil conditions, as suggested by the Order, would have limited the ability of the Coalition to calculate summary statistics. Hence, this section reports statistical summaries only by similar crops and T-R, and the analysis by soil types is presented separately in the following section.

Even without grouping by soil conditions, the outlier identification by T-R is not reliable because, when grouping by crop type, most T-Rs have very small sample sizes. Any T-R with only one MU (or two MUs with identical A/Ys) will have no summary statistics and no outliers, even if the MU has a very large A/Y relative to neighboring T-Rs with more data points. If only two data points are available, the default method to calculate quantiles assumes that those are the range (e.g. 0% and 100% percentiles). All other percentiles are then calculated linearly, at the corresponding steps between those two points (i.e., the 90th percentile is one ninth of the way from the highest value). Thus, for any T-R with only two MUs in any particular crop type, the highest value will always be considered an outlier (>90th percentile). This would happen even if both points have very low A/Y values relative to neighboring T-Rs with more data points. Hence, the summary statistics are more meaningful when calculated from a larger sample size, and thus require the use of the region-wide data grouped by similar crop.

Box and Whisker (BW) plots and summary statistics by specific crop type and by T-R are provided in Appendix I. For each crop group, the Coalition generated two sets of BW plots and summary statistics: 1) plots and statistics by T-R (as requested by the Order), and 2) plots and statistics for the whole region (to provide a more robust estimate of outliers). In an attempt to increase the sample size to calculate summary statistics by T-Rs, the Coalition grouped similar crops within each crop group as listed in Table 5. To calculate summary statistics for the whole region, the Coalition used the appropriate specific crop type. Tables of summary statistics are also submitted with this report electronically as an Excel file.

The Regional Board requested that the Coalition evaluate and provide an analysis of nitrogen applied relative to recommended fertilizer application rates. Appendix I includes scatter plots showing the amount of nitrogen applied vs. the yield for each crop within the entire Coalition region. This plot

includes the fertilizer recommendations. Actual fertilizer recommendations vary depending on factors such as age of crop, target yield, soil type, and irrigation method. A table explaining the source and applicability of each of the fertilizer recommendations for each crop is provided next to the corresponding scatter plot. It is important to note that this is not a comprehensive review of recommended application rates and should not be used to draw any conclusions regarding their accuracy or applicability to specific fields.

In scatter plots, each dot is an MU, and outliers (A/Y > 90% for the crop category) are highlighted in red. The NMP SRs do not include information that would explain very low yields (i.e., if a crop was lost or why), or application rates that are elevated due to irrigation with high nitrate concentration groundwater. However, these kinds of plots can be used to prioritize outreach to growers that have outlier MUs due to high nitrogen applications, as opposed to growers that are outliers due to reduced or lost yield.

Comparison of Outliers from 2016 NMP Analysis

The Coalition compared the outliers obtained in this analysis to the outliers from the analysis of the 2015 NMP SR data. Because of the problems identifying outliers by T-R, the Coalition compared only outliers by crop type (for the whole Coalition region). The table below shows the number of Coalition members with at least one outlier in the 20 top crops in the region. Not included are outliers from crops that had fewer than 20 MUs, and from crops that were classified differently in each year. Table 9 suggests that there is not much consistency between the outlier members from one year to another. Very few members are identified as having outlier MUs both years.

For most crops (14, Table 9) there were more outliers this year. This is almost certainly due to larger sample size this year, as many members from small farming operations submitted NMP SR this year. Hence, and the Coalition received and analyzed data from considerably more MUs. The low number of farmers that had outliers in both 2015 and 2016 could be a result of crop rotation, in the case of annual crops. In addition, growers may have changed their fertilizer management practices due to increased awareness from the requirements of the NMP reporting.

Efforts to communicate the occurrence and significance of outlier status to growers are outlined in the Outreach and Education section below.

Table 9. Count of members having at least one outlier NMP MU in some of the top crops in the region.
This count is by member only. Members can have outliers in more than one crop, or more than one MU per crop. This table does not indicate if outliers belong to the same MU.

Specific Crop Type	Number of members with at least one outlier MU[1]		Number of members with outliers both years
	2015 Crop Year report	2016 Crop Year	
ALFALFA, HAY	7	24	1
ALMONDS	90	212	21
CORN, GRAIN	2	2	0
CORN, SILAGE	10	15	1
FIGS	3	2	2
GRAPES, RAISINS	6	9	1
GRAPES, TABLE	5	4	1
GRAPES, WINE	18	16	3

Specific Crop Type	Number of members with at least one outlier MU[1]		Number of members
OATS, SILAGE	8	11	1
PEACHES, FRESH MARKET	4	1	0
PEACHES, PROCESSING	3	8	2
PISTACHIOS	6	9	1
SWEET POTATOES	6	10	1
WALNUTS	21	34	4
COTTON	1	1	0
SORGHUM/SUDAN, SILAGE	1	2	0
CHERRY	0	2	0
POMEGRANATES	1	2	1
CITRUS, MANDARINS	1	0	0
TOMATOES, PROCESSING	1	0	0

[1] The number of outliers is based on the information reported in the NMP SR Analysis and may not reflect all member NMP SRs returned to the Coalition.

Evaluation of A/Y by Soil Type

The goal of this section is to determine if soil type groupings can be a useful category to calculate the summary statistics and identify outliers in a meaningful way. It is possible that farming operations in sandy soils may have higher A/Y values because of their lower nutrient retention capacity. When soil nutrient retention is low, farmers may apply larger amounts of fertilizer (increase A) to compensate for loss due to leaching, or may realize lower yields due to the lower availability of fertilizers (decrease Y), although these possible scenarios depend largely on management of nitrogen and irrigation water. To evaluate the possible effect of soil type on A/Y, the Coalition tested for differences in A/Y among NMP MUs with different soil types.

The analysis focused on the 12 most common crops in the region. These are almonds, walnuts, grapes (table, wine, and raisins), alfalfa hay, corn silage, pistachios, oat silage, sweet potatoes, peach processing, and forage grass/pasture. By acreage, wheat and citrus are more abundant than the latter two crops. However, those crops could not be used for this analysis as: 1) Most members reporting information on A and A/Y for wheat did not specify the crop type; and 2) no one single citrus crop (i.e., oranges, mandarins, or tangelos) was abundant enough on its own to provide a sample size sufficient to provide meaningful results. The 12 crops analyzed comprise 88% of the acreage available for this report.

The Coalition characterized soil types within the ESJWQC region based on the saturated hydraulic conductivity (K_{sat}) of the soils. The K_{sat} is a measure of the potential for water percolation and leaching of nutrients through the soil. The K_{sat} values are associated with the soil texture, which determines the rate at which water moves through the soil profile. Lower K_{sat} values are characteristic of clay soils, with low porosity, percolation, and low potential for leaching of nutrients to groundwater. Higher K_{sat} values are characteristic of sandy soils with high porosity, percolation, and potential for leaching of nutrients below the root zone and to the groundwater.

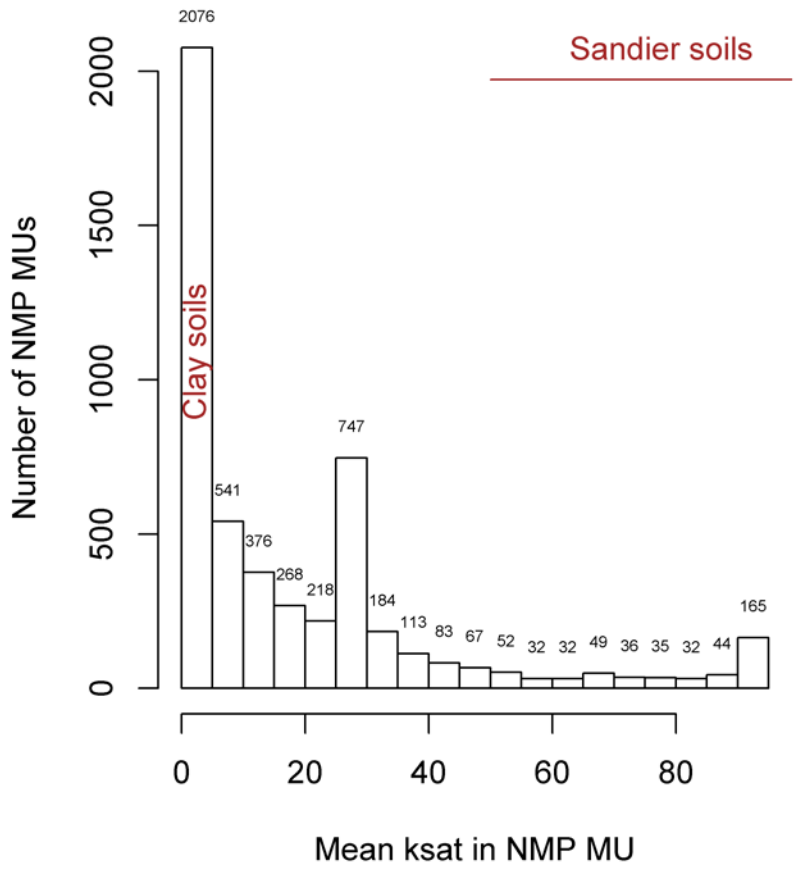
Soil data were obtained from the USDA Soil Survey Geographic Database (SSURGO: http://www.soils.usda.gov/survey/geography/ssurgo/). The “Gridded Soil Survey Geographic (gSSURGO) Database State-tile Package" product is derived from the Soil Survey Geographic (2.2)

Database dated November 16, 2015. Parcel layer data were developed by the Coalition. Parcel layer data were overlaid on the SSURGO soil data using the 'Identify' processing tool; all soil map units present in each parcel were identified. Soil information was assigned to each NMP MU by linking the map unit from the soil data to each parcel within each NMP MU.

Soil K_{sat} in each parcel and NMP MU can vary vertically with soil depth, and horizontally among different soil types. Vertical variation in K_{sat} was summarized by selecting the minimum value among all horizons down to a 1 meter depth. The horizon with the minimum K_{sat} is the one that will limit the hydraulic conductivity of the soil profile. Summarizing horizontal variation in K_{sat} within a parcel or NMP MU was more challenging. Most NMP MUs had two or more soil types associated to them. Some NMP MUs contained over 20 different soil types. Soil types within one NMP MU could have similar properties or be dramatically different. For example, some NMP MUs had portions of clay and portions of sandy soils, resulting in K_{sat} ranges of 92 µm/s within a single NMP MU.

Due to the horizontal variability in soil types within each NMP MU, it was necessary to use summary statistics to obtain a K_{sat} value representative of each NMP MU. For this analysis, the Coalition calculated the weighted average K_{sat} in each NMP MU (from here on called *mean K_{sat}*). The mean K_{sat} is the average of all K_{sat} values from different soil types inside one NMP MU, weighted by the area of each soil type. This mean K_{sat} satisfactorily identifies NMP MUs with consistently large or small K_{sat} values. The NMP MUs with contrasting soil types produce intermediate mean K_{sat} that cannot be differentiated from soil types with intermediate conductivity. Figure 3 shows the frequency of different mean K_{sat} values among MUs in the Coalition region.

Figure 3. Distribution of mean K_{sat} values for MUs throughout the Coalition region based on parcels reported for the 2016 Crop Year.



For the purpose of this analysis, and based on the range of K_{sat} values in the ESJWQC region, soils were classified as "Low" conductivity ($K_{sat} \leq 10$), "Medium" conductivity (K_{sat} from 10 to 30), and "High" conductivity ($K_{sat} \geq 30$). Most of the ESJWQC NMP MUs are characterized by low conductivity soils (Figure 3).

The Coalition evaluated if A/Y differed among the K_{sat} categories described above using simple linear models for each of the major crops (Figure 4 and Figure 5). Linear models test the hypothesis that the mean A/Y differs among any of the soil type categories. One weakness of linear models is that, in skewed data such as A/Y, the mean A/Y is mostly influenced by the number and size of the outliers. To avoid cases where a few outlier values bias the test (by increasing the mean they exert an overly large impact on the results), the Coalition excluded some extremely large A/Y outliers (larger than two times the 90th quantile of the data for that crop) from the analysis. Eliminated outliers are indicated in a cut y-axis in Figure 4 and Figure 5. The Coalition also determined if the frequency of outliers differed among K_{sat} categories using Chi-square tests (Table 10). Chi-squared tests are based on counts and are not affected by the size of the outliers. Hence, chi-square analyses can use all the data, and are a good compliment to linear models.

Overall, there was little evidence that soil type influenced the mean A/Y in the ESJWQQC region (Figure 4 and Figure 5). Only wine grapes had a significant difference in average A/Y among soil types (Figure 5). However, that difference indicated lower A/Y in intermediate soils and did not have a corresponding difference in the frequency of outliers (Table 10). Hence, this is most likely a spurious correlation influenced by the tail of outliers. Sweet potatoes had a significantly higher frequency of outliers at low conductivity soil types (Table 10). But average A/Y in sweet potatoes did not differ much among soil types (Figure 5), indicating that the trends were not general among all MUs in the soil type.

The Coalition concludes that, for the crops that cover nearly 90% of the reported area, the average A/Y and frequency of outliers is mostly unaffected by the soil type. It is unlikely that differentiating by soil categories could generally improve the calculation or accuracy of the summary statistics and identification of outliers through the Coalition region.

The efficacy of the statistical tests decreases with the smaller sample size of the other crops. Lower efficacy indicates a lower likelihood of detecting significant differences. Some of the crops included in this analysis have very small sample sizes. When evaluating multiple crops separately, as in this analysis, the probability of finding a significant result simply by chance (i.e., not real differences) increases. For instance, when using an $\alpha = 0.05$ as the threshold to indicate statistical significance, it is possible to find p-values < 0.05 in 1 in every 20 tests (5%) purely by chance.

The Coalition recognizes that soil type is important when understanding the potential for nitrogen to leach past the root zone. However, the available data suggests that soil type is not important to understand the frequency of A/Y outliers. This is probably because A/Y depends largely on the management of nitrogen and irrigation water. Properly managed operations in sandy soils are unlikely to differ much in their A/Y from properly managed operations in clay soils. The Coalition will continue to work with its members during grower outreach meeting and the MPEP to better understand the effectiveness of management practices in different soil types.

Figure 4. Evaluation of A/Y differences among major Ksat soil type categories for the top six Specific Crop Types in the ESJWQC.

Each box represents the distribution of A/Y values within each soil category. The p-value tests the hypothesis that there are no differences in the mean A/Y among soil categories within each crop type.

Blue marks indicate the mean of each boxplot as tested in the model. Grey dotted lines show the 10, 50 and 90% quantiles for that crop through the whole Coalition region. Values above the 90% dotted line represent outliers.

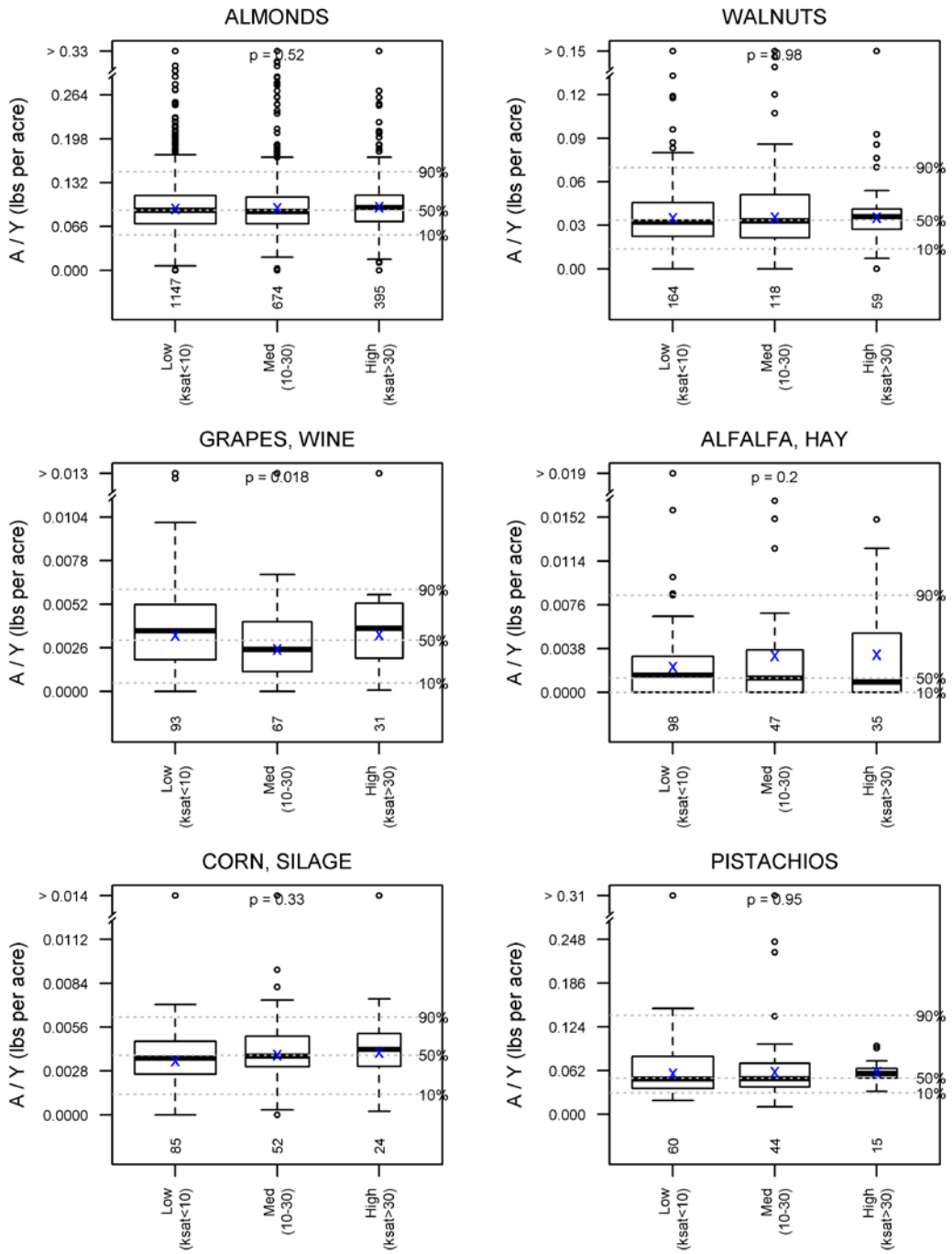


Figure 5. Evaluation of A/Y differences among major Ksat soil type categories for other major crops in the ESJWQC.

Each box represents the distribution of A/Y values within each soil category. The p-value tests the hypothesis that there are no differences in the mean A/Y among soil categories within each crop type.

Blue marks indicate the mean of each boxplot as tested in the model. Grey dotted lines show the 10, 50 and 90% quantiles for that crop through the whole Coalition region. Values above the 90% dotted line represent outliers.

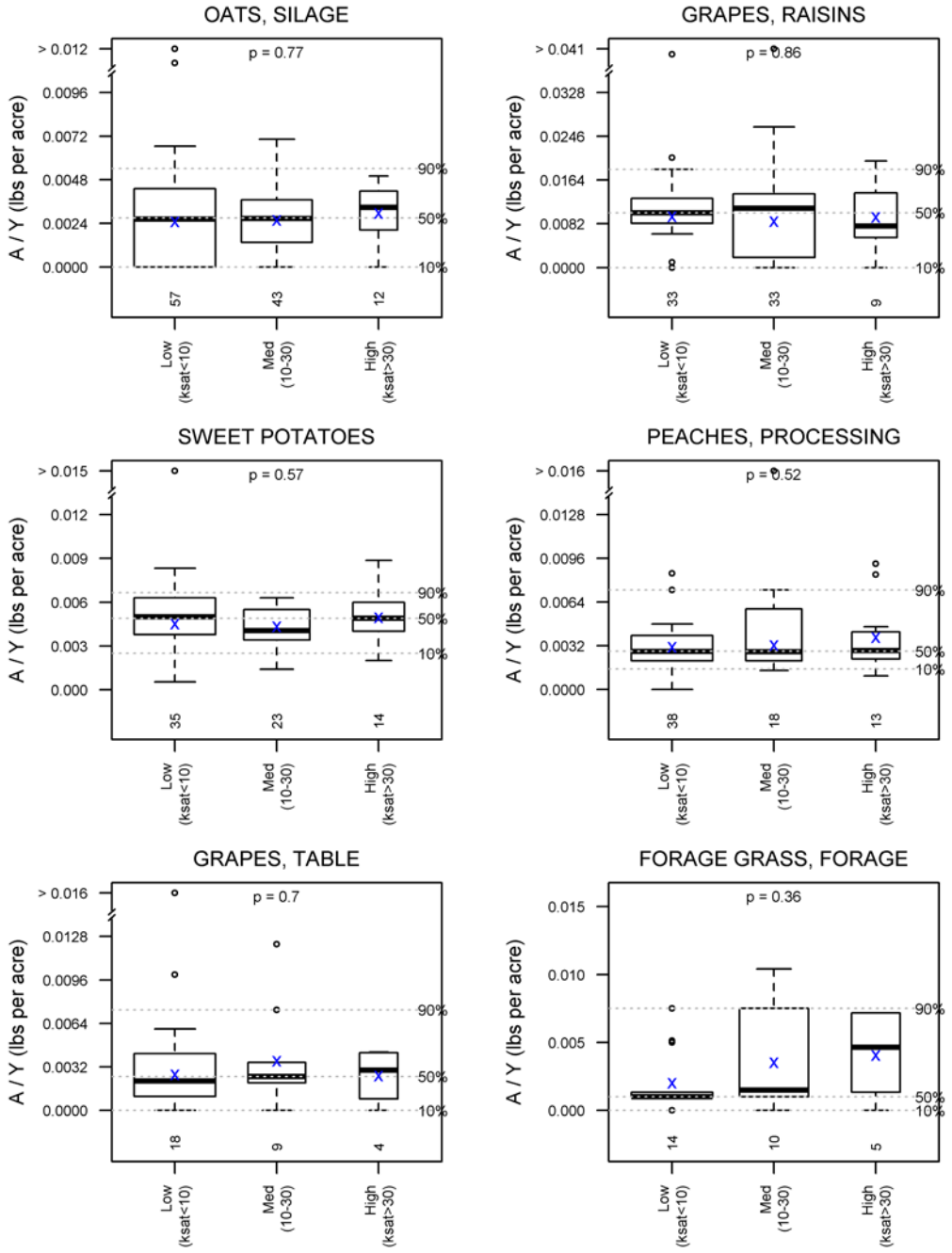


Table 10. Evaluation of the frequencies of A/Y outliers grouped by mean Ksat category for the 12 major crops in the Coalition region.

Outliers were identified grouping by specific crop for the whole Coalition region. Significant p-values are highlighted in bold.

Specific Crop Type	Soil type	Contingency table		Percent Outliers	p.value
		Non-outlier	Outlier		
ALMONDS	Low	1033	114	11%	0.42
	Med	612	62	10%	
	High	349	46	13%	
WALNUTS	Low	151	13	9%	0.27
	Med	102	16	16%	
	High	54	5	9%	
GRAPES, WINE	Low	81	12	15%	0.26
	Med	61	6	10%	
	High	30	1	3%	
ALFALFA, HAY	Low	92	6	7%	0.14
	Med	41	6	15%	
	High	29	6	21%	
CORN, SILAGE	Low	80	5	6%	0.21
	Med	44	8	18%	
	High	21	3	14%	
PISTACHIOS	Low	53	7	13%	0.44
	Med	39	5	13%	
	High	15	0	0%	
OATS, SILAGE	Low	49	8	16%	0.36
	Med	39	4	10%	
	High	12	0	0%	
GRAPES, RAISINS	Low	31	2	6%	0.45
	Med	30	3	10%	
	High	7	2	29%	
SWEET POTATOES	Low	28	7	25%	**0.03**
	Med	23	0	0%	
	High	13	1	8%	
PEACHES, PROCESSING	Low	37	1	3%	0.22
	Med	16	2	13%	
	High	11	2	18%	
GRAPES, TABLE	Low	16	2	13%	1.00
	Med	8	1	13%	
	High	4	0	0%	
FORAGE GRASS, FORAGE	Low	14	0	0%	0.14
	Med	8	2	25%	
	High	5	0	0%	

Evaluation of A/Y by Irrigation Practices

For some crops, recommended nitrogen application rates can be different for flood vs. pressurized operations. In some cases, recommended application rates can be higher for flood-irrigated operations to compensate for the different efficiency of the delivery method and the greater potential for loss. As not all Coalition members are able to switch to more expensive, pressurized irrigation practices, irrigation type could be a useful grouping to compare A/Y in the region.

The Coalition obtained a list of management practices implemented by members from the Farm Evaluation (FE) Surveys. Coalition members in high vulnerability areas are required to submit FEs annually, to provide information regarding irrigation practices, nitrogen management practices, active and abandoned wells, pesticide practices and sediment/erosion control practices. The Coalition determined which irrigation practices were implemented in each NMP MU by linking the two datasets based on the parcel number. When one parcel included multiple NMP MUs, the corresponding FE data were identified by the specific crop type. In total, 4,511 NMP MUs were satisfactorily associated with the respective parcel management practices from the FE surveys. These NMP MUs covered 373,566 acres (98% of the complete dataset).

The Coalition grouped irrigation practices into two broad categories: flood irrigation (which includes flood and furrow) and pressurized irrigation (which includes drip, sprinkler, and micro-sprinkler). As with the soil analysis, the Coalition evaluated the 12 most abundant specific crop types in the region (for a total of 3,595 NMP MUs). The Coalition tested whether A/Y and the frequency of outliers vary depending on the primary irrigation practices.

As with the soil types, the Coalition tested if there were differences in average A/Y among NMP MUs with different irrigation types. Differences in average A/Y among the different irrigation types were evaluated using a simple linear model after excluding very large A/Y outliers. The Coalition also evaluated if the frequency of outliers differed among MUs with different irrigation practices using Chi-square tests.

None of the 12 crops evaluated had significant differences in average A/Y in flood vs. pressurized irrigated fields (Figure 6 and Figure 7). Neither was there any difference in the proportion of outliers for the different irrigation types (Table 11). Hence, differentiating MUs by irrigation management is not useful when calculating or interpreting the summary statistics and identification of outliers.

Figure 6. Evaluation of A/Y differences among MUs with different irrigation practices for the top six major crops in the ESJWQC.

Each box represents the distribution of A/Y values within each irrigation category. The p-value tests the hypothesis that there are no differences in the mean A/Y among irrigation categories within each crop type. Blue marks indicate the mean of each boxplot as tested in the model. Grey dotted lines show the 10, 50 and 90% quantiles for that crop through the whole Coalition region. Values above the 90% dotted line represent outliers.

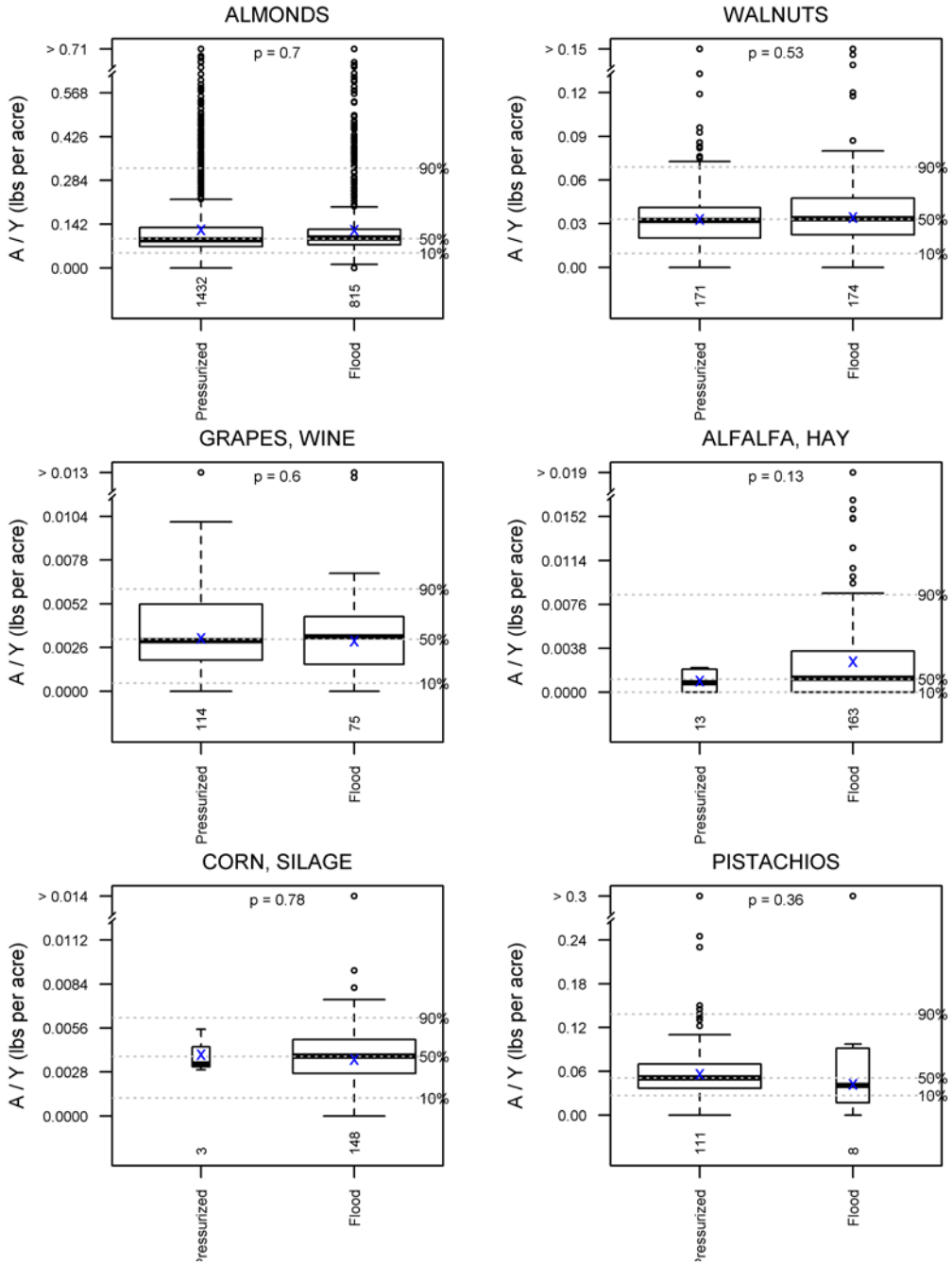


Figure 7. Evaluation of A/Y differences among MUs with different irrigation practices for the next six major crops in the ESJWQC.

Each box represents the distribution of A/Y values within each irrigation category. The p-value tests the hypothesis that there are no differences in the mean A/Y among irrigation categories within each crop type. Blue marks indicate the mean of each boxplot as tested in the model. Grey dotted lines show the 10, 50 and 90% quantiles for that crop through the whole Coalition region. Values above the 90% dotted line represent outliers.

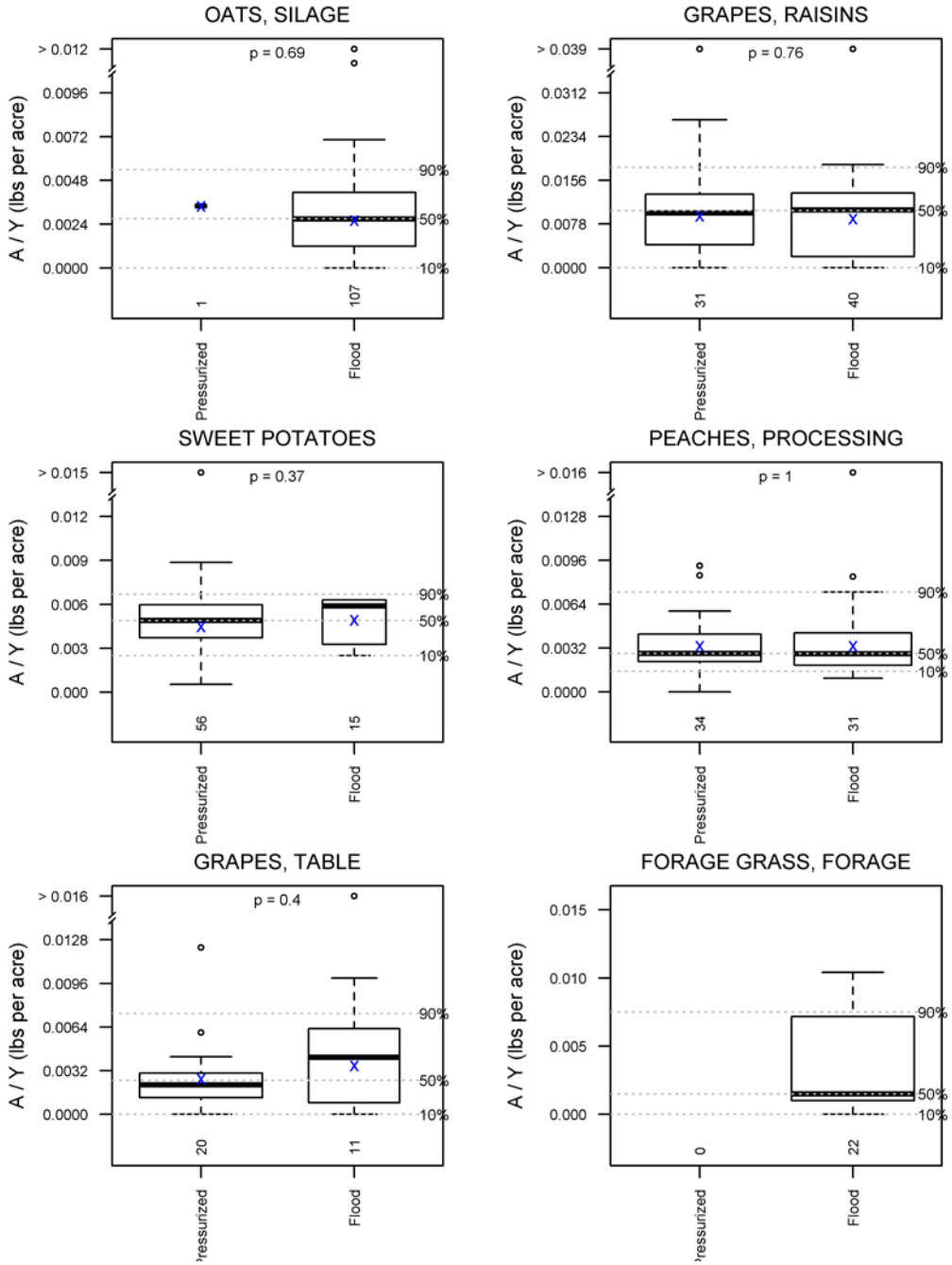


Table 11. Evaluation of the frequencies of A/Y outliers for the 12 major crops in the Coalition region by irrigation practices.
Outliers were identified by Specific Crop Type.

Specific Crop Type	Contingency table			Proportion of Outliers	p-value
	Irrigation	Non-outlier	Outlier		
ALMONDS	Pressurized	1281	151	12%	0.350
	Flood	740	75	10%	
WALNUTS	Pressurized	152	19	13%	0.47
	Flood	159	15	9%	
GRAPES, WINE	Pressurized	101	13	13%	0.46
	Flood	69	6	9%	
ALFALFA, HAY	Pressurized	13	0	0%	0.38
	Flood	147	16	11%	
CORN, SILAGE	Pressurized	3	0	0%	1.00
	Flood	134	14	10%	
PISTACHIOS	Pressurized	99	12	12%	1.00
	Flood	7	1	14%	
OATS, SILAGE	Pressurized	1	0	0%	1.00
	Flood	96	11	11%	
GRAPES, RAISINS	Pressurized	27	4	15%	0.71
	Flood	36	4	11%	
SWEET POTATOES	Pressurized	49	7	14%	0.33
	Flood	15	0	0%	
PEACHES, PROCESSING	Pressurized	32	2	6%	0.66
	Flood	28	3	11%	
GRAPES, TABLE	Pressurized	19	1	5%	0.54
	Flood	9	2	22%	
FORAGE GRASS, FORAGE	Pressurized	0	0	n.a.	n.a.
	Flood	20	2	10%	

n.a. -Not available, cannot be calculated

Nitrogen Management Practices

Implementation of some management practices can result in reduced nitrogen applications. To test if the implementation of N management practices reduces A/Y, the Coalition evaluated nitrogen management practices reported on the FEs. As a preliminary analysis, the Coalition evaluated the effect of N Management Practices on Almonds' A/Y, thus focusing on the single most common crop in the region.

Nitrogen management practices are not implemented in isolation. Growers normally implement more than one management practice at the same time. Hence, to evaluate their effect, it is necessary to use multivariate statistical techniques. The Coalition used a multiple generalized linear model to evaluate if the frequency of A/Y outliers in almonds changes as a function of each individual N management practice in the absence of all other practices (Table 12). The model used evaluates the effect of each of the management practices as if they were applied in isolation (i.e., one practice applied at a time). It is reasonable to expect that simultaneous implementation of more than one practice would also result in A/Y reductions. However, more elaborated linear models, outside the scope of this report, are required to evaluate those effects.

Table 12. Multiple linear model showing the effects of individual N management practices on A/Y in the absence of all other practices.

Bold numbers indicate significant effects. A negative effect indicates that the application of that management practice by itself decreases the probability of determining A/Y outliers. Evaluation of the simultaneous implementation of multiple management practices requires a more complex model not discussed here.

	EFFECT	STD. ERROR	T-VALUE	P-VALUE
Fertigation	0.195	0.116	1.682	0.09
Foliar N Application	0.024	0.134	0.176	0.86
Irrigation Water N Testing	**-0.250**	**0.116**	**-2.151**	**0.03**
Soil Testing	0.226	0.179	1.262	0.21
Split Fertilizer Applications	**-0.392**	**0.161**	**-2.432**	**0.02**
Tissue Petiole Testing	0.029	0.152	0.189	0.85
Variable Rate Applications using GPS	-0.331	0.282	-1.177	0.24

The analysis shows that the implementation of N management practices reduced the frequency of A/Y outliers. MUs implementing irrigation water N testing or split fertilizer applications had lower frequency of outliers than MUs not implementing either (Table 12). The Coalition believes that other N management practices also reduce A/Y. However, at this point it is not possible to detect those effects due to the quality of the data. A model to detect smaller changes in A/Y with management practices would need to evaluate changes in the average A/Y. However, this type of model cannot currently be run because the A/Y index is very non-normal. It is possible that, as the quality of the data improves over time, better models can be run that will allow the Coalition to identify in greater detail, the factors responsible for changes in A/Y.

Caveats

There are several caveats that compromise our interpretation of the results (and particularly the correct identification of outliers) including:

1. Although the Coalition has achieved 85% response from members in high vulnerability areas with large farming operations, a return rate of less than 100% of the NMP SRs results in potentially greater variability in the summary statistics relative to when more data are available. Additional data volunteered by small farming operations partially mitigates these effects; however, the possibility for data variability remains. It is not possible to determine how the statistics will change, but it will certainly affect the less common crops. The Coalition expects to continue receiving NMP SRs after the preparation of this report.
2. Even when all NMP SRs are returned, it is almost certain that many crops will still have only a few (ten or less) MUs in most T-Rs. The identification of outliers in these cases is compromised.
3. Some of the reported information is clearly in error. The Coalition made every effort to flag data with QC concerns. However, the turnaround time between the submission of the NMP SR by the growers and the preparation of this report was not sufficient to follow up and correct most of the identified data quality concerns. The Coalition excluded 235 MUs (5% of the total MUs with returned NMP SRs) from the analysis that had data quality concerns that could not be resolved with the grower. It is likely that some errors were not identified which now contribute

to the variability and uncertainty of the data. All summary statistics, box and whisker plots, and outliers, are likely to change as better data become available over time.

4. The Coalition has made a concerted effort to verify the N Removal Factors used in this report. However, Dr. Daniel Geisseler, the author of the document from which the N Removal Factors were obtained, points out that a large number of the factors are only rough estimates, and it is unknown the extent to which some values are a good representation of N removal in the Central Valley. In addition, there are uncertainties in the reporting of the yield by the growers that make it difficult to apply appropriate N Removal Factors.
5. The association of soils characteristics to specific NMP MUs reported by the members is very inexact. Members can include within a single NMP MU different parcels located some distance from each other, provided they are managed the same way. Furthermore, soil types can vary substantially even within a single field. Thus, soils can vary considerably within MUs, and is difficult to assign representative soils properties to those MUs.
6. Similarly, the association of irrigation and nitrogen management practices to specific NMP MUs is also inexact. The FE MUs are recorded by the growers potentially at a different scale than NMP MUs. Every effort was done to associate NMP MUs to FE MUs based on the parcel number and crop name. However, not all MUs were associated satisfactorily, and errors in the association may have happened due to inconsistencies in crop naming.

OUTREACH AND EDUCATION

In an effort to inform Coalition members on the potential effects of nitrogen management practices on groundwater quality, the Coalition undertook multiple outreach and education efforts in 2017. On February 1, 2017, the Coalition mailed Nitrogen Use Evaluations to each grower who returned 2015 crop year data. A total of 1,167 growers received evaluations, each of which summarized the data the grower reported in 2015 and provided summary statistics that placed each member's A/R performance in the context of all member's MUs across the Coalition. Each evaluation provided nitrogen removal estimates for crops with available R values, bell curves comparing each grower's MUs to others reporting on the same crop across the Coalition, and identification of outlier status for growers with A/Y values above the 90th percentile. An example of the Nitrogen Use Evaluation packet that these growers received can be found in Appendix II.

The Nitrogen Use Evaluations are meant to illustrate nitrogen use efficiency for each grower with the potential to leach nitrates into groundwater and to place each of these grower's practices within the context of other growers in the Coalition. Additionally, reporting the data back to each grower provides the opportunity for growers to address any data quality concerns that may not have been identified in the quality control and follow-up processes outlined above. Growers are encouraged to contact the Coalition with data change requests, questions, and concerns with their Nitrogen Use Evaluation, and as such, the packets will aid in more accurate and comprehensive data over time.

In addition to mailing Nitrogen Use Evaluations, the Coalition held six crop-specific meetings during February and March of 2017. These meetings focused on nutrient management practices for three major tree crops (almonds, pistachios, and walnuts), and for three major row crops (corn, grapes, and

tomatoes). The meetings covered nutrient management planning, explanations of how to interpret and utilize the information provided in the Nitrogen Use Evaluations, as well as provided additional resources for efficient and ground water protective nutrient practices, including crop-specific materials distributed to each attendee.

Additionally, any grower with a MU identified as an outlier will be receiving individual surveys to be returned to the Coalition. The survey requests further information regarding how growers made nitrogen application decisions and details about their crop yield for 2015. These surveys will aid the Coalition in identifying which growers' practices may be of concern for groundwater quality, and which may have had high A/Y values due to data reporting errors or anomalous yields out of their control. The information collected in these surveys will also aid the Coalition in making future individualized recommendations to promote nitrogen use efficiency, should any growers show consistently high A/Y values over time.

This is the first year the Coalition has attempted these outreach measures. As most of these measures were implemented in early 2017, the data analyzed in this report are not yet expected to reflect these outreach efforts. The Coalition will continue to monitor NMP data trends, and adjust outreach and education efforts to better increase nitrogen efficiency and ultimately reduce A/Y ratios over time.

RECOMMENDATIONS FOR DATA ANALYSIS

Because nitrogen use and yields clearly differ among crops, calculating summary statistics and identifying outliers by crop type is most reasonable.

The analysis of A/Y by T-R (Appendix I) indicates how, in most T-Rs, there are insufficient data to generate reliable summary statistics by crop. For instance, in almonds, the most common crop in the region, nearly one third of the T-Rs had only one or two NMP MUs. It is meaningless to estimate summary statistics or calculate outliers with a single data point. Also, T-Rs with only a few data points end up with an unrealistically high frequency of outliers, as the highest value will almost always be flagged as an outlier. For instance, outliers represent 50% of MUs in T-Rs with only two data points, and 33% of the MUs in T-Rs with only three data points. Furthermore, because of the way 90% quantiles are estimated, all T-Rs had outliers even when all data points had low A/Y values relative to neighboring T-Rs. In fact, in the analysis of the 2015 NMP SRs, some NMP MUs that were associated with multiple T-Rs were found to be outliers in one T-R but not in the other. In the 2016 NMP SR analysis, the Coalition assigned each MU to a single T-R to avoid this issue.

The Coalition considers that conducting the analysis grouping by T-R, as required by the Order, results in unreliable summary statistics. Furthermore, because of the small sample size in most T-Rs it is an unreliable method for identifying quantiles that results in a very large number of different outlier thresholds (90th quantiles) through the coalition. Outreach and education to the growers would be very challenging if the thresholds indicating what constitutes and outlier are very different in different parts of the coalition.

The Order additionally requires the Coalition to report statistical summaries for parcels grouped by similar soil conditions. Using soil types as subgroupings within T-R exacerbates the problem with small sample size to a level where statistical analyses are meaningless. Furthermore, the analysis of A/Y

grouped by soil type and irrigation management practices found that these groupings had no clear effect on the A/Y or in the frequency of outliers. A/Y ranges overlapped considerably, and the differences among soil categories were quite small. This is true of the 2015 and the 2016 NMP SR data Therefore, subdividing A/Y data by soil type provides no additional insight. Furthermore, similar to the grouping by T-R, having different thresholds to identify outliers throughout the region is likely to confuse the outreach and education efforts.

The general goal of this NMP SR analysis is to understand nitrogen use in the region, and identify Coalition members that can be targeted for focused outreach. With this goal in mind, there is little benefit in using groupings other than crop type to identify outliers for the reasons explained before: 1) the differences in A/Y between soil types or irrigation practices are not large enough to justify separate analysis; 2) grouping crops by T-R, soil type, or management practices will reduce the sample size, and therefore the accuracy of summary statistics, especially for less common crops; and 3) grouping crops by T-R, soil type, or management practices will produce multiple conflicting thresholds throughout the Coalition region.

The Coalition recommends grouping only by crop type for calculating summary statistics and identifying outliers. If, over the long term, the quality of the NMP data improves, the Coalition could revisit the idea of calculating outliers based on soil types or irrigation practices. In the meantime, the most informative grouping, and the one that would be more useful for outreach and education is a simple grouping by specific crop type. This grouping can be refined by separating those outliers that are due to high nitrogen application rates from those that are due to low yields. The scatter plots of A vs. Y in Appendix Iare a valuable tool to this purpose.

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APPENDIX I

SUMMARY STATISTICS BY CROP AND TOWNSHIP-RANGE

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INTRODUCTION

This appendix shows the results of summary statistics calculations for all crops in the region. Sections I through XXII contain results for the most common crop types in the region. Section XXIII lists summary statistics for all other crops. Sections I through XXII each group similar crops or harvest types. For example, field crops are grouped by forage, hay, silage, or grains; each containing different crop types (e.g., wheat, oats, and sorghum). Tree crop sections group trees of different age. Each section (I through XXII) contains Box and Whisker (BW) plots and summary statistics. BW plots were not generated for the crops in Section XXIII, because there were not sufficient Management Units per TR to produce an informative figure.

In each section, the Coalition generated two sets of BW plots and summary statistics: 1) plots and statistics by TR (as requested by the order) and 2) plots and statistics by crop for the whole region (to provide a more robust estimate of outliers). To calculate summary statistics by TRs, the Coalition grouped all similar crops within the section in an attempt to increase sample size. To calculate summary statistics for the whole region, the Coalition used the appropriate specific crop type. Outliers in BW plots are identified as red circles. Tables of summary statistics are also submitted with this report electronically as an Excel file.

Because this appendix reports summary statistics based on yield, only Management Units with complete data are included. The detailed explanation of data exclusions due to completeness and quality is found in the section "Data Quality Control". Non-bearing and not harvested crops are not included in the analysis because they do not have an A/Y value. Also, ambiguous crop types (see section "Crop Classification") are excluded from this analysis, as crop information is insufficient to compare these to other operations with similar management practices and yields.

Summary statistics for A/R and A-R are also provided when an N Removal Factor is available. It is important to note that outliers for A/R are the same as outliers for A/Y as the two values differ only by a conversion factor. On the other hand, A-R has a different distribution and outliers are not comparable.

All N Removal Factors were obtained from the Geisseler's 2016 report[3] (with the single exception of berries). To obtain nitrogen concentrations for the different crops, Geisseler performed an extensive literature review. Data from the different studies identified in the report were summarized as an average N removal per crop. In addition, Geisseler provides an assessment of the quality, completeness, and relevance of the data for each crop. The Coalition believes the literature review is, in fact, exhaustive. Hence, here the Coalition uses the N Removal Factors as calculated by Geisseler, with the forewarning that, by Geisseler's own assessment, many of those values are only poor or unreliable estimates for the Central Valley. The specific N Removal Factors used for the analysis of each crop, together with their quality assessments, are provided in Table 4 in the report and under the heading of

[3] Geisseler, Daniel. 2016. Nitrogen concentrations in harvested plant parts – A literature overview. Prepared for the Central Valley ILRP Water Quality Coalitions.

"Important Analysis Considerations" at the beginning of each section in this Appendix. The Coalition plans on updating and improving these values over time as more data become available.

Occasionally, the crop type classifications used by ESJWQC and the specific crops reported by growers were slightly different from those evaluated by Geisseler. In some of those cases, the Coalition used N Removal Factors from other similar crops reported by Geisseler. For example, Geisseler only reports N Removal Factors for lemons, oranges, tangerines, and grapefruits, while ESJWQC growers also reported on tangelos and mandarins. Because N Removal Factors for all citrus crops Geisseler are quite similar and have substantially overlapping ranges, the Coalition calculated an average N Removal Factor for citrus crops and used it for the additional citrus crops. Those averages were only used when evaluation of Geisseler's data suggested that similar crops also had similar N Removal Factors. The exact values used and the assumptions made by the Coalition are explained under the "Important Analysis Considerations" subheading in each section. The complete list of N Removal Factors is found in Table 4 in the report.

The Regional Board requested that the Coalition evaluate and provide an analysis of nitrogen applied relative to recommended fertilizer application rates. To this effect, each section also contains a scatter plot of A vs. Y. Scatter plots show lines with some typical N application rates found in the literature. However, optimal N application rates can vary considerably due to factors such as crop stage, soil type, and irrigation system. Because the goal of this analysis is not to provide a comprehensive review of recommended application rates or to draw any conclusion regarding their accuracy or applicability to specific fields, all values are plotted for reference. An associated table in each section provides more detail regarding the range of values, sources, specific conditions, and other information regarding the N application rates shown in the figure.

In addition to recommended fertilization rates, these plots show when outlier A/Y values result from N applications that are very high or from yield that was very low. Hence, these kinds of plots can be used to prioritize outreach to growers that have outliers due to high nitrogen applications, as opposed to growers that are outliers due to lost yield.

I. ALMONDS

Important Analysis Considerations:

The calculation of N removed at harvest for ALMONDS assumes that 0.068 lbs of N are removed per lb of marketable kernels. This estimate is obtained from Geisseler (2016). **Geisseler considers that the value is a good estimate for N removed from almond orchards in the Central Valley.**

In previous years, growers have reported either kernel weights or the weight of kernels + hulls + shells (KHS). This year the Coalition identified 68 MUs that had yields consistent with growers reporting KHS. For this report, the Coalition tentatively converted these 68 yields to kernel yield using the approximation that kernels represent 23% of the KHS weight. Given the short turnaround time between the submission of the NMP SR and the preparation of the report, the Coalition was not able to follow up with all growers to ensure that this assumption was correct and the high yield was not due to other reporting errors. This means that some A/Y values in this analysis may be in error. Fortunately, the sample size for almonds is very large, and the 68 MUs probably have little impact on thesummary statistics for almonds across the whole region.

Figure I-1. Box and Whisker plots of A/Y and A/R for Almonds Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

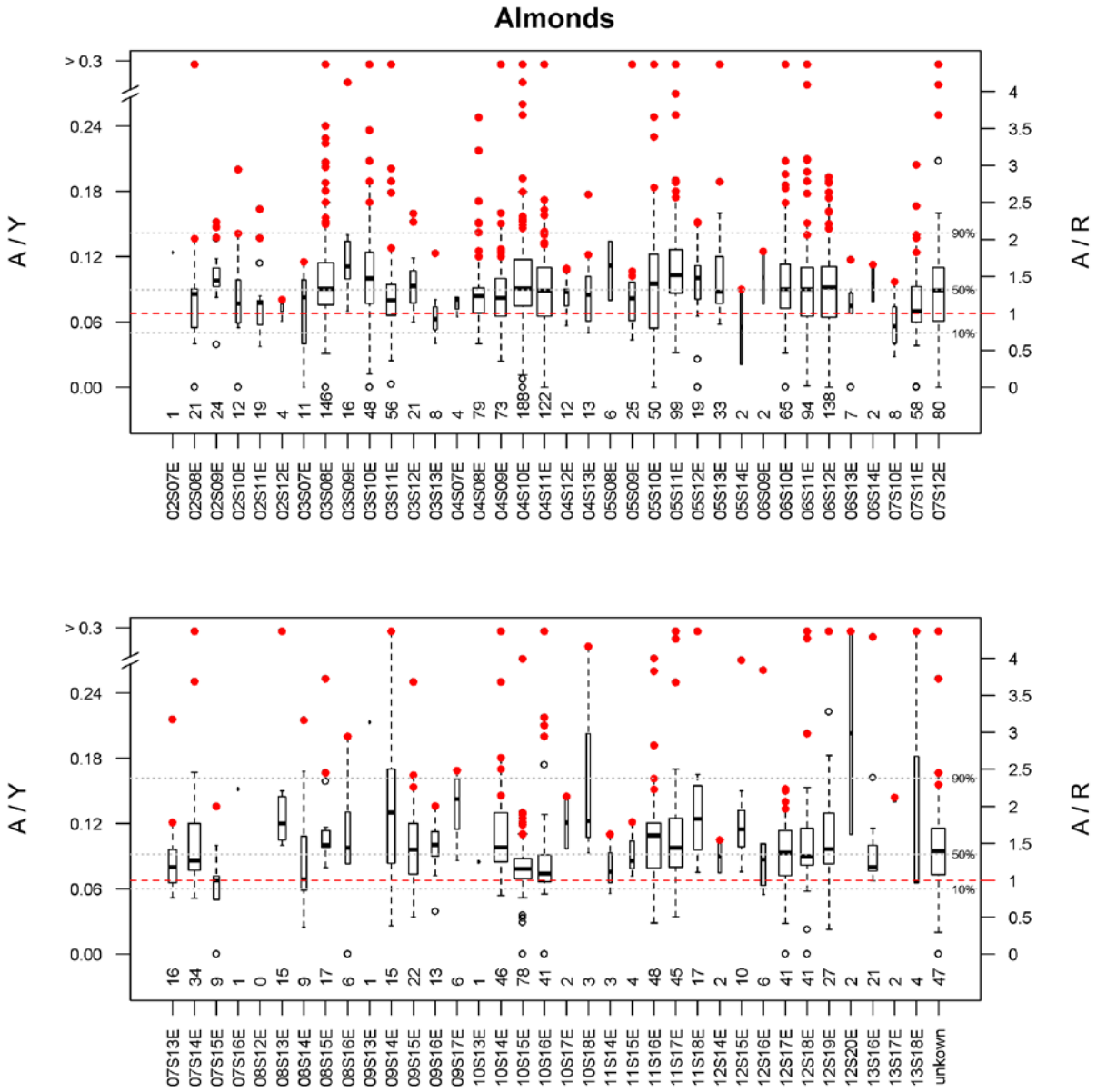


Table I-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Almonds Management Units grouped by TR blocks.

TR blocks with only one Management UnitManagement Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management UnitManagement Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Almonds A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S07E	1	14	0	0.1243	--	--	--	--	--	--
02S08E	21	813	0	1.2174	0.0400	0.0550	0.0860	0.0908	0.1206	2
02S09E	24	1543	0	0.1520	0.0877	0.0936	0.0985	0.1088	0.1374	3
02S10E	12	429	0	0.2000	0.0554	0.0597	0.0771	0.0977	0.1373	2
02S11E	19	1447	0	0.1637	0.0375	0.0575	0.0775	0.0799	0.1187	2
02S12E	4	380	0	0.0805	0.0661	0.0738	0.0781	0.0787	0.0798	1
03S07E	13	861	0	0.1153	0.0000	0.0400	0.0828	0.0987	0.1100	1
03S08E	147	5332	0	0.9096	0.0615	0.0758	0.0905	0.1137	0.1486	14
03S09E	16	436	0	0.2800	0.0875	0.0998	0.1110	0.1310	0.1400	1
03S10E	48	1883	0	0.5368	0.0620	0.0775	0.1000	0.1233	0.1693	5
03S11E	56	4117	0	0.8780	0.0540	0.0665	0.0800	0.0938	0.1194	6
03S12E	21	1429	0	0.1599	0.0670	0.0776	0.0930	0.1071	0.1190	2
03S13E	8	606	0	0.1230	0.0464	0.0555	0.0628	0.0710	0.0934	1
04S07E	4	375	0	0.0828	0.0691	0.0753	0.0807	0.0828	0.0828	0
04S08E	86	4795	0	0.2480	0.0589	0.0684	0.0840	0.0915	0.1132	8
04S09E	79	3737	0	0.6504	0.0509	0.0654	0.0823	0.1000	0.1195	8
04S10E	188	5723	0	0.9000	0.0558	0.0750	0.0912	0.1172	0.1453	19
04S11E	122	6716	0	0.4348	0.0511	0.0656	0.0888	0.1100	0.1311	13
04S12E	12	3400	0	0.1092	0.0700	0.0775	0.0875	0.0899	0.1065	2
04S13E	13	1779	0	0.1771	0.0566	0.0612	0.0850	0.1020	0.1208	2
05S08E	6	186	0	0.1340	0.0800	0.0825	0.1120	0.1340	0.1340	0
05S09E	27	1752	0	0.4198	0.0490	0.0615	0.0818	0.0965	0.1014	3
05S10E	50	1851	0	0.9027	0.0180	0.0552	0.0954	0.1223	0.1827	5
05S11E	101	6865	0	0.4770	0.0593	0.0868	0.1033	0.1265	0.1740	10
05S12E	19	3891	0	0.1520	0.0573	0.0810	0.1008	0.1118	0.1315	2
05S13E	33	5709	0	0.9900	0.0588	0.0773	0.0880	0.1200	0.1600	3
05S14E	2	272	0	0.0900	0.0279	0.0382	0.0555	0.0727	0.0831	1
06S09E	2	71	0	0.1250	0.0815	0.0888	0.1008	0.1129	0.1202	1
06S10E	65	1757	0	0.4585	0.0629	0.0727	0.0900	0.1130	0.1681	7
06S11E	94	3911	0	0.7800	0.0450	0.0657	0.0900	0.1094	0.1393	10
06S12E	138	5505	0	0.1930	0.0472	0.0643	0.0919	0.1108	0.1400	10
06S13E	7	355	0	0.1171	0.0407	0.0679	0.0750	0.0866	0.1008	1
06S14E	2	1800	0	0.1129	0.0824	0.0875	0.0960	0.1044	0.1095	1
07S10E	8	453	0	0.0970	0.0282	0.0468	0.0563	0.0680	0.0893	1
07S11E	58	2807	0	0.2044	0.0419	0.0600	0.0700	0.0919	0.1205	6
07S12E	80	7577	0	1.4444	0.0385	0.0617	0.0891	0.1100	0.2122	8
07S13E	16	1024	0	0.2160	0.0573	0.0686	0.0800	0.0940	0.1195	2
07S14E	34	2489	0	0.5844	0.0682	0.0779	0.0862	0.1164	0.2256	4
07S15E	9	2416	0	0.1360	0.0000	0.0500	0.0682	0.0720	0.1072	1
07S16E	1	158	0	0.1521	--	--	--	--	--	--
08S13E	15	2508	0	0.6811	0.1000	0.1050	0.1200	0.1450	0.3600	2
08S14E	9	824	0	0.2150	0.0484	0.0590	0.0690	0.1085	0.1775	1
08S15E	17	1440	0	0.2530	0.0848	0.0982	0.1000	0.1135	0.1620	2
08S16E	6	410	0	0.2000	0.0417	0.0833	0.0980	0.1260	0.1652	1
09S13E	1	96	0	0.2130	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
09S14E	16	2447	0	0.6693	0.0616	0.0837	0.1300	0.1701	0.1701	1
09S15E	22	3380	0	0.2500	0.0662	0.0756	0.0961	0.1159	0.1532	3
09S16E	13	3587	0	0.1363	0.0750	0.0900	0.1004	0.1127	0.1341	2
09S17E	6	930	0	0.1690	0.1007	0.1207	0.1426	0.1577	0.1651	1
10S13E	1	187	0	0.0850	--	--	--	--	--	--
10S14E	46	5485	0	0.3400	0.0800	0.0856	0.0983	0.1300	0.1430	5
10S15E	81	6490	0	0.2714	0.0561	0.0698	0.0782	0.0879	0.1086	8
10S16E	43	3946	0	0.8269	0.0600	0.0667	0.0739	0.0914	0.1739	4
10S17E	2	241	0	0.1449	0.1020	0.1091	0.1211	0.1330	0.1402	1
10S18E	3	50	0	0.2830	0.0989	0.1076	0.1222	0.2026	0.2508	1
11S14E	3	6495	0	0.1100	0.0600	0.0660	0.0760	0.0930	0.1032	1
11S15E	4	2607	0	0.1216	0.0760	0.0821	0.0858	0.0950	0.1110	1
11S16E	48	4939	0	0.2719	0.0640	0.0796	0.1093	0.1204	0.1492	5
11S17E	45	3461	0	0.9296	0.0644	0.0800	0.0980	0.1250	0.2178	5
11S18E	18	2336	0	0.3885	0.0757	0.0960	0.1245	0.1548	0.2414	2
12S14E	2	339	0	0.1050	0.0780	0.0825	0.0900	0.0975	0.1020	1
12S15E	10	2790	0	0.2700	0.0796	0.0992	0.1150	0.1300	0.1620	1
12S16E	6	1390	0	0.2609	0.0591	0.0660	0.0872	0.1011	0.1811	1
12S17E	41	4606	0	0.1520	0.0400	0.0725	0.0930	0.1136	0.1312	4
12S18E	41	3338	0	0.3333	0.0736	0.0819	0.0900	0.1156	0.1530	4
12S19E	27	2338	0	1.4239	0.0373	0.0832	0.0965	0.1298	0.2540	3
12S20E	2	1451	0	0.8667	0.1856	0.2991	0.4883	0.6775	0.7910	1
13S16E	21	2517	0	0.2916	0.0710	0.0767	0.0803	0.1000	0.1625	2
13S17E	2	95	0	0.1440	0.1404	0.1410	0.1420	0.1430	0.1436	1
13S18E	4	296	0	1.3833	0.0656	0.0659	0.0665	0.3961	0.9884	1
unknown	47	2517	0	0.3600	0.0539	0.0731	0.0950	0.1159	0.1560	5

B. Summary statistics for Almonds A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S07E	1	14.00	1.83	1.83	--	--	--	--	--	--
02S08E	21	812.88	0.00	17.90	0.59	0.81	1.26	1.33	2	2
02S09E	24	1543.47	0.58	2.24	1.29	1.38	1.45	1.60	2	3
02S10E	12	429.31	0.00	2.94	0.81	0.88	1.13	1.44	2	2
02S11E	19	1446.53	0.55	2.41	0.55	0.85	1.14	1.17	2	2
02S12E	4	380.00	0.90	1.18	0.97	1.09	1.15	1.16	1	1
03S07E	13	860.67	0.00	1.70	0.00	0.59	1.22	1.45	2	1
03S08E	147	5331.83	0.00	13.38	0.86	1.11	1.32	1.63	2	15
03S09E	16	436.00	1.03	4.12	1.29	1.47	1.63	1.93	2	1
03S10E	48	1883.04	0.00	7.89	0.82	1.12	1.47	1.81	2	5
03S11E	56	4117.08	0.04	12.91	0.70	0.90	1.18	1.33	2	6
03S12E	21	1428.93	0.35	2.35	0.37	0.99	1.19	1.58	2	2
03S13E	8	606.40	0.60	1.81	0.68	0.82	0.92	1.04	1	1
04S07E	4	374.56	0.96	1.22	1.02	1.11	1.19	1.22	1	0
04S08E	86	4795.12	0.59	3.65	0.87	1.01	1.24	1.35	2	8
04S09E	79	3737.25	0.32	9.56	0.61	0.91	1.18	1.47	2	8
04S10E	188	5723.40	0.00	13.24	0.78	1.10	1.34	1.72	2	18
04S11E	122	6716.39	0.00	2.54	0.68	0.94	1.29	1.60	2	13
04S12E	12	3400.10	0.83	1.61	1.03	1.14	1.29	1.32	2	2
04S13E	13	1779.04	0.74	2.60	0.83	0.90	1.25	1.50	2	2

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
05S08E	6	186.00	1.18	1.97	1.18	1.21	1.65	1.97	2	0
05S09E	27	1752.50	0.33	6.17	0.67	0.87	1.18	1.42	1	3
05S10E	50	1850.83	0.00	13.27	0.26	0.66	1.23	1.67	2	5
05S11E	101	6865.16	0.37	7.01	0.72	1.18	1.49	1.81	2	10
05S12E	19	3890.67	0.00	2.23	0.84	1.19	1.48	1.64	2	2
05S13E	33	5708.77	0.38	14.56	0.85	1.00	1.29	1.77	2	3
05S14E	2	272.00	0.31	1.32	0.41	0.56	0.82	1.07	1	1
06S09E	2	71.00	1.13	1.84	1.20	1.31	1.48	1.66	2	1
06S10E	65	1756.63	0.00	6.74	0.63	0.96	1.31	1.57	2	7
06S11E	94	3910.88	0.02	11.47	0.62	0.89	1.32	1.58	2	9
06S12E	138	5504.76	0.00	2.84	0.30	0.88	1.27	1.60	2	14
06S13E	7	354.70	0.00	1.72	0.60	1.00	1.10	1.27	1	1
06S14E	2	1799.98	1.16	1.66	1.21	1.29	1.41	1.54	2	1
07S10E	8	453.00	0.41	1.43	0.41	0.69	0.83	1.00	1	1
07S11E	58	2807.43	0.00	3.01	0.62	0.88	1.03	1.35	2	6
07S12E	80	7577.00	0.00	21.24	0.51	0.85	1.24	1.62	3	8
07S13E	16	1024.40	0.19	3.18	0.81	1.01	1.18	1.38	2	2
07S14E	34	2489.06	0.21	8.59	0.28	1.06	1.24	1.71	3	4
07S15E	9	2416.50	0.00	2.00	0.00	0.74	1.00	1.06	2	1
07S16E	1	158.00	2.24	2.24	--	--	--	--	--	--
08S13E	15	2507.72	1.47	10.02	1.47	1.54	1.76	2.13	5	2
08S14E	9	823.69	0.31	3.16	0.36	0.80	1.00	1.60	3	1
08S15E	17	1440.50	0.86	2.45	1.20	1.26	1.47	1.63	2	2
08S16E	6	409.50	0.00	2.94	0.61	1.23	1.44	1.85	2	1
09S13E	1	96.00	0.72	0.72	--	--	--	--	--	--
09S14E	16	2447.20	0.39	9.84	0.91	1.23	1.91	2.50	3	1
09S15E	22	3379.82	0.50	3.68	0.97	1.11	1.41	1.70	2	3
09S16E	13	3586.72	0.58	2.00	1.10	1.32	1.48	1.66	2	2
09S17E	6	929.50	1.27	2.48	1.48	1.77	2.10	2.32	2	1
10S13E	1	187.30	1.25	1.25	--	--	--	--	--	--
10S14E	46	5485.19	0.80	5.00	1.18	1.26	1.45	1.91	2	5
10S15E	81	6490.19	0.00	3.99	0.80	1.03	1.15	1.29	2	8
10S16E	43	3946.07	0.00	12.16	0.86	0.96	1.05	1.22	2	4
10S17E	2	241.30	0.49	1.43	0.58	0.72	0.96	1.19	1	1
10S18E	3	50.00	1.37	4.16	1.45	1.58	1.80	2.98	4	1
11S14E	3	6495.00	0.82	1.62	0.88	0.97	1.12	1.37	2	1
11S15E	4	2607.00	1.06	1.79	1.12	1.21	1.26	1.40	2	1
11S16E	48	4939.44	0.43	4.00	0.92	1.16	1.54	1.73	2	5
11S17E	45	3460.51	0.28	13.67	0.53	0.97	1.41	1.84	3	5
11S18E	18	2335.68	1.11	5.71	1.11	1.41	1.83	2.28	4	2
12S14E	2	339.40	1.10	1.54	1.15	1.21	1.32	1.43	1	1
12S15E	10	2790.50	1.12	3.97	1.17	1.46	1.69	1.91	2	1
12S16E	6	1390.18	0.81	1.49	0.85	0.89	1.01	1.38	1	1
12S17E	41	4605.90	0.00	2.24	0.59	1.07	1.37	1.67	2	4
12S18E	41	3338.01	0.00	4.90	1.01	1.16	1.32	1.69	2	4
12S19E	27	2337.63	0.34	20.94	0.55	1.22	1.42	1.91	4	3
12S20E	2	1451.20	1.62	12.75	2.73	4.40	7.18	9.96	12	1
13S16E	21	2516.80	0.99	2.39	0.99	1.11	1.17	1.42	2	2
13S17E	2	94.87	2.06	2.12	2.07	2.07	2.09	2.10	2	1
13S18E	4	296.50	0.96	20.34	0.96	0.97	0.98	5.82	15	1
unknown	47	2517.17	0.00	5.29	0.79	1.06	1.40	1.62	2	5

C. Summary statistics for Almonds A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S07E	1	14	97	97	--	--	--	--	--	--
02S08E	21	813	-291	264	-84	-24	34	60	95	2
02S09E	24	1543	-22	156	23	48	53	63	95	3
02S10E	12	429	-80	117	-40	-27	24	69	71	2
02S11E	19	1447	-73	144	-73	-40	19	34	86	2
02S12E	4	380	-22	35	-9	9	20	24	30	1
03S07E	13	861	-98	84	-98	7	24	63	78	1
03S08E	147	5332	-90	158	-11	20	43	71	104	15
03S09E	16	436	1	106	45	55	70	91	100	1
03S10E	48	1883	-444	178	-6	24	52	68	85	5
03S11E	56	4117	-347	166	-47	-11	26	42	82	6
03S12E	21	1429	-339	151	-318	-4	29	55	84	2
03S13E	8	606	-50	90	-38	-26	-8	6	45	1
04S07E	4	375	-6	24	3	16	23	24	24	0
04S08E	86	4795	-85	208	-21	1	30	53	101	8
04S09E	79	3737	-320	161	-62	-7	22	53	77	8
04S10E	188	5723	-519	178	-27	13	42	60	100	19
04S11E	122	6716	-299	187	-62	-8	35	72	95	12
04S12E	12	3400	-36	73	3	12	32	50	70	2
04S13E	13	1779	-54	129	-32	-17	34	81	92	2
05S08E	6	186	19	99	19	21	62	99	99	0
05S09E	27	1752	-206	106	-58	-21	30	48	65	3
05S10E	50	1851	-292	183	-86	-27	44	86	102	5
05S11E	101	6865	-266	249	-24	17	52	85	134	9
05S12E	19	3891	-136	133	-15	28	58	76	109	2
05S13E	33	5709	-509	161	-31	0	33	78	92	4
05S14E	2	272	-56	23	-48	-36	-16	3	15	1
06S09E	2	71	26	57	29	34	41	49	54	1
06S10E	65	1757	-421	148	-77	-5	28	74	99	7
06S11E	94	3911	-320	274	-47	-14	37	67	106	9
06S12E	138	5505	-485	235	-84	-9	27	72	100	10
06S13E	7	355	0	71	0	4	17	46	63	1
06S14E	2	1800	28	67	32	38	48	58	63	1
07S10E	8	453	-85	50	-85	-50	-32	-4	41	1
07S11E	58	2807	-155	118	-40	-13	6	38	82	6
07S12E	80	7577	-456	202	-59	-16	28	64	115	8
07S13E	16	1024	-309	101	-25	-2	28	50	87	2
07S14E	34	2489	-477	405	-375	9	44	68	171	4
07S15E	9	2416	-36	151	-16	-1	7	17	75	1
07S16E	1	158	61	61	--	--	--	--	--	--
08S12E	1	44	95	95	--	--	--	--	--	--
08S13E	15	2508	95	260	102	113	132	186	234	2
08S14E	9	824	-423	101	-144	-33	0	29	66	1
08S15E	17	1440	-42	144	35	46	46	74	105	2
08S16E	6	410	-34	109	6	46	56	70	90	1
09S13E	1	96	-122	-122	--	--	--	--	--	--
09S14E	16	2447	-79	226	-17	28	101	151	169	2
09S15E	22	3380	-79	164	-7	21	54	90	118	3
09S16E	13	3587	-73	152	22	43	80	106	128	2

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
09S17E	6	930	42	244	68	96	108	139	195	1
10S13E	1	187	59	59	--	--	--	--	--	--
10S14E	46	5485	-26	205	27	39	73	115	156	5
10S15E	81	6490	-234	142	-32	6	22	41	86	8
10S16E	43	3946	-120	197	-28	-6	9	38	66	4
10S17E	2	241	-208	73	-180	-138	-68	3	45	1
10S18E	3	50	41	425	52	69	98	262	360	1
11S14E	3	6495	-27	62	-18	-6	15	39	53	1
11S15E	4	2607	15	108	23	35	46	65	91	1
11S16E	48	4939	-186	184	-15	19	57	108	143	5
11S17E	45	3461	-300	349	-61	-6	51	96	189	5
11S18E	18	2336	18	227	24	68	98	141	213	2
12S14E	2	339	14	37	16	19	25	31	35	1
12S15E	10	2790	16	209	39	60	100	118	159	1
12S16E	6	1390	-47	71	-43	-32	1	42	61	1
12S17E	41	4606	-104	160	-4	13	50	72	116	4
12S18E	41	3338	-294	186	3	29	51	88	151	4
12S19E	27	2338	-95	274	-54	40	61	99	197	3
12S20E	2	1451	60	61	60	60	61	61	61	1
13S16E	21	2517	-4	113	-1	15	28	45	89	2
13S17E	2	95	80	137	85	94	108	123	131	1
13S18E	4	296	-7	182	-7	-6	-4	44	127	1
unknown	47	2517	-73	146	-31	8	50	80	110	5

Figure I-2. Box and Whisker plots of A/Y for Almonds Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

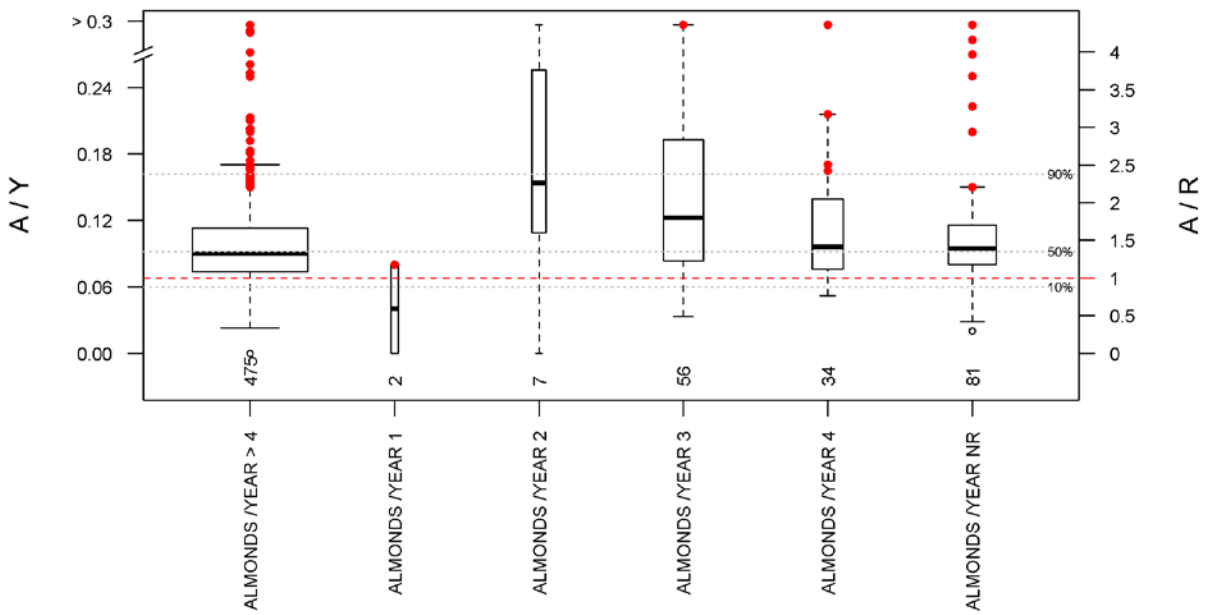


Table I-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Almonds Management Units grouped by specific crop.

A. Summary statistics for Almonds A/Y.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
ALMONDS /YEAR > 4	1747	127208.8	0.0000	1.4444	0.0529	0.0700	0.0891	0.1095	0.1400	173
ALMONDS /YEAR 1	8	271.6	0.0000	0.1690	0.0360	0.0700	0.0824	0.0894	0.1216	1
ALMONDS /YEAR 2	27	1621.0	0.0000	0.9000	0.0670	0.0750	0.1148	0.3550	0.6772	3
ALMONDS /YEAR 3	125	9663.0	0.0000	1.3833	0.0600	0.0780	0.1125	0.1625	0.2900	11
ALMONDS /YEAR 4	104	8037.2	0.0209	0.9900	0.0700	0.0895	0.1060	0.1570	0.2469	11
ALMONDS /YEAR NR	238	23443.7	0.0000	0.3571	0.0421	0.0682	0.0860	0.1100	0.1300	24

B. Summary statistics for Almonds A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
ALMONDS /YEAR > 4	1747	127208.8	0.00	21.24	0.64	0.99	1.28	1.58	2.01	173
ALMONDS /YEAR 1	8	271.6	0.00	2.49	0.53	1.03	1.21	1.31	1.79	1
ALMONDS /YEAR 2	27	1621.0	0.00	13.24	0.99	1.10	1.69	5.22	9.96	3
ALMONDS /YEAR 3	125	9663.0	0.00	20.34	0.86	1.10	1.62	2.29	4.26	11

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
ALMONDS /YEAR 4	104	8037.2	0.14	14.56	1.01	1.30	1.55	2.26	3.50	11
ALMONDS /YEAR NR	238	23443.7	0.00	5.25	0.62	1.00	1.26	1.62	1.91	24

C. Summary statistics for Almonds A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
ALMONDS /YEAR > 4	1747	127208.8	-519	405	-47	0	38	72	106	171
ALMONDS /YEAR 1	8	271.6	-9	107	-1	6	19	30	64	1
ALMONDS /YEAR 2	27	1621.0	-2	202	3	13	35	80	123	3
ALMONDS /YEAR 3	125	9663.0	-112	249	-12	8	44	72	131	13
ALMONDS /YEAR 4	104	8037.2	-320	194	1	21	51	91	141	11
ALMONDS /YEAR NR	238	23443.7	-291	425	-23	5	37	73	112	23

Figure I-3. Scatter plot of A vs. Y for Almonds crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

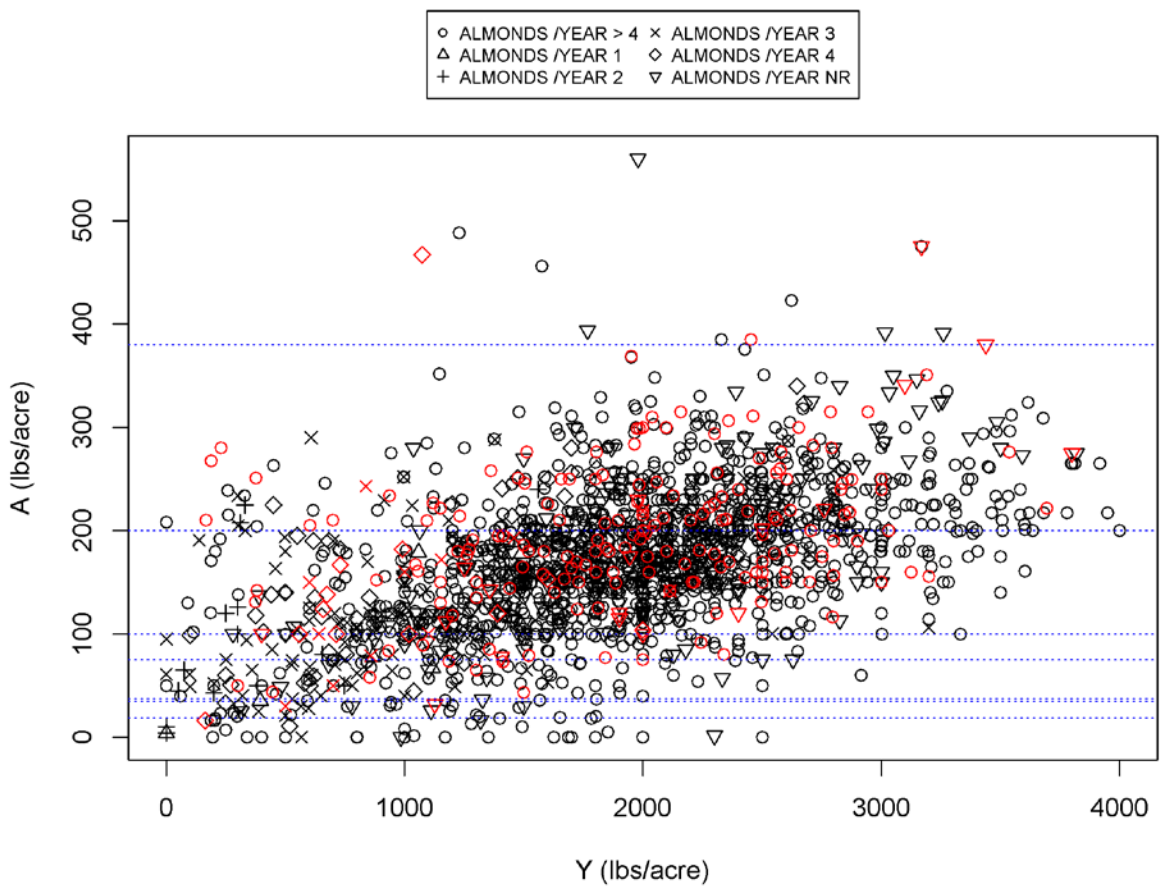


Table I-3. List of recommended nitrogen application values for Almonds (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Almonds /Year>4	95	380.00	The fertilization rate of mature trees is dependent on desired yield. Minimum value yields 1000 lbs/acre; maximum yields 4,000 lbs/acre. Applied by fertigation via low volume irrigation.	CDFA
Almonds /Year 1	20	35.00	A total annual application of up to 4 ounces/tree (20-35 lbs/acre) to first leaf trees may increase growth, while higher rates have no benefits.	CDFA
Almonds /Year 1	6.25	18.75	Meyer suggested these rates for drip-irrigated trees on non-fertile soils. Values were converted from ounces/tree to lbs/acre assuming 100 trees/acre.	CDFA
Almonds /Year 2	12.5	37.50		
Almonds /Year 3	25	75.00		
Almonds /Year 4	37.5	100.00		
Almonds /Year 5	100	200.00		

CDFA - https://www.cdfa.ca.gov/is/ffldrs/frep/

II. BEANS

Important Analysis Considerations:

The calculation of N removed at harvest for BLACK-EYED BEANS assumes that 0.0365 lbs of N are removed per lb of mature dry beans at 12% moisture. The calculation of N removed at harvest for BEANS, DRY, GARBANZO assumes that 0.0336 lbs of N are removed per lb of mature dry beans at 12% moisture. These values do not include N in the pods and foliage. Both estimates are obtained from Geisseler (2016).

In both cases, Geisseler considers that there is not enough data from California to determine whether these are good estimates of bean N concentrations in the Central Valley. However, both values are very similar and overlap substantially with lima beans from California. This suggests that variability among beans is not large and these are probably reasonable estimates for the region.

In two instances, the grower did not specify the kind of bean that was harvested. Because N concentrations ranges are quite similar among the different kinds of bean, the Coalition obtained an N removed at harvest averaging values from black-eyed, garbanzo and lima beans. Hence, the Coalition estimated an N removed from unspecified dry beans of 0.035 lbs of N removed per lb of mature dry beans at 12% moisture. As means and ranges overlap substantially for the different beans, and some values were obtained in California, this is likely a reasonable estimate for the Central Valley.

Figure II-1. Box and Whisker plots of A/Y and A/R for Beans Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

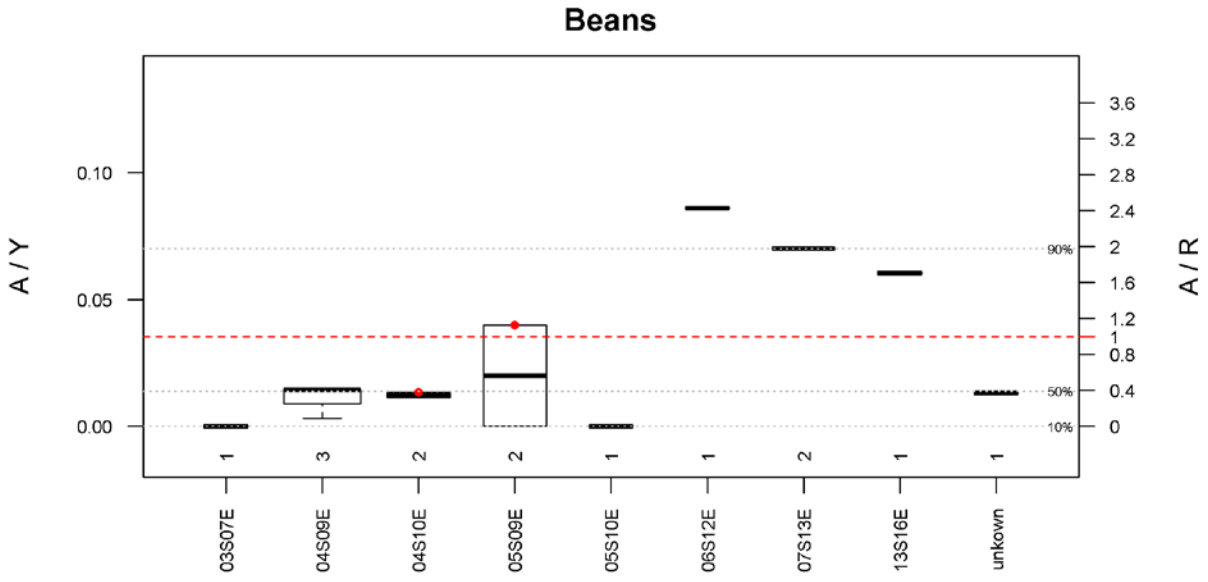


Table II-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Beans Management Units grouped by TR blocks.

TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Beans A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	1	77	0	0.0000	--	--	--	--	--	--
04S09E	3	130	0	0.0145	0.0055	0.0089	0.0145	0.0145	0.0145	0
04S10E	2	24	0	0.0133	0.0115	0.0118	0.0123	0.0128	0.0131	1
05S09E	2	338	0	0.0400	0.0040	0.0100	0.0200	0.0300	0.0360	1
05S10E	1	19	0	0.0000	--	--	--	--	--	--
06S12E	1	10	0	0.0860	--	--	--	--	--	--
07S13E	2	50	0	0.0700	--	--	--	--	--	--
13S16E	1	50	0	0.0604	--	--	--	--	--	--
unknown	1	18	0	0.0133	--	--	--	--	--	--

B. Summary statistics for Beans A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	1	77.00	0.00	0.00	--	--	--	--	--	--
04S09E	3	130.47	0.09	0.40	0.15	0.24	0.40	0.40	0	0
04S10E	2	24.50	0.31	0.37	0.32	0.32	0.34	0.35	0	1
05S09E	2	338.00	0.00	1.10	0.11	0.27	0.55	0.82	1	1
05S10E	1	19.40	0.00	0.00	--	--	--	--	--	--
06S12E	1	10.00	2.36	2.36	--	--	--	--	--	--
07S13E	2	50.40	1.92	1.92	--	--	--	--	--	--
13S16E	1	50.00	1.80	1.80	--	--	--	--	--	--
unknown	1	17.50	0.36	0.36	--	--	--	--	--	--

C. Summary statistics for Beans A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S09E	3	130	-125	-68	-114	-97	-68	-68	-68	0
04S10E	2	24	-111	-87	-109	-105	-99	-93	-89	1
05S09E	2	338	-71	11	-63	-50	-30	-9	3	1
06S12E	1	10	31	31	--	--	--	--	--	--
07S13E	2	50	21	21	--	--	--	--	--	--
13S16E	1	50	67	67	--	--	--	--	--	--
unknown	1	18	-88	-88	--	--	--	--	--	--

Figure II-2. Box and Whisker plots of A/Y for Beans Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

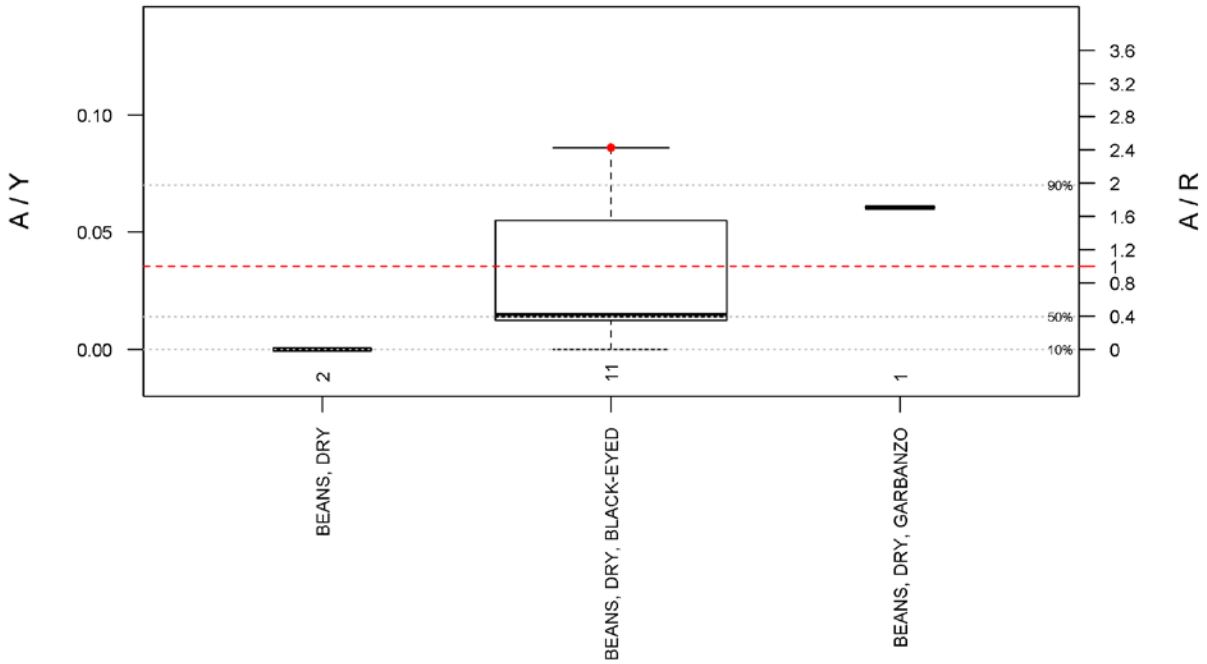


Table II-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Beans Management Units grouped by specific crop.

A. Summary statistics for Beans A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
BEANS, DRY	2	349.4	0.0000	0.0000	--	--	--	--	--	--
BEANS, DRY, BLACK-EYED	11	317.9	0.0000	0.0860	0.0032	0.0123	0.0145	0.055	0.07	1
BEANS, DRY, GARBANZO	1	50.0	0.0604	0.0604	--	--	--	--	--	--

B. Summary statistics for Beans A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
BEANS, DRY	2	349.4	0.0	0.00	--	--	--	--	--	--
BEANS, DRY, BLACK-EYED	11	317.9	0.0	2.36	0.09	0.34	0.4	1.51	1.92	1
BEANS, DRY, GARBANZO	1	50.0	1.8	1.80	--	--	--	--	--	--

C. Summary statistics for Beans A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
BEANS, DRY	2	349.4	-71	-71	--	--	--	--	--	--
BEANS, DRY, BLACK-EYED	11	317.9	-125	31	-112	-87	-68	18	22	1
BEANS, DRY, GARBANZO	1	50.0	67	67	--	--	--	--	--	--

Figure II-3. Scatter plot of A vs. Y for Beans crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

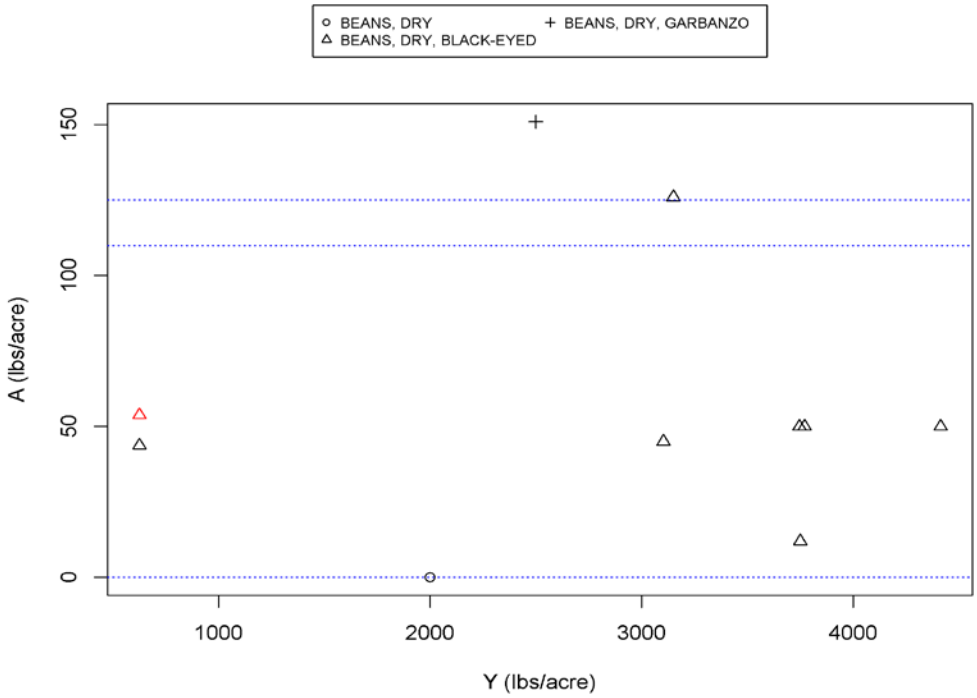


Table II-3. List of recommended nitrogen application values for Beans (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Blackeye	0	0	Dry bean N requirements depend on the yield, the total amount of N taken up by the plant, and the amount of N the plant is able to fix from the atmosphere. The table assumes N-fixation rates ranging from of 20-40%, 20-60% and 20-50% for common, garbanzo and lima beans, respectively. A rate of 90% is assumed for black-eyed. Assumes garbanzo N harvest index of 0.7-0.85, which is based on studies from Australia and Saskatchewan.	CDFA
Common dry beans	65	125	same	CDFA
Garbanzo	35	110	same	CDFA
Lima	55	125	same	CDFA

CDFA - https://www.cdfa.ca.gov/is/ffldrs/frep/

III. CHERRIES

Important Analysis Considerations:

The calculation of N removed at harvest for CHERRY assumes that 0.00221 lbs of N are removed per lb of fruits. This estimate is obtained from Geisseler (2016). **Geisseler considers that the value is only a rough estimate.**

Figure III-1. Box and Whisker plots of A/Y and A/R for Cherries Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

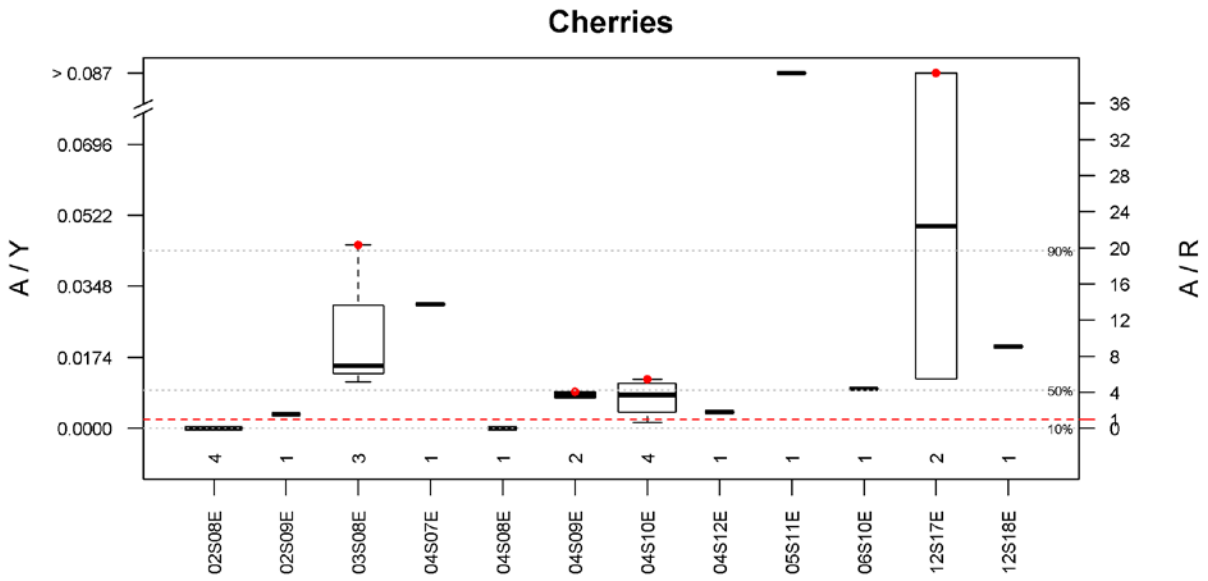


Table III-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Cherries Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Cherries A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	4	89	0	0.0000	--	--	--	--	--	--
02S09E	1	30	0	0.0035	--	--	--	--	--	--
03S08E	3	100	0	0.0449	0.0122	0.0134	0.0154	0.0301	0.0390	1
04S07E	1	123	0	0.0304	--	--	--	--	--	--
04S08E	1	63	0	0.0000	--	--	--	--	--	--
04S09E	2	40	0	0.0090	0.0076	0.0079	0.0082	0.0086	0.0088	1
04S10E	4	148	0	0.0120	0.0030	0.0052	0.0082	0.0104	0.0114	1
04S12E	1	28	0	0.0040	--	--	--	--	--	--
05S11E	1	4	0	0.1085	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
06S10E	1	4	0	0.0097	--	--	--	--	--	--
12S17E	2	176	0	0.1870	0.0296	0.0558	0.0996	0.1433	0.1695	1
12S18E	1	21	0	0.0200	--	--	--	--	--	--

B. Summary statistics for Cherries A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	4	88.94	0.00	0.00	--	--	--	--	--	--
02S09E	1	30.00	1.58	1.58	--	--	--	--	--	--
03S08E	3	100.00	5.17	20.33	5.53	6.06	6.95	13.64	18	1
04S07E	1	123.00	13.74	13.74	--	--	--	--	--	--
04S08E	1	63.00	0.00	0.00	--	--	--	--	--	--
04S09E	2	40.00	3.39	4.07	3.46	3.56	3.73	3.90	4	1
04S10E	4	147.60	0.68	5.43	1.34	2.34	3.69	4.72	5	1
04S12E	1	28.00	1.81	1.81	--	--	--	--	--	--
05S11E	1	4.00	49.12	49.12	--	--	--	--	--	--
06S10E	1	4.00	4.38	4.38	--	--	--	--	--	--
12S17E	2	176.20	5.49	84.60	13.40	25.27	45.05	64.82	77	1
12S18E	1	21.00	9.05	9.05	--	--	--	--	--	--

C. Summary statistics for Cherries A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	4	89	-36	-36	--	--	--	--	--	--
02S09E	1	30	19	19	--	--	--	--	--	--
03S08E	3	100	44	52	45	46	47	50	51	1
04S07E	1	123	76	76	--	--	--	--	--	--
04S08E	1	63	-22	-22	--	--	--	--	--	--
04S09E	2	40	63	68	64	65	66	67	67	1
04S10E	4	148	-14	73	-5	10	20	36	58	1
04S12E	1	28	28	28	--	--	--	--	--	--
05S11E	1	4	124	124	--	--	--	--	--	--
06S10E	1	4	62	62	--	--	--	--	--	--
12S17E	2	176	63	96	66	71	79	88	92	1
12S18E	1	21	42	42	--	--	--	--	--	--

Figure III-2. Box and Whisker plots of A/Y for Cherries Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

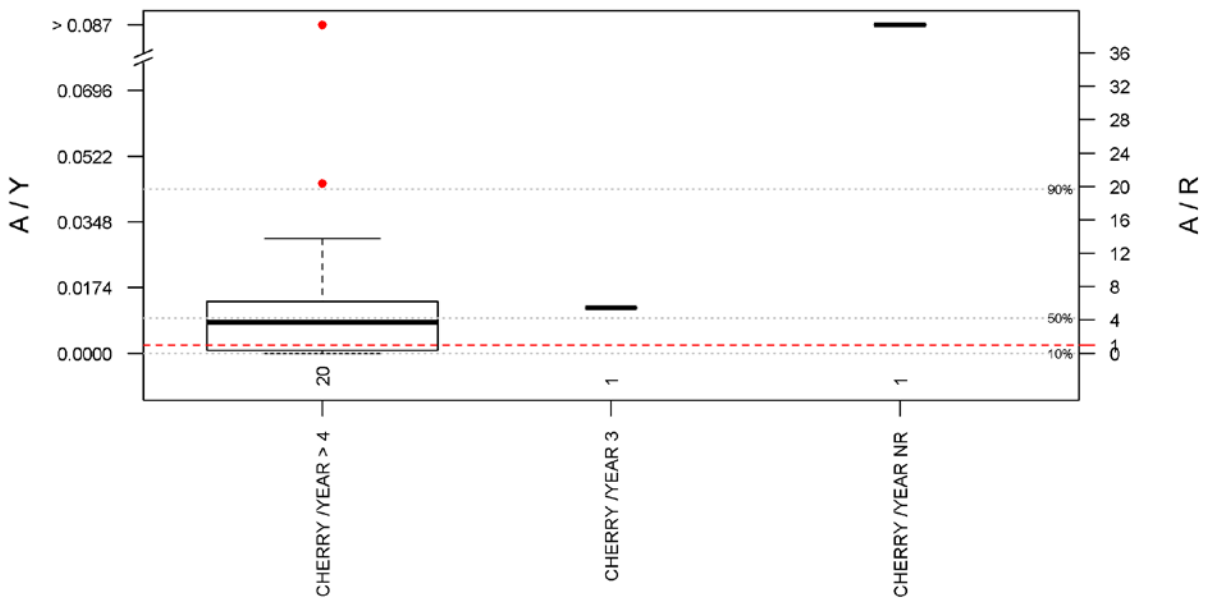


Table III-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Cherries Management Units grouped by specific crop.

A. Summary statistics for Cherries A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CHERRY / YEAR > 4	20	801.7	0.0000	0.1870	0	0.0011	0.0082	0.0129	0.0318	2
CHERRY /YEAR 3	1	20.0	0.0120	0.0120	--	--	--	--	--	--
CHERRY / YEAR NR	1	4.0	0.1085	0.1085	--	--	--	--	--	--

B. Summary statistics for Cherries A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CHERRY /YEAR > 4	20	801.7	0.00	84.60	0	0.51	3.73	5.86	14.4	2
CHERRY /YEAR 3	1	20.0	5.43	5.43	--	--	--	--	--	--
CHERRY /YEAR NR	1	4.0	49.12	49.12	--	--	--	--	--	--

C. Summary statistics for Cherries A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CHERRY /YEAR > 4	20	801.7	-36	96	-36	-16	35	62	69	2
CHERRY /YEAR 3	1	20.0	73	73	--	--	--	--	--	--
CHERRY /YEAR NR	1	4.0	124	124	--	--	--	--	--	--

Figure III-3. Scatter plot of A vs. Y for Cherries crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

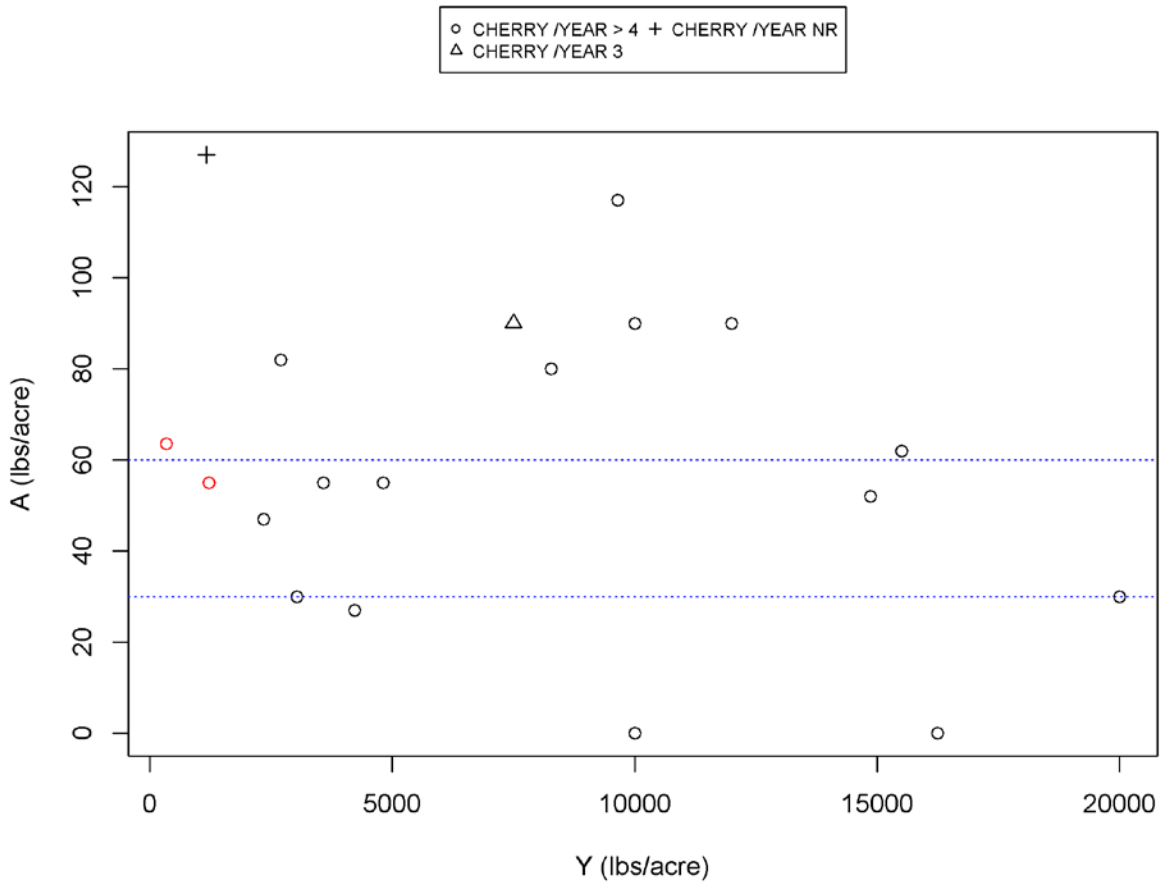


Table III-3. List of recommended nitrogen application values for Cherries (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Sweet Cherries /Year < 4	10	30	Values are not recommendations, but rates considered typical of a well-managed orchard. May not be applicable to all operations.	UC Davis
Sweet Cherries /Year > 4	35	60	same	UC Davis

UC Davis - http://coststudies.ucdavis.edu/current/

IV. CITRUS

Important Analysis Considerations:

The calculation of N removed at harvest for ORANGES assumes that 0.00148 lbs of N are removed per lb of fruits. This estimate is obtained from Geisseler (2016). **Geisseler considers that the dataset is a reasonable estimate of N removed with oranges. However, there is a need for more recent data from the Central Valley.**

The calculation of N removed at harvest for MANDARINS and TANGELO are based on the assumption that 0.00138 lbs of N are removed per lb of fruits. This value is an average of N Removal Factors from grapefruit, lemons, oranges, and tangerines. Because all values for the different citrus are very similar to each other, this average can be considered a good estimate for citrus in general.

Figure IV-1. Box and Whisker plots of A/Y and A/R for Citrus Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

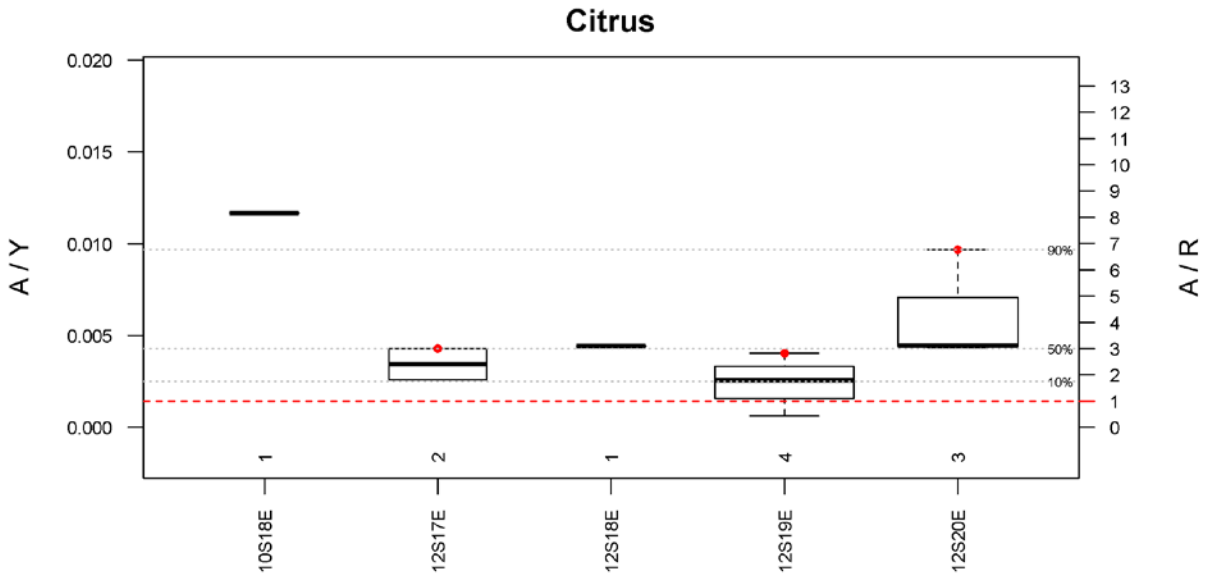


Table IV-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Citrus Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Citrus A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
10S18E	1	2004	0	0.0117	--	--	--	--	--	--
12S17E	2	84	0	0.0043	0.0028	0.0030	0.0034	0.0039	0.0041	1
12S18E	1	36	0	0.0044	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
12S19E	5	597	0	0.0040	0.0012	0.0020	0.0026	0.0030	0.0036	1
12S20E	3	2674	0	0.0097	0.0044	0.0044	0.0045	0.0071	0.0086	1

B. Summary statistics for Citrus A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
10S18E	1	2004.26	8.45	8.45	--	--	--	--	--	--
12S17E	2	83.57	1.88	3.11	2.00	2.19	2.49	2.80	3	1
12S18E	1	35.91	3.21	3.21	--	--	--	--	--	--
12S19E	5	596.80	0.45	2.92	0.86	1.47	1.86	2.16	3	1
12S20E	3	2673.64	2.93	7.00	2.95	2.98	3.02	5.01	6	1

C. Summary statistics for Citrus A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
10S18E	1	2004	149	149	--	--	--	--	--	--
12S17E	2	84	83	120	87	92	102	111	116	1
12S18E	1	36	126	126	--	--	--	--	--	--
12S19E	5	597	-36	105	-20	5	22	47	82	1
12S20E	3	2674	68	143	69	70	72	107	129	1

Figure IV-2. Box and Whisker plots of A/Y for Citrus Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

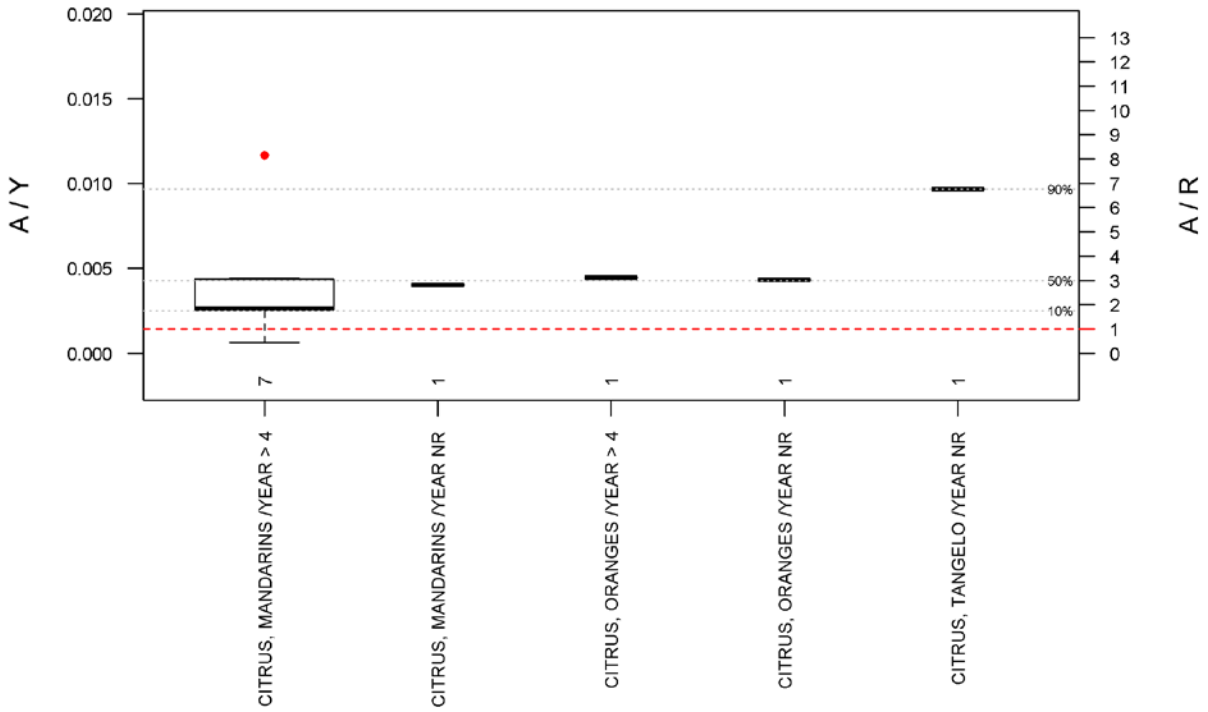


Table IV-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Citrus Management Units grouped by specific crop.

A. Summary statistics for Citrus A/Y.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CITRUS, MANDARINS / YEAR > 4	8	2690.5	0.0006	0.0117	0.0017	0.0025	0.0026	0.0044	0.0073	1
CITRUS, MANDARINS / YEAR NR	1	30.0	0.0040	0.0040	--	--	--	--	--	--
CITRUS, ORANGES /YEAR > 4	1	1441.7	0.0045	0.0045	--	--	--	--	--	--
CITRUS, ORANGES /YEAR NR	1	800.8	0.0043	0.0043	--	--	--	--	--	--
CITRUS, TANGELO /YEAR NR	1	431.1	0.0097	0.0097	--	--	--	--	--	--

B. Summary statistics for Citrus A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CITRUS, MANDARINS /YEAR > 4	8	2690.5	0.45	8.45	1.27	1.85	1.9	3.16	5.31	1
CITRUS, MANDARINS /YEAR NR	1	30.0	2.92	2.92	--	--	--	--	--	--
CITRUS, ORANGES /YEAR > 4	1	1441.7	3.02	3.02	--	--	--	--	--	--
CITRUS, ORANGES /YEAR NR	1	800.8	2.93	2.93	--	--	--	--	--	--

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CITRUS, TANGELO /YEAR NR	1	431.1	7.00	7.00	--	--	--	--	--	--

C. Summary statistics for Citrus A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CITRUS, MANDARINS /YEAR > 4	8	2690.5	-36	149	-4	22	83	123	135	1
CITRUS, MANDARINS /YEAR NR	1	30.0	105	105	--	--	--	--	--	--
CITRUS, ORANGES /YEAR > 4	1	1441.7	72	72	--	--	--	--	--	--
CITRUS, ORANGES /YEAR NR	1	800.8	68	68	--	--	--	--	--	--
CITRUS, TANGELO /YEAR NR	1	431.1	143	143	--	--	--	--	--	--

Figure IV-3. Scatter plot of A vs. Y for Citrus crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

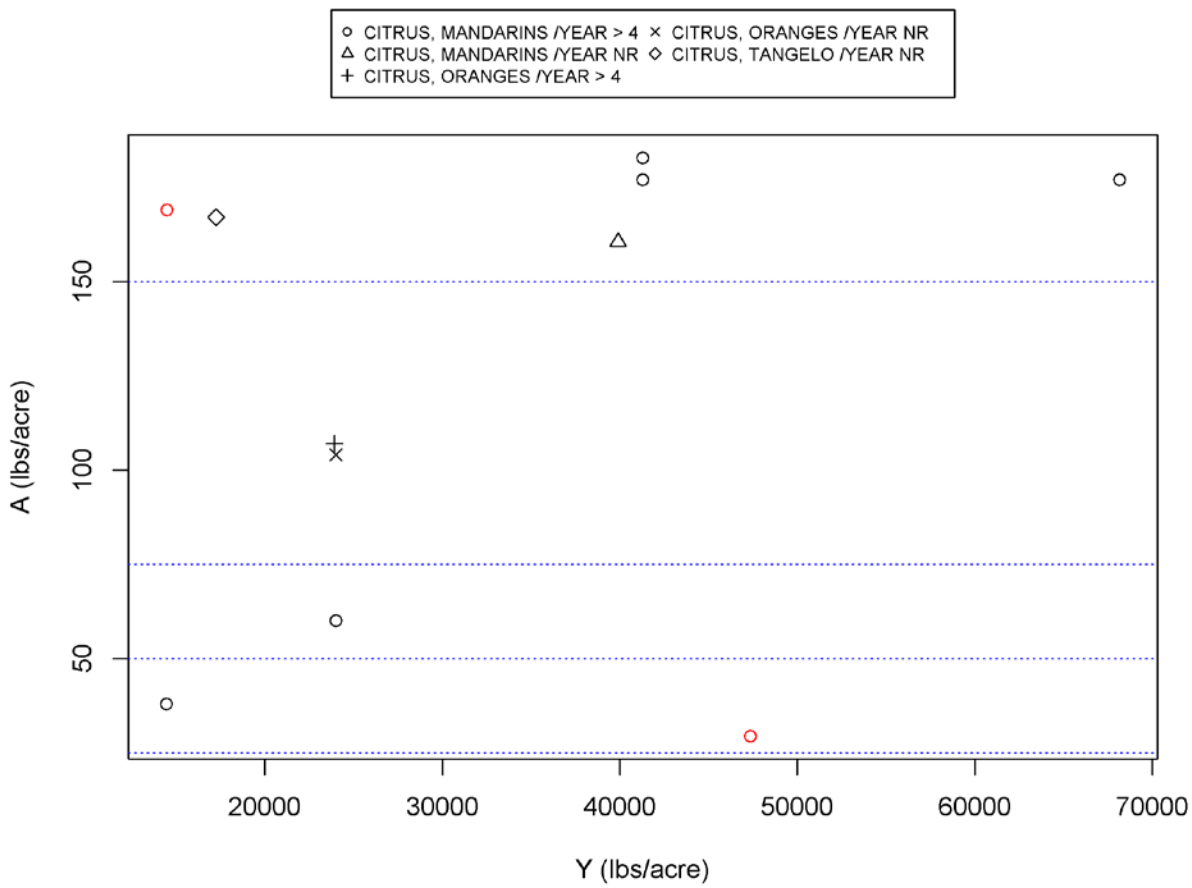


Table IV-3. List of recommended nitrogen application values for Citrus (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Citrus /Year >4	100	150	Based on a study on navel oranges with a tree spacing of 22 x 20 feet.	CDFA
Citrus /Year 1	13	25	Rate assumes 100 trees/acre. Nitrogen fertilizer requirements of young citrus trees depend on the N supplying capacity of the soil. The lower limit is adequate for soils with a soil organic matter content of 2% or more and soils previously used for pasture or vegetable production.	CDFA
Citrus /Year 2	25	50	same	CDFA
Citrus /Year 3	50	75	same	CDFA

CDFA - https://www.cdfa.ca.gov/is/ffldrs/frep/

V.COTTON

Important Analysis Considerations:

The calculation of N removed at harvest for COTTON assumes that 0.02185 lbs N/lb of lint & seed are removed at harvest. The calculation of N removed at harvest for COTTON, PIMA assumes that 0.02185 lbs N/lbs lint & seed are removed at harvest. The calculation of N removed at harvest for COTTON, UPLAND assumes that 0.02185 lbs N/lbs lint & seed are removed at harvest.

All estimates are obtained from Geisseler (2016). **Geisseler believes that the values can be considered a very good estimate of the N concentration in cotton from the Central Valley.** However, the information provided by the farmers does not specify if the yield reported represents yield of lint + seed or lint alone. Lint represents only a 36% of the total yield extracted from the field. Hence, if some growers reported yield of lint alone, a different conversion factor should be used. At the time of this analysis, there was not sufficient information about cotton yields and the Coalition assumed that all farmers reported yield of lint + seed. This means that some MUs may be using an incorrect N Removal Factor, and some A/R and A-R values in this section may be erroneous.

Figure V-1. Box and Whisker plots of A/Y and A/R for Cotton Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

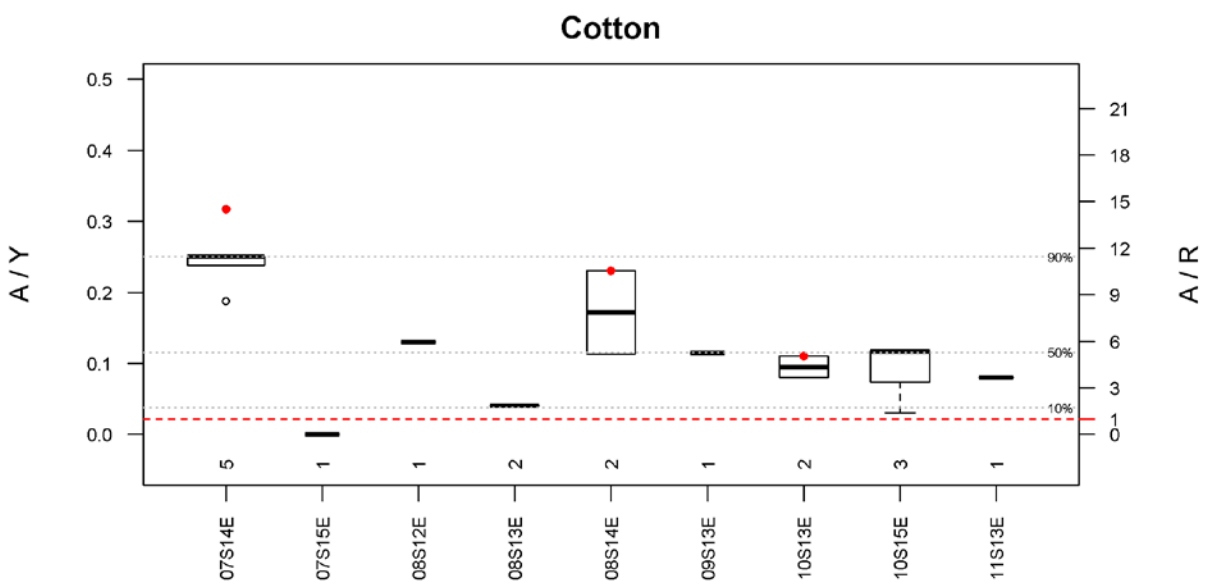


Table V-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Cotton Management Units grouped by TR blocks.

TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Cotton A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
07S14E	5	289	0	0.3168	0.2076	0.2376	0.2500	0.2500	0.2901	1
07S15E	1	294	0	0.0000	--	--	--	--	--	--
08S12E	1	454	0	0.1300	--	--	--	--	--	--
08S13E	2	269	0	0.0405	--	--	--	--	--	--
08S14E	2	49	0	0.2308	0.1251	0.1427	0.1721	0.2014	0.2190	1
09S13E	1	990	0	0.1146	--	--	--	--	--	--
10S13E	2	216	0	0.1100	0.0830	0.0875	0.0950	0.1025	0.1070	1
10S15E	3	234	0	0.1165	0.0473	0.0733	0.1165	0.1165	0.1165	0
11S13E	1	216	0	0.0800	--	--	--	--	--	--

B. Summary statistics for Cotton A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
07S14E	5	289.32	8.58	14.50	9.50	10.88	11.44	11.44	13	1
07S15E	1	294.00	0.00	0.00	--	--	--	--	--	--
08S12E	1	453.60	5.95	5.95	--	--	--	--	--	--
08S13E	2	269.47	1.86	1.86	--	--	--	--	--	--
08S14E	2	48.98	5.19	10.56	5.72	6.53	7.87	9.22	10	1
09S13E	1	990.00	5.24	5.24	--	--	--	--	--	--
10S13E	2	215.70	3.66	5.03	3.80	4.00	4.35	4.69	5	1
10S15E	3	234.00	1.37	5.33	2.16	3.35	5.33	5.33	5	0
11S13E	1	215.50	3.66	3.66	--	--	--	--	--	--

C. Summary statistics for Cotton A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
07S14E	5	289	133	168	134	137	137	164	166	1
08S12E	1	454	150	150	--	--	--	--	--	--
08S13E	2	269	31	31	--	--	--	--	--	--
08S14E	2	49	69	136	75	85	102	119	129	1
09S13E	1	990	172	172	--	--	--	--	--	--
10S13E	2	216	144	173	147	151	159	166	170	1
10S15E	3	234	27	97	41	62	97	97	97	0
11S13E	1	216	129	129	--	--	--	--	--	--

Figure V-2. Box and Whisker plots of A/Y for Cotton Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

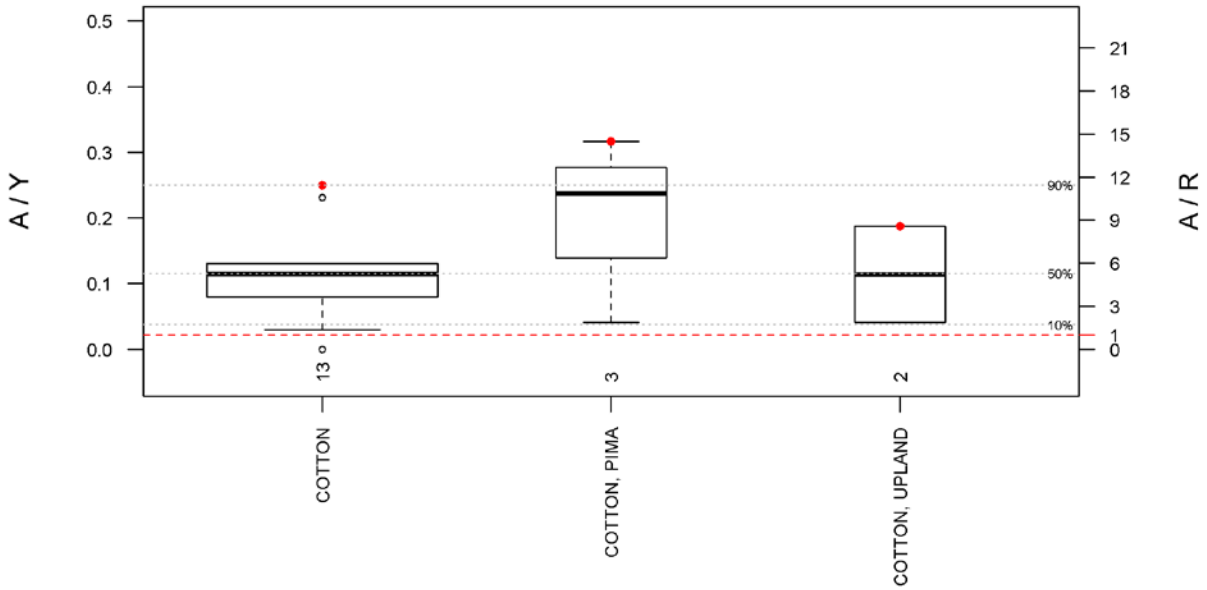


Table V-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Cotton Management Units grouped by specific crop.

A. Summary statistics for Cotton A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
COTTON	13	2499.8	0.0000	0.2500	0.0400	0.0800	0.1146	0.1300	0.2462	2
COTTON, PIMA	3	211.0	0.0405	0.3168	0.0800	0.1391	0.2376	0.2772	0.3010	1
COTTON, UPLAND	2	299.8	0.0405	0.1875	0.0552	0.0773	0.1140	0.1508	0.1728	1

B. Summary statistics for Cotton A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
COTTON	13	2499.8	0.00	11.44	1.83	3.66	5.24	5.95	11.27	2
COTTON, PIMA	3	211.0	1.86	14.50	3.66	6.37	10.88	12.69	13.78	1
COTTON, UPLAND	2	299.8	1.86	8.58	2.53	3.54	5.22	6.90	7.91	1

C. Summary statistics for Cotton A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
COTTON	13	2499.8	27	173	72	97	136	145	169	2
COTTON, PIMA	3	211.0	31	168	57	97	164	166	167	1
COTTON, UPLAND	2	299.8	31	133	41	56	82	107	122	1

Figure V-3. Scatter plot of A vs. Y for Cotton crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

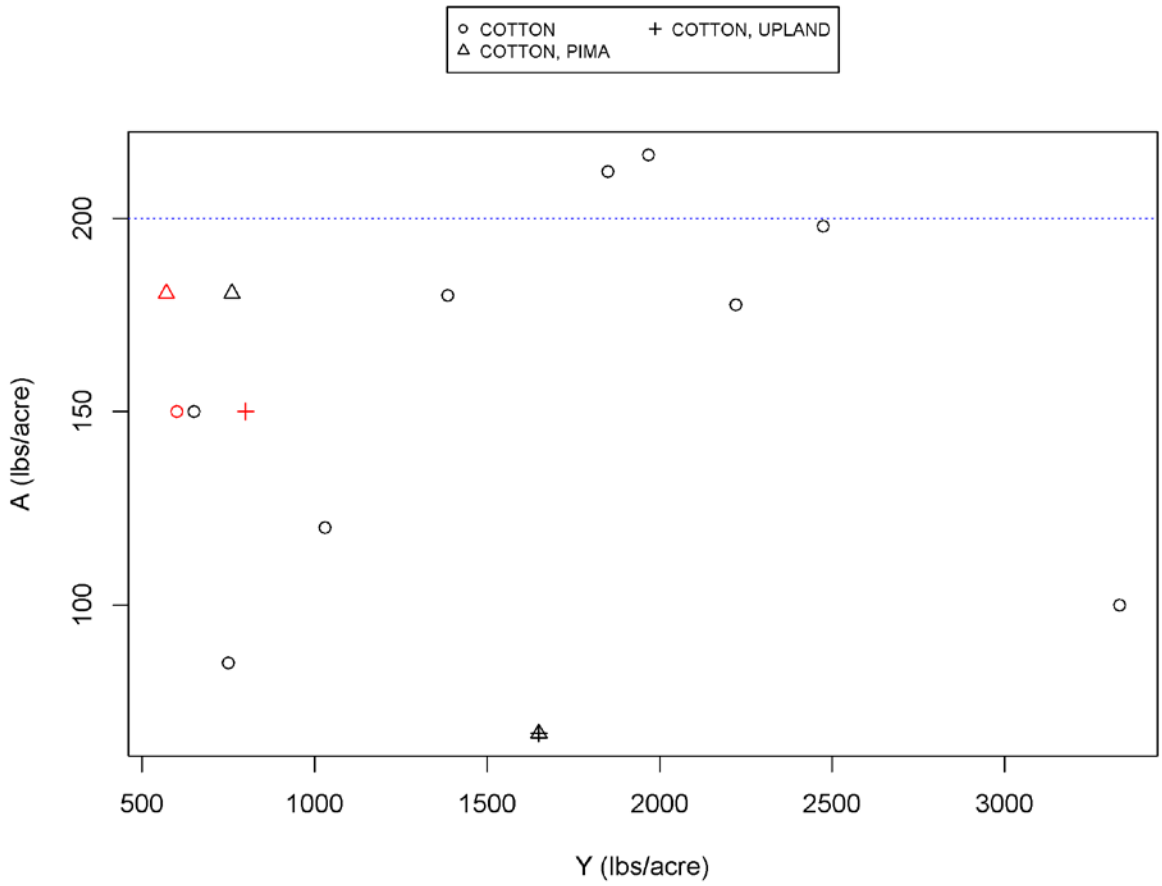


Table V-3. List of recommended nitrogen application values for Cotton (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Cotton	180	200	To yield 1300 lbs lint/acre.	CDFA

CDFA - https://www.cdfa.ca.gov/is/ffldrs/frep/

VI. FIGS

Important Analysis Considerations:

The calculation of N removed at harvest for FIGS assumes that 0.00127 lbs N/lbs of fruits are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that there is not sufficient data from California available.** Hence, it cannot be determined how well this value represents figs from California.

Figure VI-1. Box and Whisker plots of A/Y and A/R for Figs Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

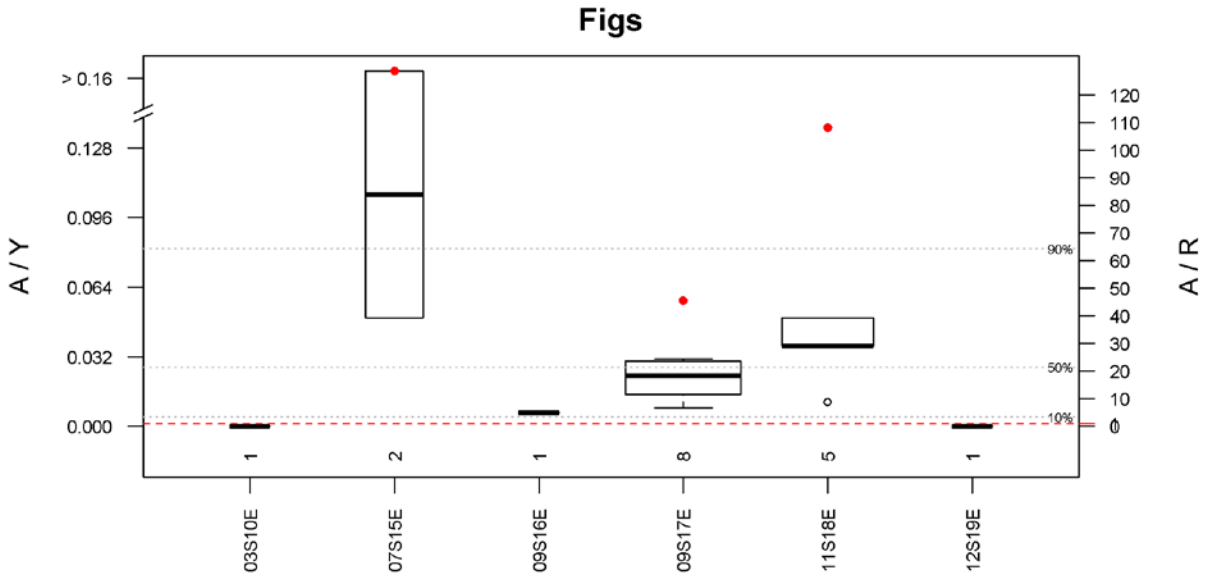


Table VI-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Figs Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Figs A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S10E	1	2	0	0.0000	--	--	--	--	--	--
07S15E	2	70	0	0.2000	0.0650	0.0875	0.1250	0.1625	0.1850	1
09S16E	1	160	0	0.0062	--	--	--	--	--	--
09S17E	8	870	0	0.0578	0.0111	0.0158	0.0232	0.0296	0.0390	1
11S18E	5	640	0	0.1374	0.0215	0.0370	0.0370	0.0499	0.1024	1
12S19E	1	45	0	0.0000	--	--	--	--	--	--

B. Summary statistics for Figs A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S10E	1	2	0.00	0.00	--	--	--	--	--	--
07S15E	2	70	39.37	157.48	51.18	68.90	98.43	127.95	146	1
09S16E	1	160	4.92	4.92	--	--	--	--	--	--
09S17E	8	870	6.65	45.48	8.76	12.45	18.28	23.32	31	1
11S18E	5	640	8.81	108.16	16.95	29.14	29.14	39.27	81	1
12S19E	1	45	0.00	0.00	--	--	--	--	--	--

C. Summary statistics for Figs A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
07S15E	2	70	97	99	98	98	98	99	99	1
09S16E	1	160	40	40	--	--	--	--	--	--
09S17E	8	870	19	142	19	49	64	76	97	1
11S18E	5	640	51	127	69	97	97	99	116	1
12S19E	1	45	-4	-4	--	--	--	--	--	--

Figure VI-2. Box and Whisker plots of A/Y for Figs Management Units grouped by specific crop types or tree age. Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

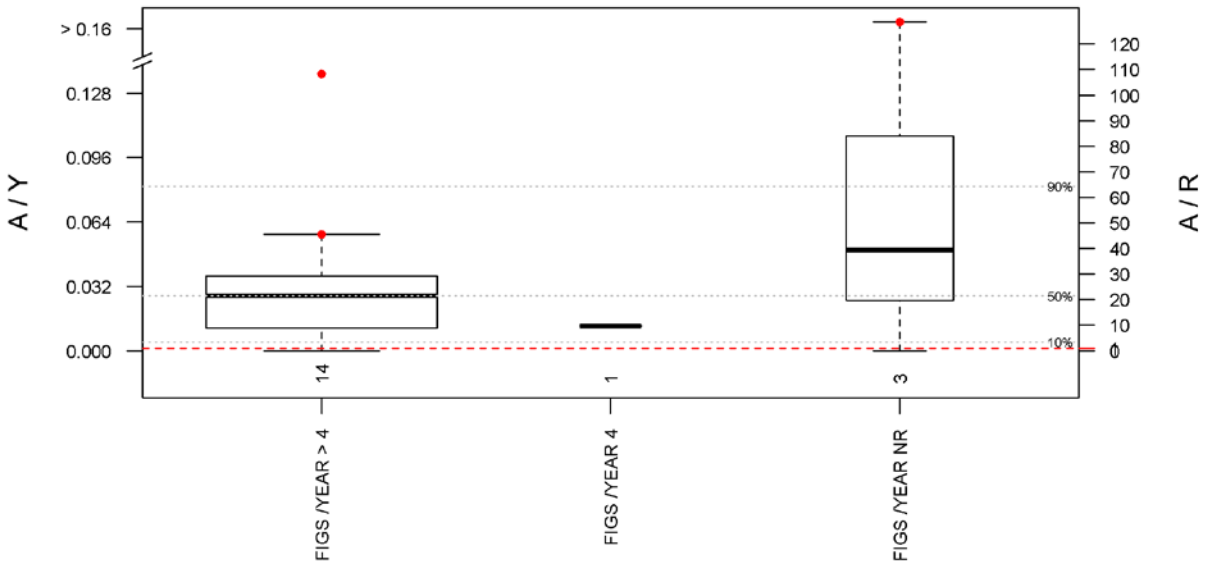


Table VI-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Figs Management Units grouped by specific crop.

A. Summary statistics for Figs A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
FIGS /YEAR > 4	14	1615	0.0000	0.1374	0.0069	0.0126	0.0272	0.037	0.0554	2
FIGS /YEAR 4	1	100	0.0123	0.0123	--	--	--	--	--	--
FIGS /YEAR NR	3	72	0.0000	0.2000	0.0100	0.0250	0.0500	0.125	0.1700	1

B. Summary statistics for Figs A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
FIGS /YEAR > 4	14	1615	0.00	108.16	5.44	9.95	21.41	29.14	43.62	2
FIGS /YEAR 4	1	100	9.66	9.66	--	--	--	--	--	--
FIGS /YEAR NR	3	72	0.00	157.48	7.87	19.69	39.37	98.43	133.86	1

C. Summary statistics for Figs A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
FIGS /YEAR > 4	14	1615	-4	142	25	53	72	97	119	2
FIGS /YEAR 4	1	100	20	20	--	--	--	--	--	--
FIGS /YEAR NR	3	72	97	99	98	98	98	99	99	1

Figure VI-3. Scatter plot of A vs. Y for Figs crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

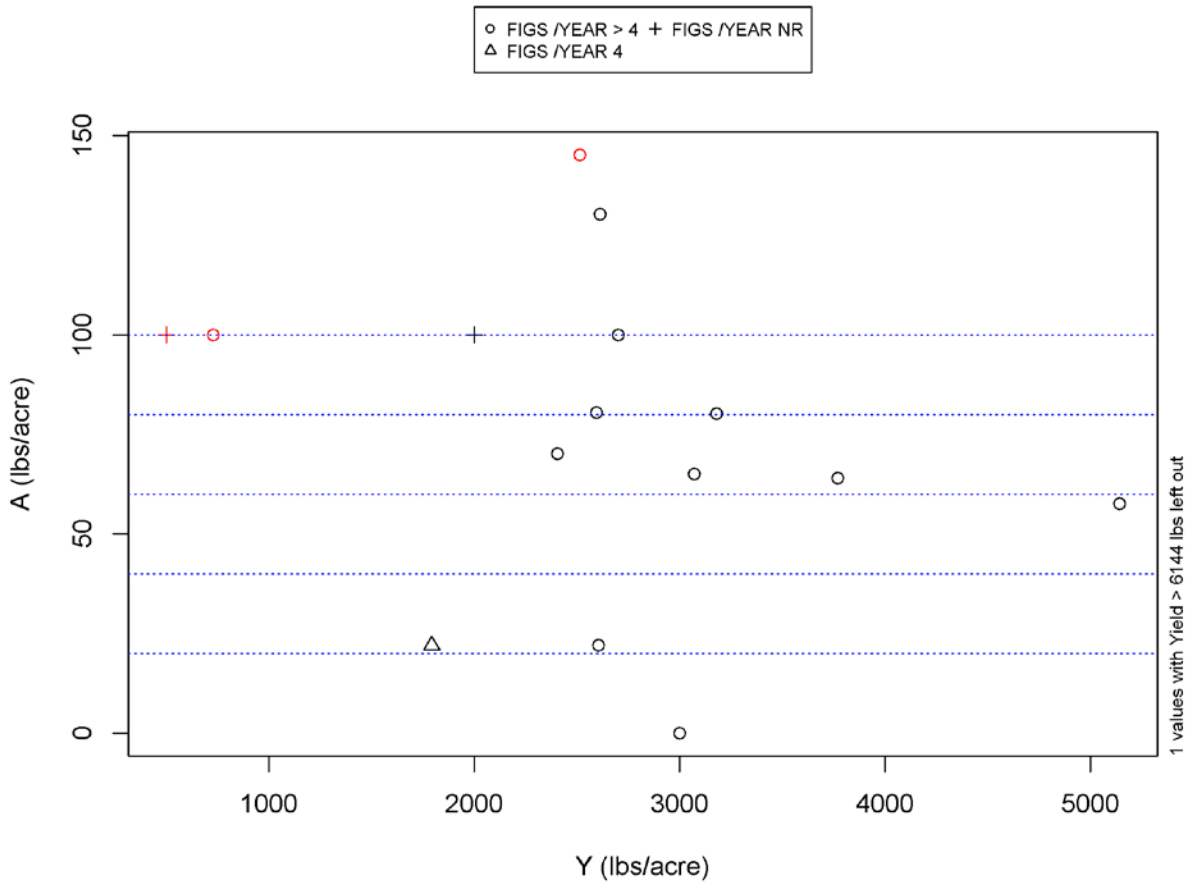


Table VI-3. List of recommended nitrogen application values for Figs (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Figs /Year > 5	100	100	Values are not recommendations, but rates considered typical of a well-managed orchard. May not be applicable to all operations.	UC Davis
Figs /Year 1	20	20	Conadria variety spaced 155 trees/acre. Typical yield for trees older than 3 is between 372-4,464 lbs/acre.	UC Davis
Figs /Year 2	40	40	same	UC Davis
Figs /Year 3	60	60	same	UC Davis
Figs /Year 4	80	80	same	UC Davis

UC Davis - http://coststudies.ucdavis.edu/current/

VII. FORAGE

Important Analysis Considerations:

As foraged pastures are not harvested, the yield reported in the NMP SR is estimated by the growers. Also, there is no N Removal Factor for foraged pastures available in the sources evaluated by the Coalition. Hence, only summary statistics by A/Y are provided.

Figure VII-1. Box and Whisker plots of A/Y for Forage Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

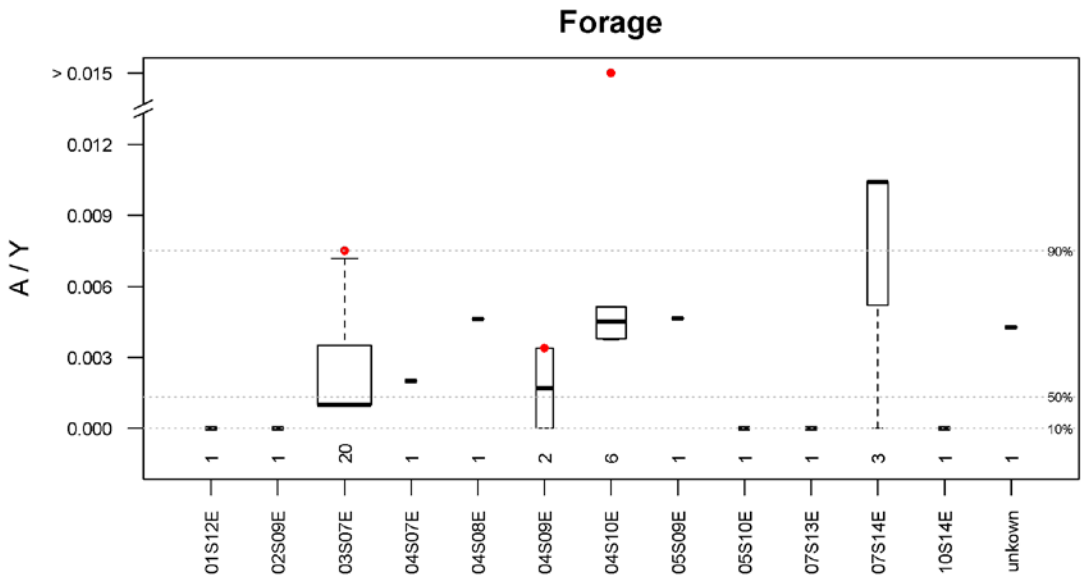


Table VII-1. Summary statistics for A/Y from Forage Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
01S12E	1	17	0	0.0000	--	--	--	--	--	--
02S09E	1	3	0	0.0000	--	--	--	--	--	--
03S07E	20	1880	0	0.0075	0.0010	0.0010	0.0010	0.0028	0.0072	2
04S07E	1	18	0	0.0020	--	--	--	--	--	--
04S08E	1	20	0	0.0046	--	--	--	--	--	--
04S09E	2	31	0	0.0034	0.0003	0.0008	0.0017	0.0025	0.0030	1
04S10E	6	148	0	41.4286	0.0038	0.0039	0.0045	0.0051	20.7168	1
05S09E	1	73	0	0.0046	--	--	--	--	--	--
05S10E	1	17	0	0.0000	--	--	--	--	--	--
07S13E	1	63	0	0.0000	--	--	--	--	--	--
07S14E	3	20	0	0.0104	0.0021	0.0052	0.0104	0.0104	0.0104	0
10S14E	1	37	0	0.0000	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
unknown	1	18	0	0.0043	--	--	--	--	--	--

Figure VII-2. Box and Whisker plots of A/Y for Forage Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

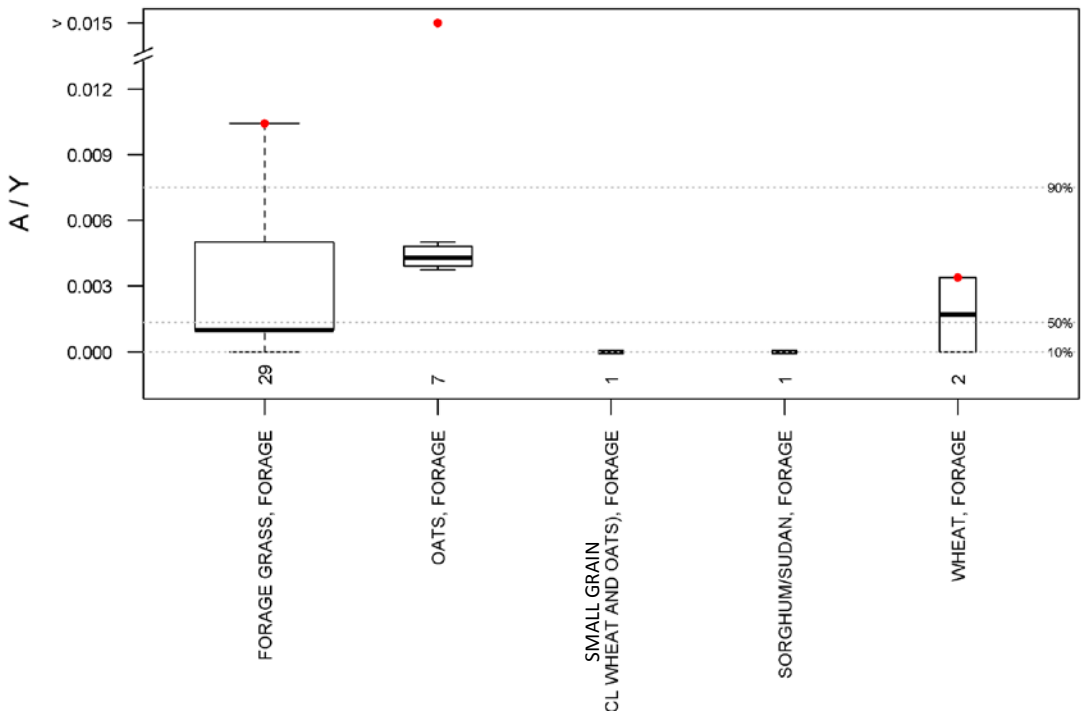
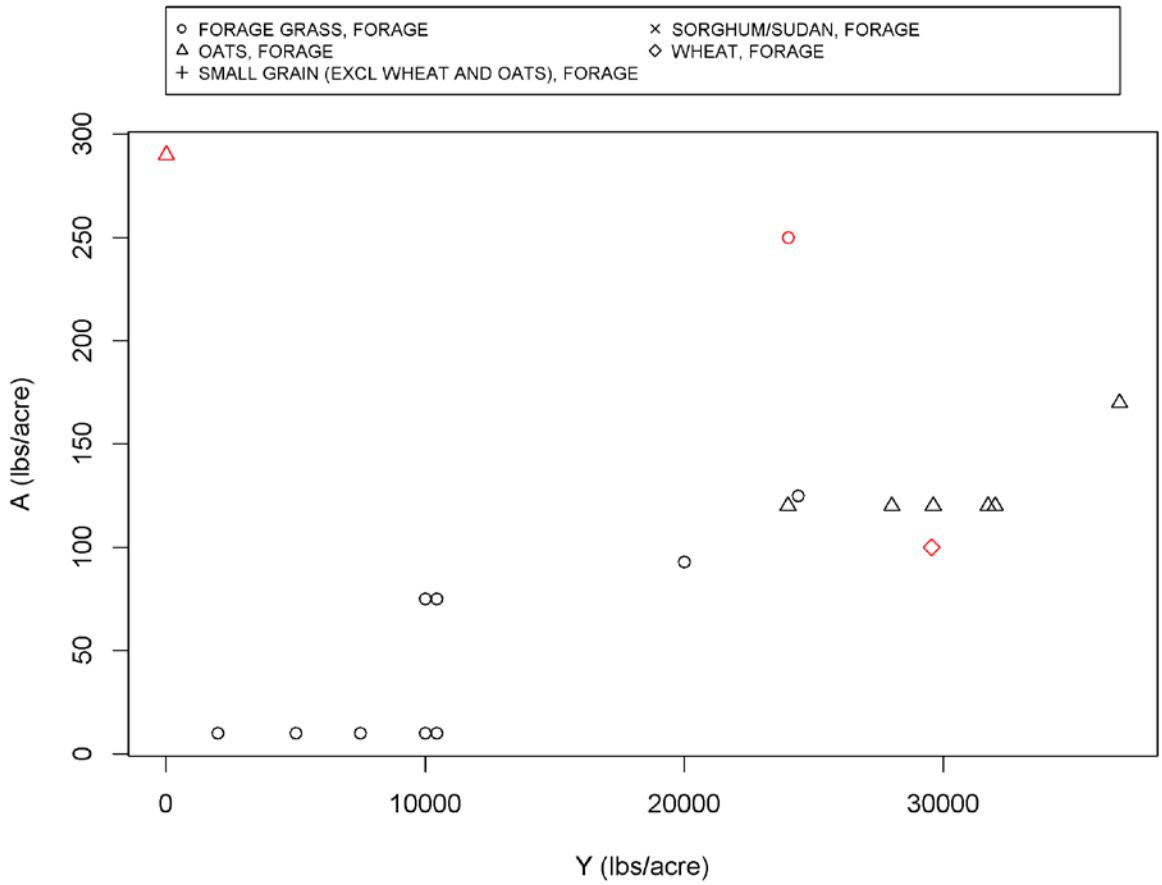


Table VII-2. Summary statistics for A/Y from Forage Management Units grouped by specific crop.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
FORAGE GRASS, FORAGE	29	2083.2	0.0000	0.0104	0.0000	0.0010	0.0010	0.0050	0.0075	2
OATS, FORAGE	7	150.6	0.0038	41.4286	0.0038	0.0039	0.0043	0.0048	16.5744	1
SMALL GRAIN (EXCL WHEAT AND OATS), FORAGE	1	14.0	0.0000	0.0000	--	--	--	--	--	--
SORGHUM/SUDAN, FORAGE	1	17.0	0.0000	0.0000	--	--	--	--	--	--
WHEAT, FORAGE	2	80.5	0.0000	0.0034	0.0003	0.0008	0.0017	0.0025	0.0030	1

Figure VII-3. Scatter plot of A vs. Y for Forage crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.



VIII. GRAINS

Important Analysis Considerations:

The calculation of N removed at harvest for WHEAT, GRAIN assumes that 0.021275 lbs N/lbs of grain at 12% moisture are removed at harvest. This estimate is an average of common and durum wheat obtained from Geisseler (2016). **The results are highly representative for the Central Valley** and are nearly identical between the two wheat species.

The calculation of N removed at harvest for OATS, GRAIN assumes that 0.01885 lbs N/lbs of grain at 12% moisture are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that with no data available from California, the values may not be representative of oats grown in California.**

The calculation of N removed at harvest for all other small grains assumes that 0.0198875 lbs N/lbs of grain at 12% moisture are removed at harvest. This value is the average of barley, oats, triticale, and wheat. **As means and ranges overlap substantially for the different grains, this is likely a good estimate of grain N Removal in the Central Valley.**

Figure VIII-1. Box and Whisker plots of A/Y and A/R for Small Grains Management Units grouped by TR blocks. Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

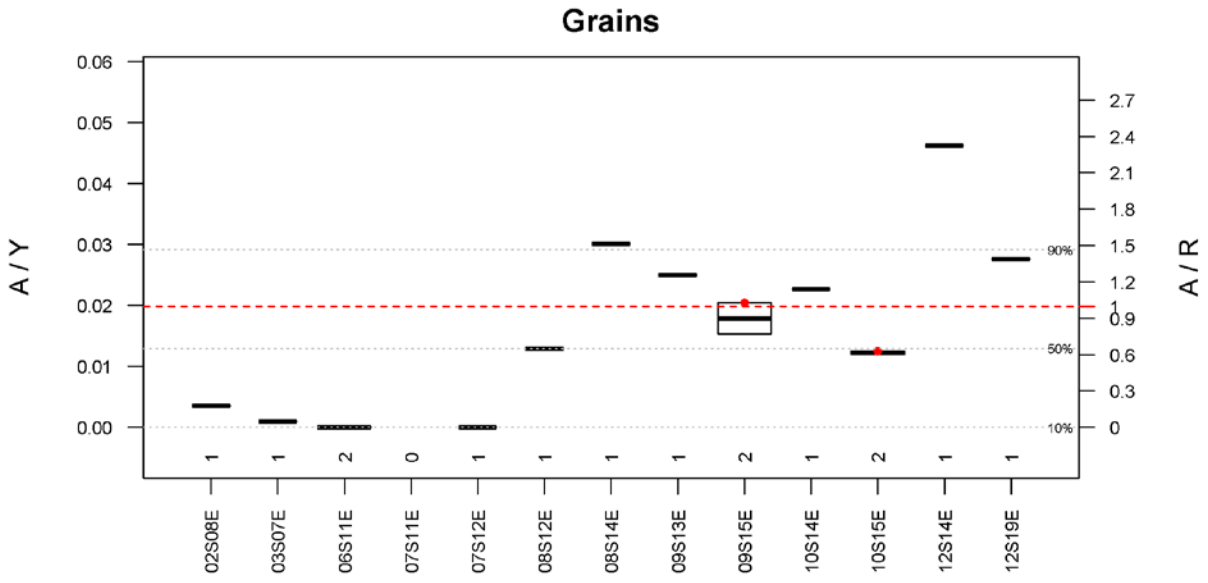


Table VIII-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Grains Management Units grouped by TR blocks.

TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Grains A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	1	8	0	0.0035	--	--	--	--	--	--
03S07E	1	15	0	0.0010	--	--	--	--	--	--
06S11E	2	189	0	0.0000	--	--	--	--	--	--
07S12E	1	772	0	0.0000	--	--	--	--	--	--
08S12E	1	230	0	0.0130	--	--	--	--	--	--
08S14E	1	142	0	0.0301	--	--	--	--	--	--
09S13E	1	33	0	0.0250	--	--	--	--	--	--
09S15E	2	206	0	0.0204	0.0158	0.0166	0.0179	0.0192	0.0199	1
10S14E	1	73	0	0.0227	--	--	--	--	--	--
10S15E	2	327	0	0.0125	0.0120	0.0121	0.0122	0.0124	0.0125	1
12S14E	1	117	0	0.0462	--	--	--	--	--	--
12S19E	1	100	0	0.0277	--	--	--	--	--	--

B. Summary statistics for Grains A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	1	8.00	0.16	0.16	--	--	--	--	--	--
03S07E	1	15.00	0.05	0.05	--	--	--	--	--	--
06S11E	2	189.20	0.00	0.00	--	--	--	--	--	--
07S12E	1	772.00	0.00	0.00	--	--	--	--	--	--
08S12E	1	230.30	0.61	0.61	--	--	--	--	--	--
08S14E	1	141.50	1.41	1.41	--	--	--	--	--	--
09S13E	1	33.26	1.18	1.18	--	--	--	--	--	--
09S15E	2	206.00	0.72	0.96	0.74	0.78	0.84	0.90	1	1
10S14E	1	72.90	1.07	1.07	--	--	--	--	--	--
10S15E	2	327.00	0.56	0.66	0.57	0.59	0.61	0.64	1	1
12S14E	1	116.80	2.45	2.45	--	--	--	--	--	--
12S19E	1	100.00	1.30	1.30	--	--	--	--	--	--

C. Summary statistics for Grains A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	1	8	-178	-178	--	--	--	--	--	--
03S07E	1	15	-883	-883	--	--	--	--	--	--
06S11E	2	189	-1193	-49	-1079	-907	-621	-335	-164	1
08S12E	1	230	-53	-53	--	--	--	--	--	--
08S14E	1	142	59	59	--	--	--	--	--	--
09S13E	1	33	22	22	--	--	--	--	--	--
09S15E	2	206	-36	-6	-33	-28	-21	-13	-9	1
10S14E	1	73	9	9	--	--	--	--	--	--
10S15E	2	327	-46	-20	-44	-40	-33	-27	-23	1
12S14E	1	117	95	95	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
12S19E	1	100	30	30	--	--	--	--	--	--

Figure VIII-2. Box and Whisker plots of A/Y for Grains Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

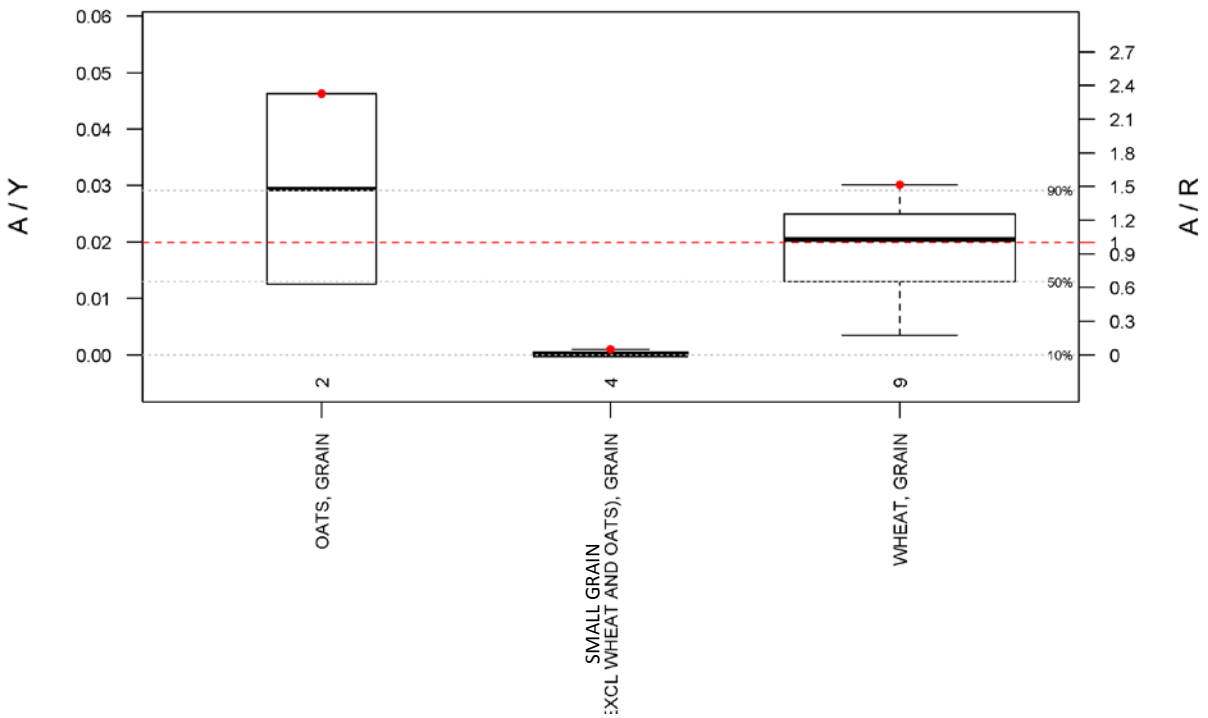


Table VIII-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Grains Management Units grouped by specific crop.

A. Summary statistics for Grains A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
OATS, GRAIN	2	192.8	0.0125	0.0462	0.0159	0.0209	0.0294	0.0378	0.0429	1
SMALL GRAIN (EXCL WHEAT AND OATS), GRAIN	5	1033.2	0.0000	0.0010	0.0000	0.0000	0.0000	0.0002	0.0007	1
WHEAT, GRAIN	9	1043.0	0.0035	0.0301	0.0103	0.0130	0.0204	0.0250	0.0281	1

B. Summary statistics for Grains A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

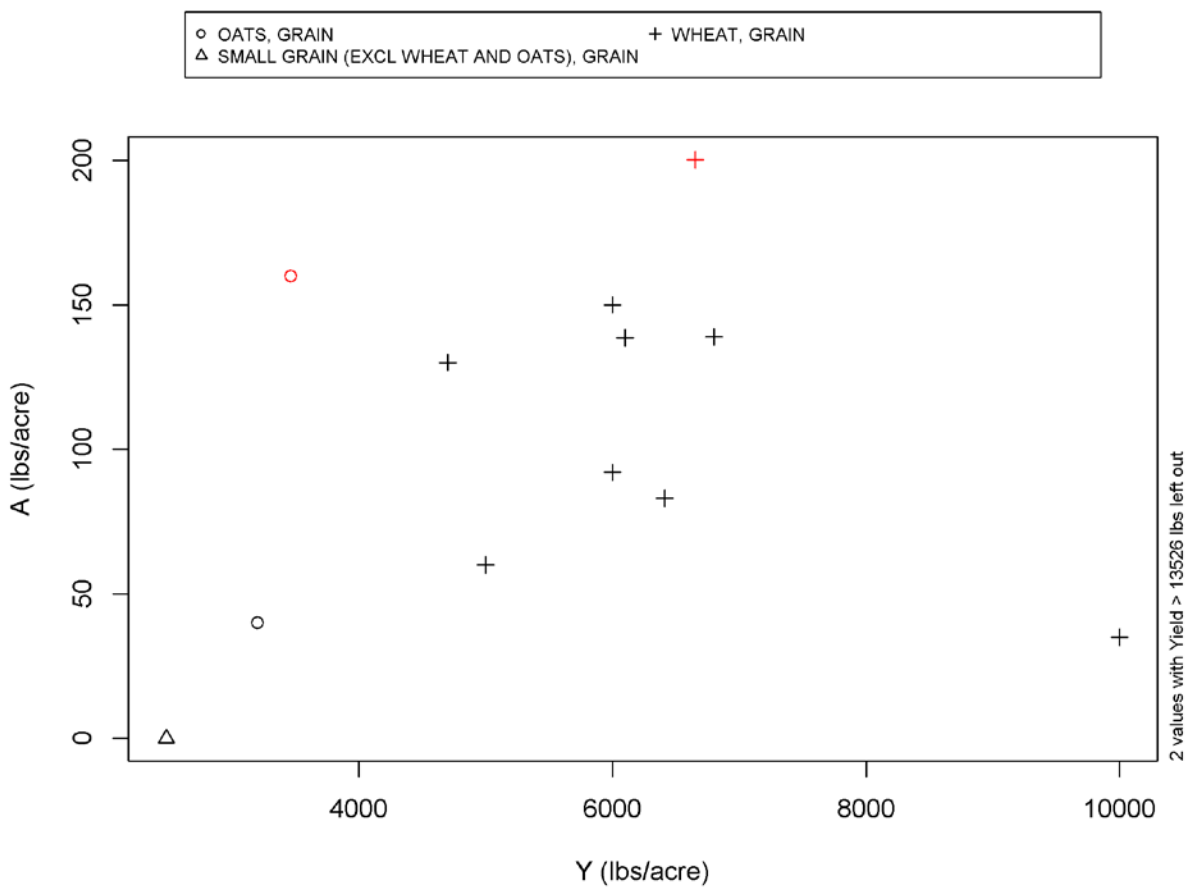
SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
OATS, GRAIN	2	192.8	0.66	2.45	0.84	1.11	1.56	2.01	2.27	1

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
SMALL GRAIN (EXCL WHEAT AND OATS), GRAIN	5	1033.2	0.00	0.05	0.00	0.00	0.00	0.01	0.03	1
WHEAT, GRAIN	9	1043.0	0.16	1.41	0.48	0.61	0.96	1.18	1.32	1

C. Summary statistics for Grains A-R. See the "Important Analysis Considerations" notes at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
OATS, GRAIN	2	192.8	-20	95	-9	8	37	66	83	1
SMALL GRAIN (EXCL WHEAT AND OATS), GRAIN	5	1033.2	-1193	-49	-1131	-1038	-883	-466	-216	1
WHEAT, GRAIN	9	1043.0	-178	59	-78	-46	-6	22	36	1

Figure VIII-3. Scatter plot of A vs. Y for Grains crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.



IX. GRAINS, CORN

Important Analysis Considerations:

The calculation of N removed at harvest for CORN, GRAIN assumes that 0.012 lbs N/lbs of grain at 15.5% moisture are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that Corn grain samples should be collected from Central Valley fields to determine whether the value is a good estimate for California.**

Figure IX-1. Box and Whisker plots of A/Y and A/R for Grains, Corn Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

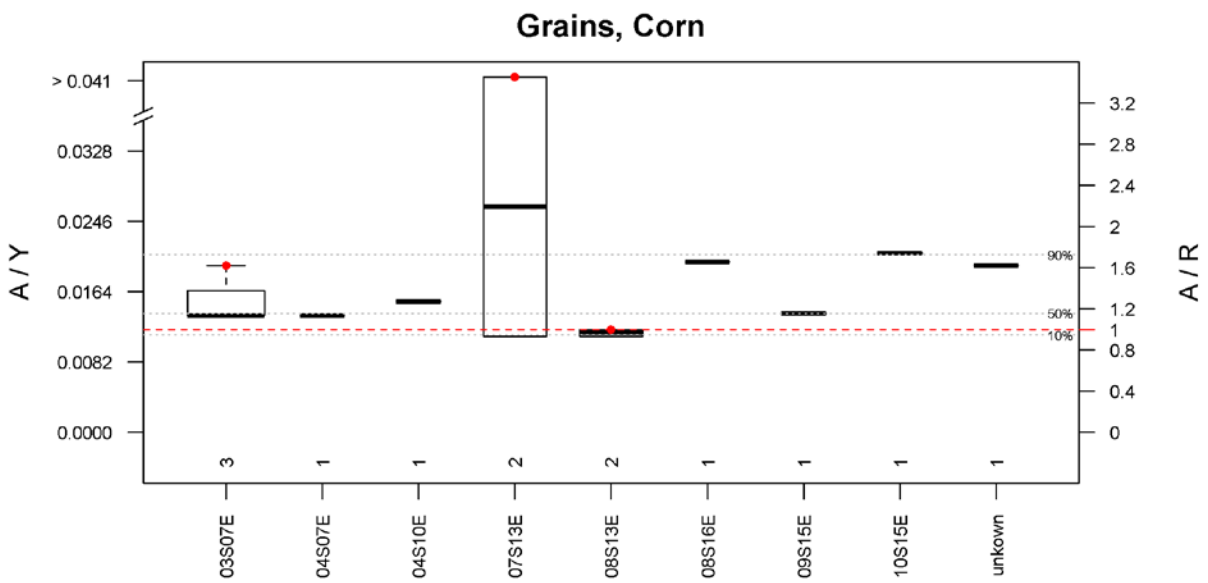


Table IX-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Grains, Corn Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Grains, Corn A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	3	199	0	0.0195	0.0136	0.0136	0.0136	0.0166	0.0183	1
04S07E	1	28	0	0.0136	--	--	--	--	--	--
04S10E	1	35	0	0.0153	--	--	--	--	--	--
07S13E	2	179	0	6.4545	0.6555	1.6220	3.2329	4.8437	5.8102	1
08S13E	2	65	0	0.0120	0.0113	0.0114	0.0116	0.0118	0.0119	1
08S16E	1	36	0	0.0199	--	--	--	--	--	--
09S15E	1	47	0	0.0139	--	--	--	--	--	--
10S15E	1	108	0	0.0209	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
unknown	1	40	0	0.0195	--	--	--	--	--	--

B. Summary statistics for Grains, Corn A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	3	199.25	1.14	1.62	1.14	1.14	1.14	1.38	2	1
04S07E	1	28.00	1.14	1.14	--	--	--	--	--	--
04S10E	1	35.00	1.27	1.27	--	--	--	--	--	--
07S13E	2	179.00	0.93	537.88	54.63	135.17	269.41	403.64	484	1
08S13E	2	65.00	0.93	1.00	0.94	0.95	0.97	0.98	1	1
08S16E	1	36.00	1.66	1.66	--	--	--	--	--	--
09S15E	1	47.00	1.16	1.16	--	--	--	--	--	--
10S15E	1	108.50	1.74	1.74	--	--	--	--	--	--
unknown	1	40.00	1.62	1.62	--	--	--	--	--	--

C. Summary statistics for Grains, Corn A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	3	199	18	58	18	18	18	38	50	1
04S07E	1	28	18	18	--	--	--	--	--	--
04S10E	1	35	56	56	--	--	--	--	--	--
07S13E	2	179	-10	142	5	28	66	104	127	1
08S13E	2	65	-10	0	-9	-7	-5	-2	-1	1
08S16E	1	36	104	104	--	--	--	--	--	--
09S15E	1	47	17	17	--	--	--	--	--	--
10S15E	1	108	64	64	--	--	--	--	--	--
unknown	1	40	58	58	--	--	--	--	--	--

Figure IX-2. Box and Whisker plots of A/Y for Grains, Corn Management Units.
Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

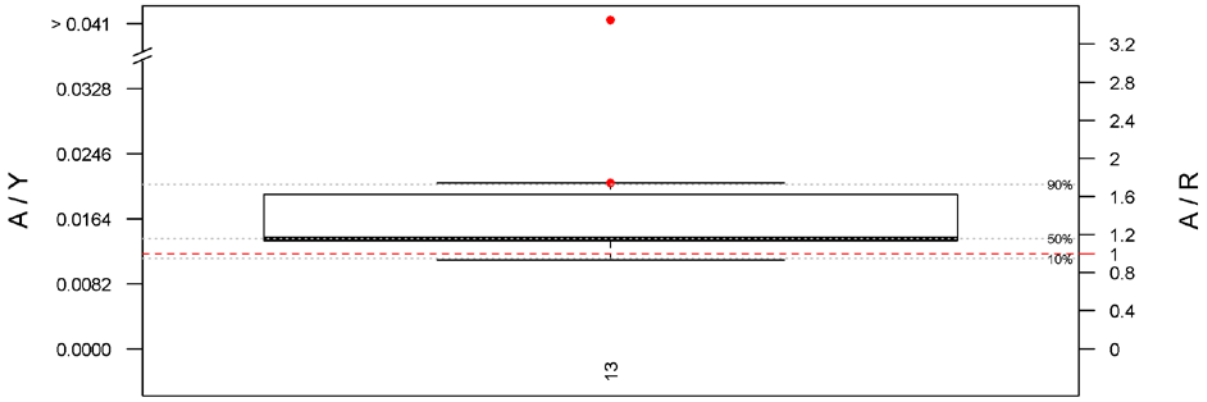


Table IX-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Grains, Corn Management Units grouped by specific crop.

A. Summary statistics for Grains, Corn A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CORN, GRAIN	13	737.8	0.0112	6.4545	0.0114	0.0136	0.0139	0.0195	0.0207	2

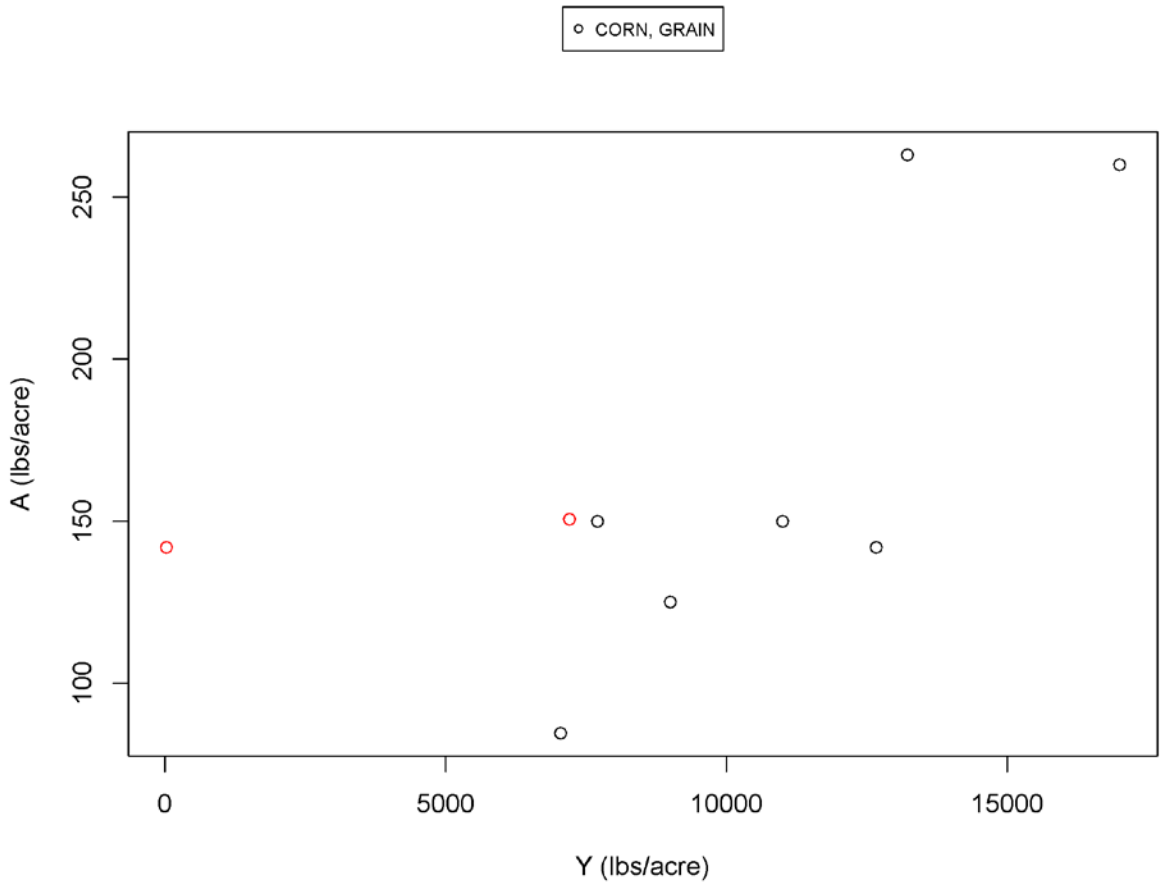
B. Summary statistics for Grains, Corn A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CORN, GRAIN	13	737.8	0.93	537.88	0.95	1.14	1.16	1.62	1.73	2

C. Summary statistics for Grains, Corn A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CORN, GRAIN	13	737.8	-10	142	-8	17	18	58	96	2

Figure IX-3. Scatter plot of A vs. Y for Grains, Corn crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.



X.GRAPES

Important Analysis Considerations:

The calculation of N removed at harvest for GRAPES, TABLE assumes that 0.00113 lbs N/lbs of grapes are removed at harvest. This estimate is obtained from Geisseler (2016). **The value is a good estimate of N removed with 'Thompson Seedless' grapes from California vineyards. However, it likely underestimates the variability of grape N concentrations in commercial vineyards.**

The calculation of N removed at harvest for GRAPES, WINE assumes that 0.0018 lbs N/lbs of grapes are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that it cannot be determined the degree to which the average value in the table is representative for wine grapes from California.**

A number of growers did not report the kind of grapes grown. For these, the calculation of N removed at harvest for GRAPES, NR assumes that 0.001465 lbs N/lbs of grapes are removed at harvest. This estimate is an average of N removal from wine and table grapes. **Because both ranges overlap substantially, the average may be reasonable for the Central Valley.**

Figure X-1. Box and Whisker plots of A/Y and A/R for Grapes Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

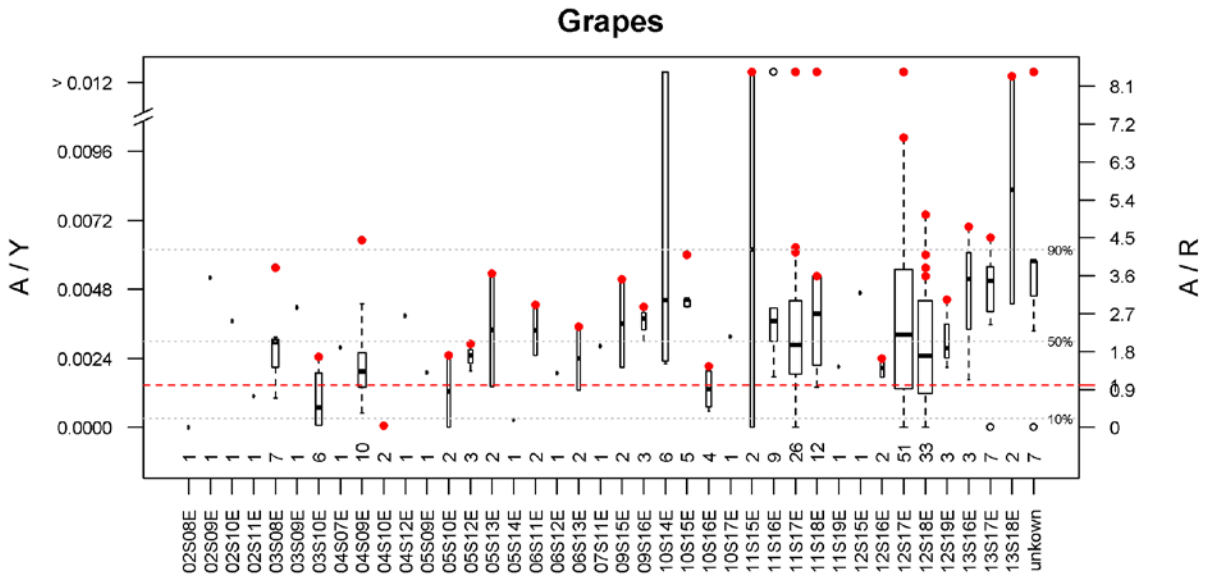


Table X-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Grapes Management Units grouped by TR blocks.

TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Grapes A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	1	50	0	0.0000	--	--	--	--	--	--
02S09E	1	24	0	0.0052	--	--	--	--	--	--
02S10E	1	8	0	0.0037	--	--	--	--	--	--
02S11E	1	218	0	0.0011	--	--	--	--	--	--
03S08E	7	375	0	0.0055	0.0014	0.0021	0.0030	0.0031	0.0041	1
03S09E	1	10	0	0.0042	--	--	--	--	--	--
03S10E	6	1212	0	0.0024	0.0001	0.0002	0.0007	0.0016	0.0022	1
04S07E	1	30	0	0.0028	--	--	--	--	--	--
04S09E	10	576	0	0.0065	0.0012	0.0015	0.0019	0.0026	0.0045	1
04S10E	2	39	0	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	1
04S12E	1	56	0	0.0039	--	--	--	--	--	--
05S09E	1	75	0	0.0019	--	--	--	--	--	--
05S10E	2	28	0	0.0025	0.0003	0.0006	0.0012	0.0019	0.0022	1
05S12E	3	326	0	0.0029	0.0021	0.0022	0.0025	0.0027	0.0028	1
05S13E	2	2779	0	0.0054	0.0018	0.0024	0.0034	0.0044	0.0050	1
05S14E	1	112	0	0.0003	--	--	--	--	--	--
06S11E	2	4521	0	0.0043	0.0027	0.0029	0.0034	0.0038	0.0041	1
06S12E	1	18	0	0.0019	--	--	--	--	--	--
06S13E	2	65	0	0.0035	0.0015	0.0018	0.0024	0.0029	0.0033	1
07S11E	1	38	0	0.0028	--	--	--	--	--	--
09S15E	2	758	0	0.0051	0.0024	0.0028	0.0036	0.0044	0.0048	1
09S16E	3	226	0	0.0042	0.0032	0.0034	0.0038	0.0040	0.0041	1
10S14E	6	3485	0	0.0614	0.0023	0.0028	0.0044	0.0381	0.0553	1
10S15E	5	548	0	0.0060	0.0042	0.0042	0.0044	0.0044	0.0054	1
10S16E	4	372	0	0.0021	0.0007	0.0008	0.0013	0.0019	0.0020	1
10S17E	1	425	0	0.0032	--	--	--	--	--	--
11S15E	2	1060	0	1.4545	0.1455	0.3636	0.7273	1.0909	1.3091	1
11S16E	9	989	0	2.5333	0.0025	0.0030	0.0037	0.0041	1.3867	1
11S17E	26	1943	0	12.6250	0.0007	0.0019	0.0029	0.0043	0.0057	3
11S18E	12	476	0	0.0183	0.0020	0.0022	0.0040	0.0052	0.0052	5
11S19E	1	1262	0	0.0021	--	--	--	--	--	--
12S15E	1	1405	0	0.0047	--	--	--	--	--	--
12S16E	2	1567	0	0.0024	0.0018	0.0019	0.0021	0.0022	0.0023	1
12S17E	51	5439	0	4.6836	0.0000	0.0014	0.0032	0.0055	0.0100	5
12S18E	34	1866	0	0.0074	0.0001	0.0012	0.0025	0.0044	0.0051	4
12S19E	4	350	0	0.0044	0.0022	0.0024	0.0028	0.0036	0.0041	1
13S16E	3	1893	0	0.0070	0.0024	0.0034	0.0052	0.0061	0.0066	1
13S17E	7	1470	0	0.0066	0.0021	0.0040	0.0051	0.0056	0.0063	1
13S18E	2	225	0	0.0122	0.0051	0.0063	0.0083	0.0102	0.0114	1
unknown	7	206	0	0.1178	0.0020	0.0046	0.0058	0.0058	0.0506	1

B. Summary statistics for Grapes A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	1	50.00	0.00	0.00	--	--	--	--	--	--
02S09E	1	24.00	2.89	2.89	--	--	--	--	--	--
02S10E	1	8.00	2.06	2.06	--	--	--	--	--	--
02S11E	1	218.00	0.61	0.61	--	--	--	--	--	--
03S08E	7	374.69	0.91	3.08	0.92	1.16	1.65	1.70	2	1
03S09E	1	9.50	2.31	2.31	--	--	--	--	--	--
03S10E	6	1212.45	0.05	1.36	0.05	0.12	0.38	0.89	1	1
04S07E	1	30.00	1.54	1.54	--	--	--	--	--	--
04S09E	10	575.60	0.28	3.61	0.65	0.82	1.08	1.43	3	1
04S10E	2	39.46	0.00	0.04	0.00	0.01	0.02	0.03	0	1
04S12E	1	56.00	2.15	2.15	--	--	--	--	--	--
05S09E	1	75.04	1.06	1.06	--	--	--	--	--	--
05S10E	2	28.00	0.00	1.39	0.14	0.35	0.69	1.04	1	1
05S12E	3	326.48	1.09	1.61	1.15	1.24	1.39	1.50	2	1
05S13E	2	2779.00	0.79	2.98	1.01	1.34	1.88	2.43	3	1
05S14E	1	112.00	0.14	0.14	--	--	--	--	--	--
06S11E	2	4520.80	2.21	2.37	2.23	2.25	2.29	2.33	2	1
06S12E	1	17.50	1.05	1.05	--	--	--	--	--	--
06S13E	2	65.00	0.71	1.94	0.84	1.02	1.33	1.64	2	1
07S11E	1	37.50	1.57	1.57	--	--	--	--	--	--
09S15E	2	758.00	1.16	2.86	1.33	1.58	2.01	2.43	3	1
09S16E	3	226.00	1.67	2.33	1.75	1.89	2.11	2.22	2	1
10S14E	6	3485.44	1.23	34.14	1.25	1.53	2.46	21.14	31	1
10S15E	5	547.90	2.33	5.31	2.38	2.47	2.47	3.73	5	1
10S16E	4	371.50	0.32	1.18	0.36	0.44	0.73	1.04	1	1
10S17E	1	425.00	1.76	1.76	--	--	--	--	--	--
11S15E	2	1060.00	0.00	808.08	80.81	202.02	404.04	606.06	727	1
11S16E	9	988.97	0.98	1407.41	1.41	1.76	2.23	2.65	770	1
11S17E	26	1943.22	0.00	7013.89	0.41	1.05	1.59	2.40	3	3
11S18E	12	476.14	0.78	12.49	1.13	1.21	2.45	2.92	3	1
11S19E	1	1262.00	1.17	1.17	--	--	--	--	--	--
12S15E	1	1404.69	2.60	2.60	--	--	--	--	--	--
12S16E	2	1567.00	0.97	1.33	1.00	1.06	1.15	1.24	1	1
12S17E	51	5439.10	0.00	2602.02	0.00	0.79	1.98	3.32	6	5
12S18E	34	1866.16	0.00	6.55	0.06	0.66	1.92	2.44	3	4
12S19E	4	350.00	1.53	2.47	1.59	1.69	1.84	2.16	2	1
13S16E	3	1893.30	0.92	3.87	1.31	1.90	2.88	3.37	4	1
13S17E	7	1470.05	0.00	3.67	1.19	2.24	2.83	3.10	3	1
13S18E	2	224.81	2.39	10.82	3.23	4.50	6.60	8.71	10	1
unknown	7	206.08	0.00	65.45	1.12	2.54	3.21	3.21	28	1

C. Summary statistics for Grapes A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	1	50	-48	-48	--	--	--	--	--	--
02S09E	1	24	82	82	--	--	--	--	--	--
02S10E	1	8	36	36	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S11E	1	218	-11	-11	--	--	--	--	--	--
03S08E	7	375	-3	69	-3	3	27	29	46	1
03S09E	1	10	57	57	--	--	--	--	--	--
03S10E	6	1212	-38	17	-37	-35	-29	-6	10	1
04S07E	1	30	18	18	--	--	--	--	--	--
04S09E	10	576	-29	25	-12	-6	2	11	21	1
04S10E	2	39	-28	-3	-26	-22	-15	-9	-5	1
04S12E	1	56	33	33	--	--	--	--	--	--
05S09E	1	75	2	2	--	--	--	--	--	--
05S10E	2	28	14	14	--	--	--	--	--	--
05S12E	3	326	2	13	2	4	6	9	12	1
05S13E	2	2779	-9	100	2	18	45	72	89	1
05S14E	1	112	-34	-34	--	--	--	--	--	--
06S11E	2	4521	27	52	30	33	40	46	49	1
06S12E	1	18	2	2	--	--	--	--	--	--
06S13E	2	65	-14	45	-8	1	15	30	39	1
07S11E	1	38	16	16	--	--	--	--	--	--
09S15E	2	758	5	94	14	27	50	72	85	1
09S16E	3	226	23	100	33	49	76	88	95	1
10S14E	6	3485	6	155	11	34	100	120	139	1
10S15E	5	548	2	117	40	95	95	100	110	1
10S16E	4	372	-36	10	-31	-23	-9	2	7	1
10S17E	1	425	27	27	--	--	--	--	--	--
11S15E	2	1060	-54	16	-47	-37	-19	-2	9	1
11S16E	9	989	-1	50	9	17	34	38	41	1
11S17E	26	1943	-42	107	-9	3	17	56	79	3
11S18E	12	476	-11	56	4	6	27	56	56	0
11S19E	1	1262	6	6	--	--	--	--	--	--
12S15E	1	1405	101	101	--	--	--	--	--	--
12S16E	2	1567	-2	14	0	2	6	10	13	1
12S17E	51	5439	-51	218	-24	6	33	64	89	5
12S18E	34	1866	-40	110	-18	-5	30	42	75	4
12S19E	4	350	23	31	24	26	30	30	31	1
13S16E	3	1893	-3	74	9	27	57	66	71	1
13S17E	7	1470	25	134	43	63	73	82	110	1
13S18E	2	225	50	90	54	60	70	80	86	1
unknown	7	206	34	212	65	96	96	96	154	1

Figure X-2. Box and Whisker plots of A/Y for Grapes Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

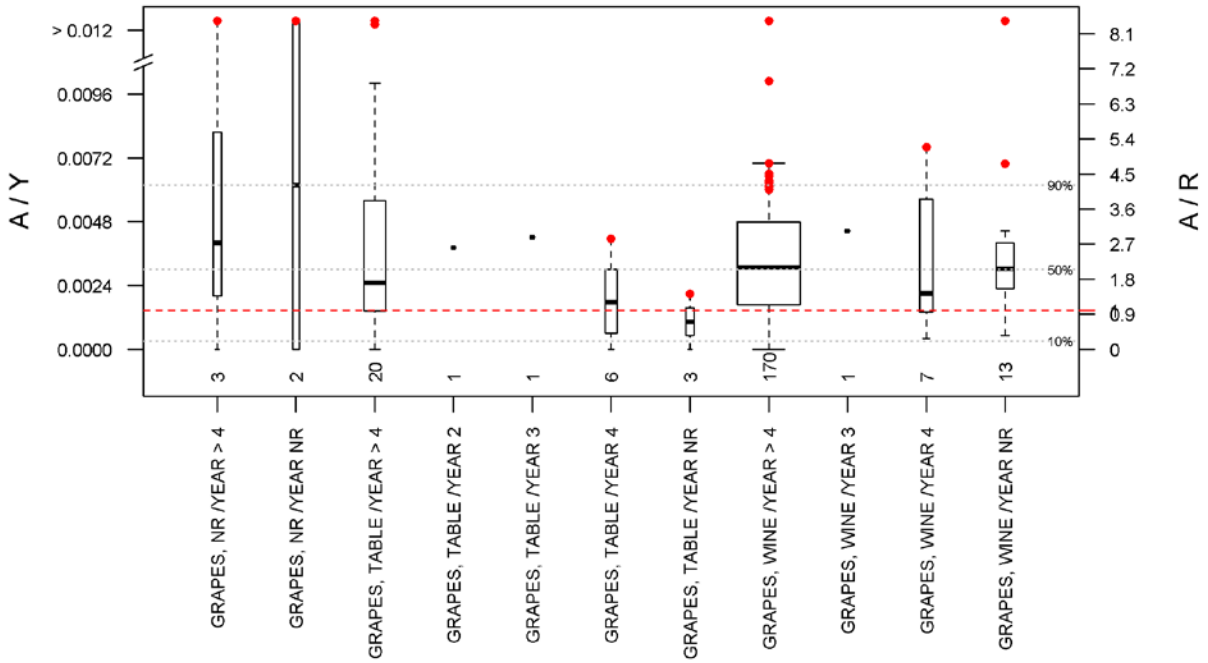


Table X-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Grapes Management Units grouped by specific crop.

A. Summary statistics for Grapes A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
GRAPES, NR /YEAR > 4	3	62.9	0.0000	0.0170	0.0008	0.0020	0.0040	0.0105	0.0144	1
GRAPES, NR /YEAR NR	2	79.5	0.0000	0.0183	0.0018	0.0046	0.0091	0.0137	0.0165	1
GRAPES, TABLE /YEAR > 4	20	1016.6	0.0000	0.0254	0.0000	0.0014	0.0025	0.0054	0.0102	2
GRAPES, TABLE /YEAR 2	1	21.1	0.0038	0.0038	--	--	--	--	--	--
GRAPES, TABLE /YEAR 3	1	83.0	0.0042	0.0042	--	--	--	--	--	--
GRAPES, TABLE /YEAR 4	6	274.8	0.0000	0.0042	0.0003	0.0008	0.0018	0.0028	0.0036	1
GRAPES, TABLE /YEAR NR	4	834.8	0.0000	0.0021	0.0002	0.0005	0.0010	0.0016	0.0019	1
GRAPES, WINE /YEAR > 4	170	30815.3	0.0000	12.6250	0.0004	0.0017	0.0031	0.0048	0.0058	17
GRAPES, WINE /YEAR 3	1	17.0	0.0044	0.0044	--	--	--	--	--	--

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
GRAPES, WINE /YEAR 4	7	1603.0	0.0004	0.0076	0.0008	0.0014	0.0021	0.0057	0.0067	1
GRAPES, WINE /YEAR NR	14	1716.4	0.0005	0.0492	0.0009	0.0023	0.0030	0.0040	0.0065	2

B. Summary statistics for Grapes A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
GRAPES, NR /YEAR > 4	3	62.9	0.00	11.60	0.55	1.37	2.73	7.17	9.83	1
GRAPES, NR /YEAR NR	2	79.5	0.00	12.49	1.25	3.12	6.24	9.36	11.24	1
GRAPES, TABLE /YEAR > 4	20	1016.6	0.00	22.49	0.00	1.28	2.21	4.76	9.05	2
GRAPES, TABLE /YEAR 2	1	21.1	3.39	3.39	--	--	--	--	--	--
GRAPES, TABLE /YEAR 3	1	83.0	3.73	3.73	--	--	--	--	--	--
GRAPES, TABLE /YEAR 4	6	274.8	0.00	3.69	0.26	0.73	1.57	2.44	3.17	1
GRAPES, TABLE /YEAR NR	4	834.8	0.00	1.84	0.18	0.45	0.91	1.38	1.66	1
GRAPES, WINE /YEAR > 4	170	30815.3	0.00	7013.89	0.22	0.94	1.71	2.66	3.24	17
GRAPES, WINE /YEAR 3	1	17.0	2.47	2.47	--	--	--	--	--	--
GRAPES, WINE /YEAR 4	7	1603.0	0.23	4.22	0.44	0.78	1.17	3.14	3.71	1
GRAPES, WINE /YEAR NR	14	1716.4	0.29	27.31	0.49	1.27	1.68	2.22	3.59	2

C. Summary statistics for Grapes A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
GRAPES, NR /YEAR > 4	3	62.9	-3	78	4	14	30	54	68	1
GRAPES, NR /YEAR NR	2	79.5	55	55	--	--	--	--	--	--
GRAPES, TABLE /YEAR > 4	20	1016.6	-24	209	0	10	35	51	83	2
GRAPES, TABLE /YEAR 2	1	21.1	40	40	--	--	--	--	--	--
GRAPES, TABLE /YEAR 3	1	83.0	117	117	--	--	--	--	--	--
GRAPES, TABLE /YEAR 4	6	274.8	-14	85	-4	10	18	50	71	1
GRAPES, TABLE /YEAR NR	4	834.8	-3	23	-1	3	10	16	20	1
GRAPES, WINE /YEAR > 4	170	30815.3	-54	218	-22	0	21	56	96	17
GRAPES, WINE /YEAR 3	1	17.0	95	95	--	--	--	--	--	--
GRAPES, WINE /YEAR 4	7	1603.0	-24	186	-21	-10	6	76	126	1
GRAPES, WINE /YEAR NR	14	1716.4	-28	123	-7	11	29	45	89	2

Figure X-3. Scatter plot of A vs. Y for Grapes crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

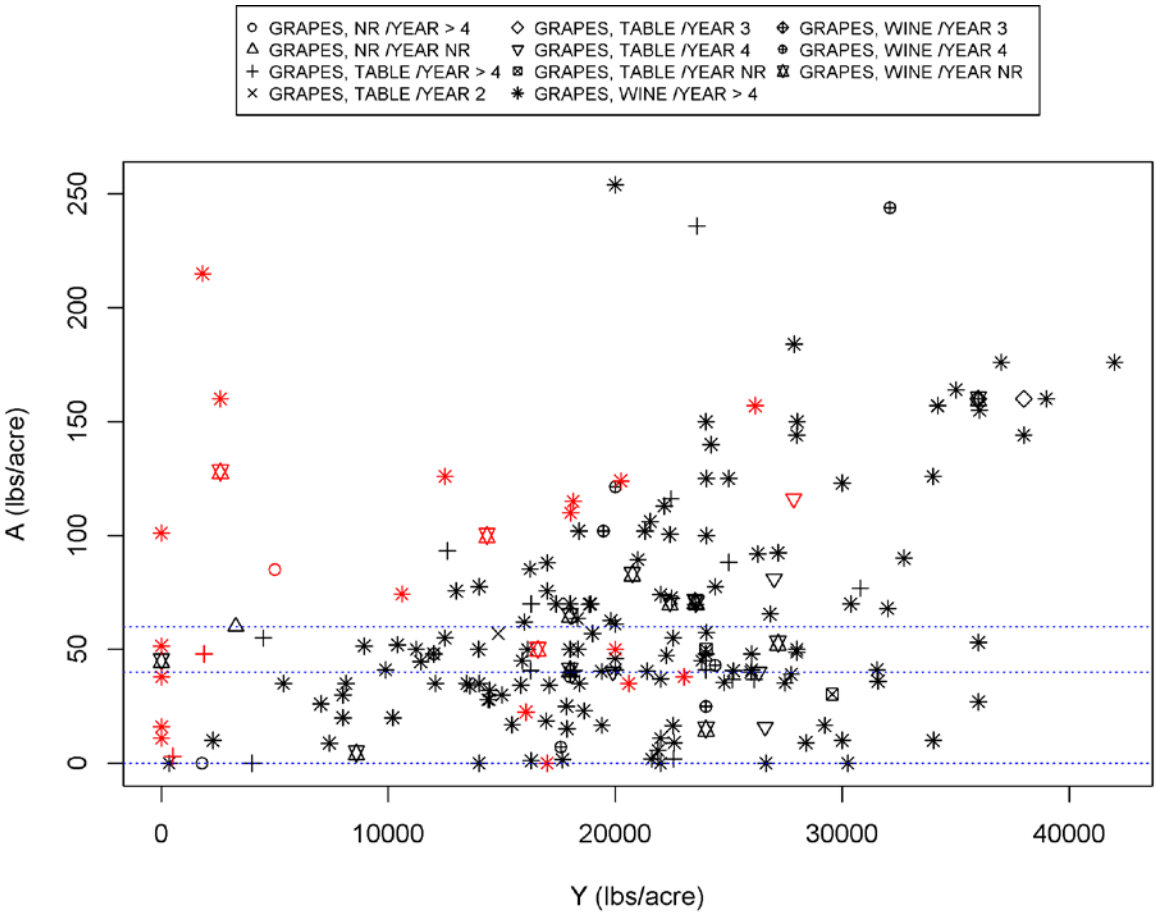


Table X-3. List of recommended nitrogen application values for Grapes (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Grapes	20	60	Values for furrow irrigated operations. Lower values recommended for medium vigor vines; highest for weak vigor, inadequate canopy and sandy soils.	CDFA
Grapes	0	0	Value for vineyard with vigorous vines and some excess growth. Grapevines have a low N fertilizer requirement compared to most other crops. On average about 2.9 lbs of N is removed from the vineyard in one ton (2000 lbs) of fresh grapes.	
Grapes	10	40	Value for drip irrigated operations. Lower values recommended for medium vigor vines; highest for weak vigor, inadequate canopy and sandy soils.	CDFA

CDFA - https://www.cdfa.ca.gov/is/ffldrs/frep/

XI. GRAPES, RAISINS

Important Analysis Considerations:

The calculation of N removed at harvest for GRAPES, RAISINS assumes that 0.00505 lbs N/lbs of grapes at 15% moisture are removed at harvest. This estimate is obtained from Geisseler (2016). The same dataset was used to determine the N removed with table grapes and raisins. The only difference is the moisture content. **The value is a good estimate of N removed with 'Thompson Seedless' grapes from California vineyards. However, it likely underestimates the variability of grape N concentrations in commercial vineyards.**

The use of this estimate requires that growers reported the dry weight of the raisins. However, the Coalition is not certain that all growers reporting raisins provided the dry weight. If some growers reported yield as fresh weight, a different conversion factor should be used (the same one as table grapes). However, at the time of this analysis, there was not sufficient information about variability in raisin yields to confidently identify growers reporting fresh weight. Hence, the Coalition assumed that all farmers reported dry weight. This means that some MUs may be using an incorrect N Removal factor, and some A/R and A-R values in this section may be erroneous.

Figure XI-1. Box and Whisker plots of A/Y and A/R for Grapes, raisins Management Units grouped by TR blocks. Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

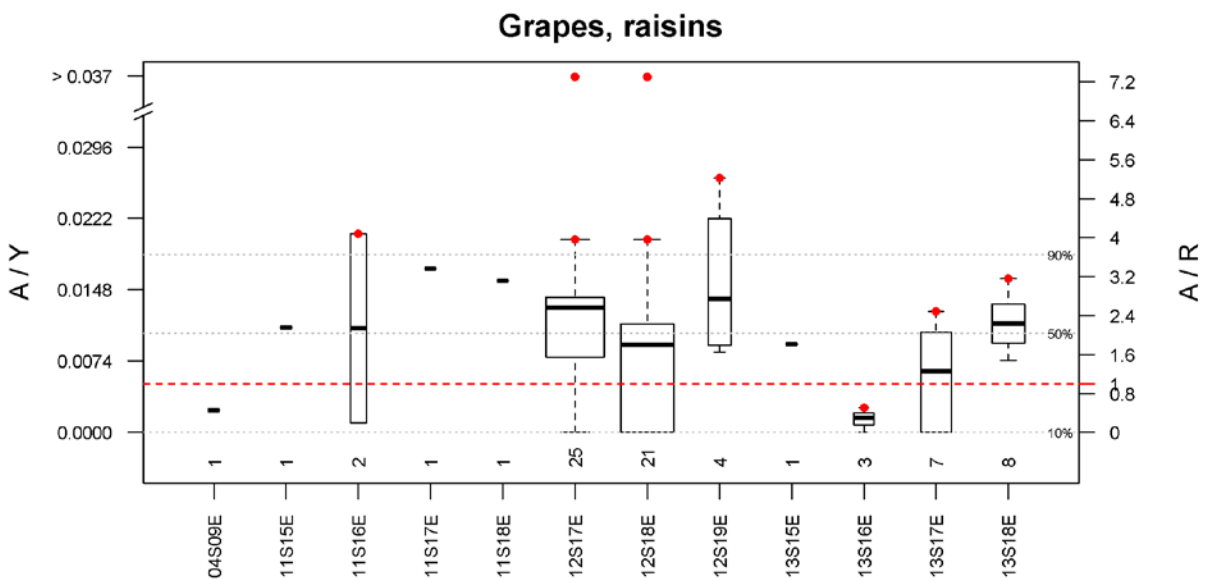


Table XI-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Grapes, raisins Management Units grouped by TR blocks.

TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Grapes, raisins A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S09E	1	20	0	0.0023	--	--	--	--	--	--
11S15E	1	965	0	0.0109	--	--	--	--	--	--
11S16E	2	70	0	0.0206	0.0030	0.0059	0.0108	0.0157	0.0186	1
11S17E	1	36	0	0.0170	--	--	--	--	--	--
11S18E	1	76	0	0.0158	--	--	--	--	--	--
12S17E	25	3295	0	0.0400	0.0006	0.0078	0.0129	0.0140	0.0194	3
12S18E	21	1993	0	0.1030	0.0000	0.0000	0.0091	0.0112	0.0132	2
12S19E	4	371	0	0.0264	0.0088	0.0094	0.0139	0.0201	0.0239	1
13S15E	1	2047	0	0.0092	--	--	--	--	--	--
13S16E	3	411	0	0.0026	0.0003	0.0008	0.0015	0.0020	0.0023	1
13S17E	7	259	0	0.0125	0.0000	0.0000	0.0063	0.0104	0.0125	1
13S18E	8	441	0	0.0160	0.0075	0.0102	0.0113	0.0132	0.0143	1

B. Summary statistics for Grapes, raisins A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S09E	1	20.00	0.45	0.45	--	--	--	--	--	--
11S15E	1	965.00	2.15	2.15	--	--	--	--	--	--
11S16E	2	69.50	0.20	4.08	0.59	1.17	2.14	3.11	4	1
11S17E	1	36.00	3.37	3.37	--	--	--	--	--	--
11S18E	1	76.00	3.12	3.12	--	--	--	--	--	--
12S17E	25	3294.69	0.00	7.92	0.13	1.54	2.56	2.77	4	3
12S18E	21	1992.93	0.00	20.40	0.00	0.00	1.80	2.23	3	2
12S19E	4	371.23	1.65	5.22	1.73	1.86	2.75	3.98	5	1
13S15E	1	2047.00	1.81	1.81	--	--	--	--	--	--
13S16E	3	411.00	0.00	0.50	0.06	0.15	0.30	0.40	0	1
13S17E	7	259.00	0.00	2.48	0.00	0.00	1.25	2.05	2	1
13S18E	8	441.00	1.48	3.16	1.49	2.01	2.23	2.60	3	1

C. Summary statistics for Grapes, raisins A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S09E	1	20	-24	-24	--	--	--	--	--	--
11S15E	1	965	47	47	--	--	--	--	--	--
11S16E	2	70	-49	78	-36	-17	15	46	65	1
11S17E	1	36	72	72	--	--	--	--	--	--
11S18E	1	76	43	43	--	--	--	--	--	--
12S17E	25	3295	-20	206	-13	19	37	45	51	2
12S18E	21	1993	-28	196	-16	-10	21	28	37	2
12S19E	4	371	20	117	25	33	45	68	98	1
13S15E	1	2047	40	40	--	--	--	--	--	--
13S16E	3	411	-20	-15	-20	-20	-19	-17	-16	1

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
13S17E	7	259	-26	31	-23	-19	8	22	28	1
13S18E	8	441	11	51	17	25	30	39	46	1

Figure XI-2. Box and Whisker plots of A/Y for Grapes, raisins Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

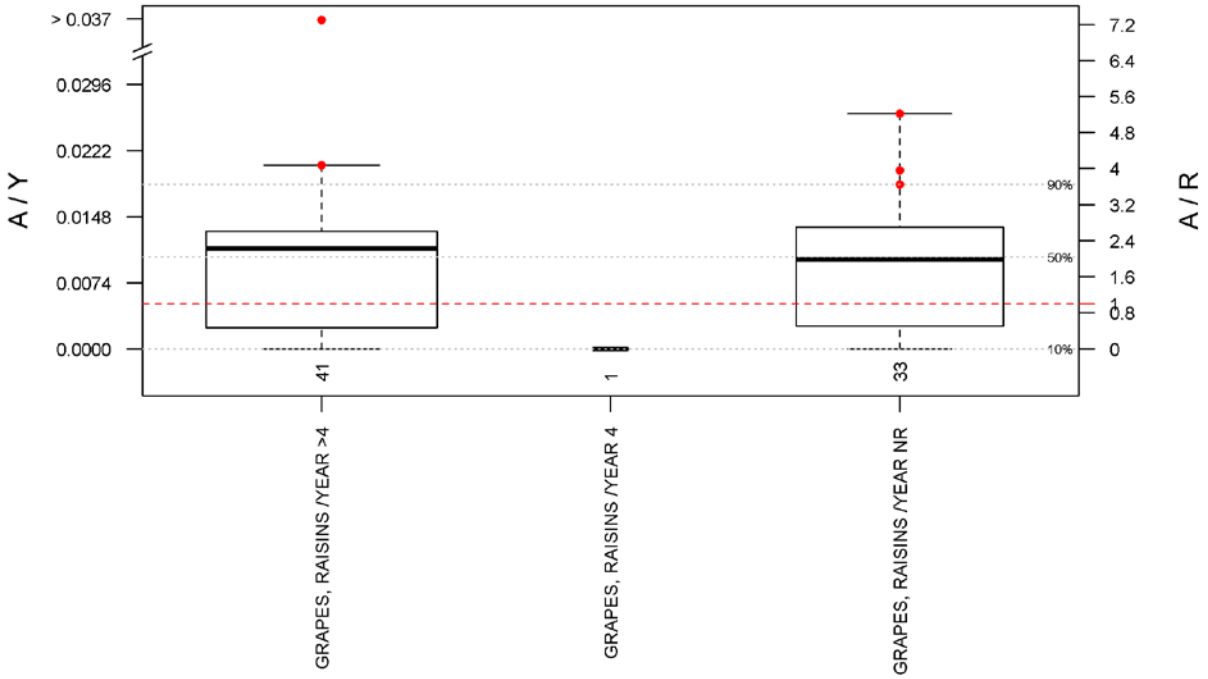


Table XI-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Grapes, raisins Management Units grouped by specific crop.

A. Summary statistics for Grapes, raisins A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
GRAPES, RAISINS /YEAR >4	41	5482.9	0	0.1030	0e+00	0.0024	0.0112	0.0132	0.0200	3
GRAPES, RAISINS /YEAR 4	1	77.2	0	0.0000	--	--	--	--	--	--
GRAPES, RAISINS /YEAR NR	33	4423.2	0	0.0264	3e-04	0.0026	0.0100	0.0136	0.0183	4

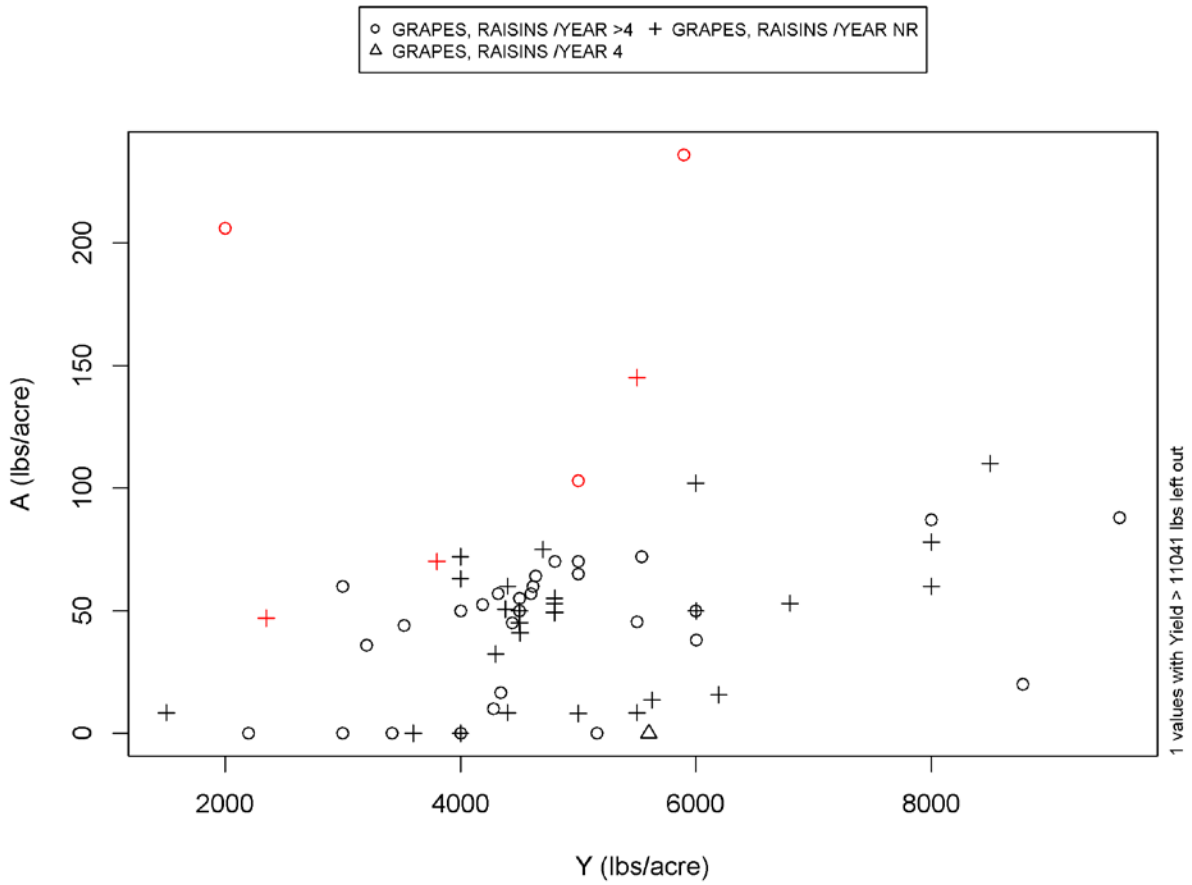
B. Summary statistics for Grapes, raisins A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
GRAPES, RAISINS /YEAR >4	41	5482.9	0	20.40	0.00	0.47	2.23	2.61	3.96	3
GRAPES, RAISINS /YEAR 4	1	77.2	0	0.00	--	--	--	--	--	--
GRAPES, RAISINS /YEAR NR	33	4423.2	0	5.22	0.06	0.50	1.98	2.70	3.63	4

C. Summary statistics for Grapes, raisins A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
GRAPES, RAISINS /YEAR >4	41	5482.9	-49	206	-18	10	32	41	46	4
GRAPES, RAISINS /YEAR 4	1	77.2	-28	-28	--	--	--	--	--	--
GRAPES, RAISINS /YEAR NR	33	4423.2	-20	117	-18	-3	25	39	52	4

Figure XI-3. Scatter plot of A vs. Y for Grapes, raisins crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.



XII. GREENS

Important Analysis Considerations:

The calculation of N removed at harvest for SALAD GREENS assumes that 0.0016lbs N/lbs fresh weight are removed at harvest. This estimate is obtained from Geisseler (2016). This value is an average of iceberg and romaine lettuce. **Geisseler believes that the value is likely a good estimate of N concentrations in the Central Valley, even though most of the data are from the Salinas Valley.**

Figure XII-1. Box and Whisker plots of A/Y for Greens Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

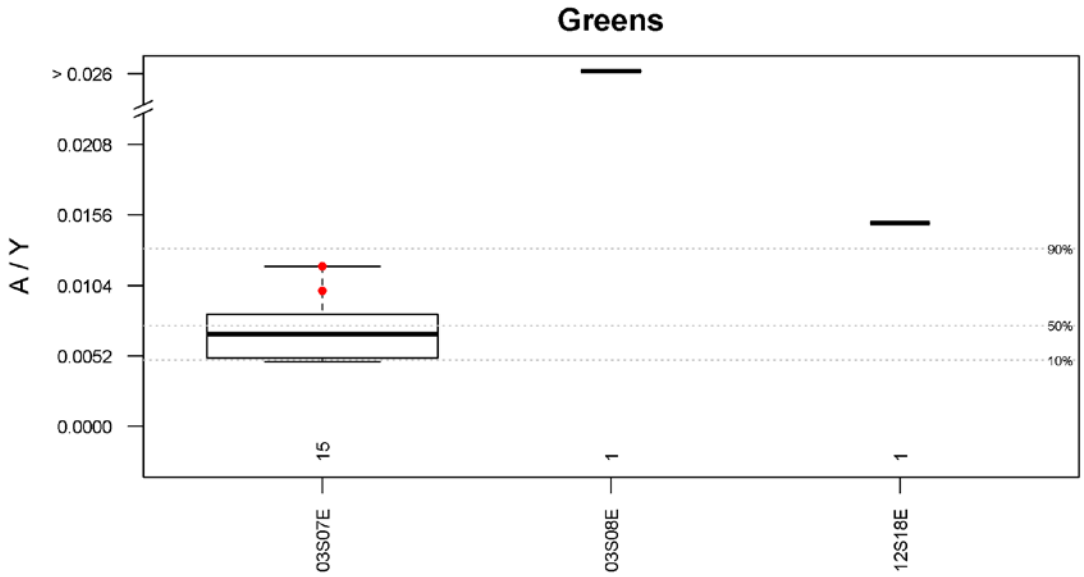


Table XII-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Greens Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Greens A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	15	980	0	0.0118	0.0049	0.005	0.0068	0.0083	0.0096	2
03S08E	1	1	0	0.4000	--	--	--	--	--	--
12S18E	1	17	0	0.0150	--	--	--	--	--	--

B. Summary statistics for Greens A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	15	980.22	3.06	7.57	3.12	3.22	4.36	5.3	6	2

C. Summary statistics for Greens A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	15	980	94	174	94	107	120	151	158	1

Figure XII-2. Box and Whisker plots of A/Y for Greens Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

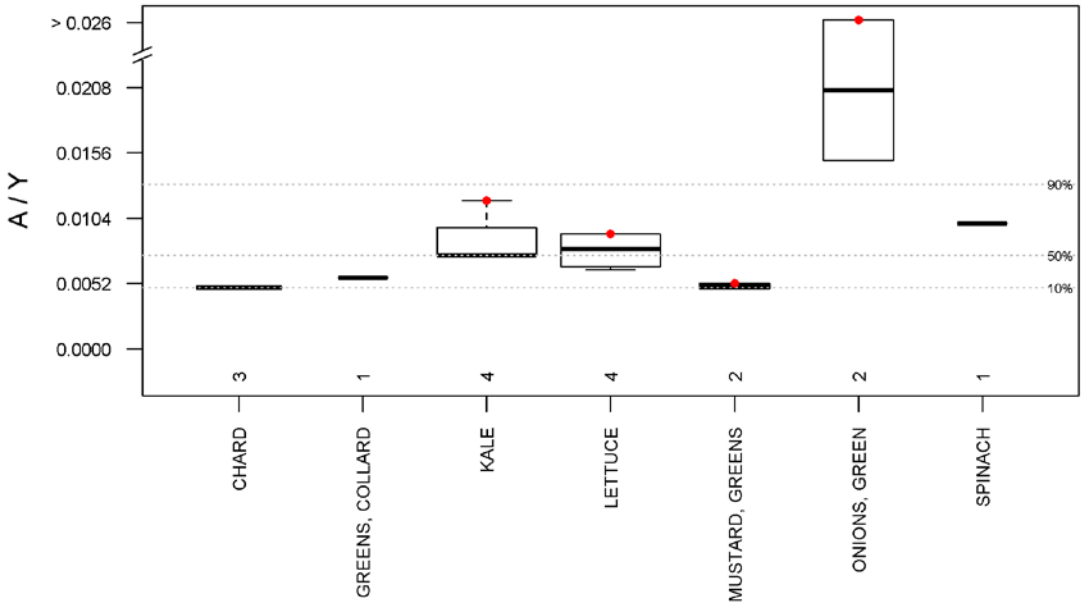


Table XII-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Greens Management Units grouped by specific crop.

A. Summary statistics for Greens A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CHARD	3	130.1	0.0049	0.0049	--	--	--	--	--	--
GREENS, COLLARD	1	128.2	0.0057	0.0057	--	--	--	--	--	--

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
KALE	4	122.9	0.0074	0.0118	0.0074	0.0074	0.0074	0.0085	0.0105	1
LETTUCE	4	385.9	0.0063	0.0091	0.0064	0.0067	0.0080	0.0091	0.0091	1
MUSTARD, GREENS	2	148.1	0.0048	0.0052	0.0048	0.0049	0.0050	0.0051	0.0052	1
ONIONS, GREEN	2	18.0	0.0150	0.4000	0.0535	0.1112	0.2075	0.3038	0.3615	1
SPINACH	1	65.1	0.0100	0.0100	--	--	--	--	--	--

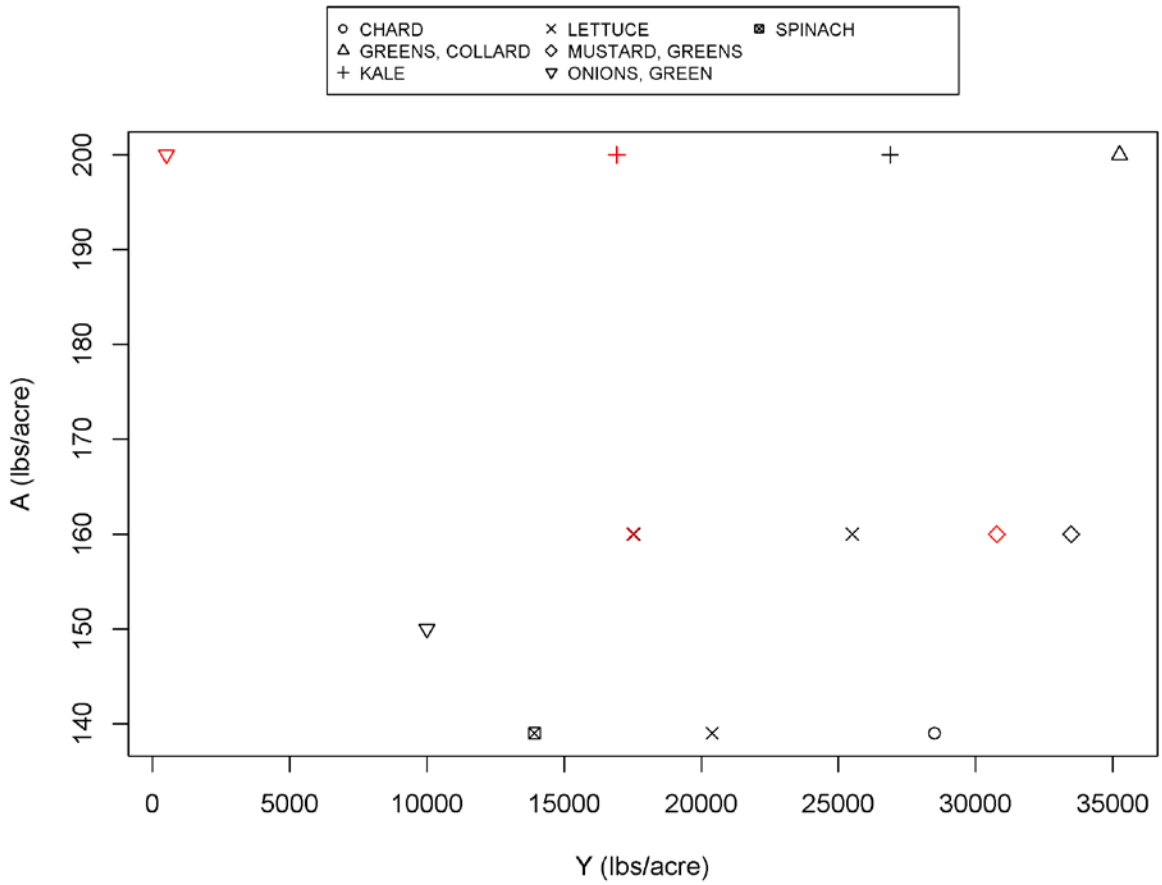
B. Summary statistics for Greens A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CHARD	3	130.1	3.12	3.12	--	--	--	--	--	--
GREENS, COLLARD	1	128.2	3.63	3.63	--	--	--	--	--	--
KALE	4	122.9	4.76	7.57	4.76	4.76	4.76	5.46	6.72	1
LETTUCE	4	385.9	4.02	5.85	4.12	4.27	5.10	5.84	5.84	1
MUSTARD, GREENS	2	148.1	3.06	3.33	3.09	3.13	3.19	3.26	3.30	1
SPINACH	1	65.1	6.39	6.39	--	--	--	--	--	--

C. Summary statistics for Greens A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CHARD	3	130.1	94	94	--	--	--	--	--	--
GREENS, COLLARD	1	128.2	145	145	--	--	--	--	--	--
KALE	4	122.9	158	174	158	158	158	162	169	1
LETTUCE	4	385.9	107	133	111	117	126	133	133	1
MUSTARD, GREENS	2	148.1	108	112	108	109	110	111	111	1
SPINACH	1	65.1	117	117	--	--	--	--	--	--

Figure XII-3. Scatter plot of A vs. Y for Greens crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.



XIII. HAY

Important Analysis Considerations:

The calculation of N removed at harvest for FORAGE GRASS, HAY assumes that 0.0267 lbs N/lbs at 12% moisture are removed at harvest. This estimate is obtained from Geisseler (2016). The value is an average of fescue, orchard grass, and rye grass. All values are very similar to each other. However, they are all from the same trial that was fertilized for maximum yield. Hence, they may overestimate the N concentrations and **may not be representative of all operations in the Central Valley.**

The calculation of N removed at harvest for OATS, HAY assumes that 0.01085 lbs N/lbs at 12% moisture are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that this is a good estimate of the average N concentration in oat hay produced in the Central Valley.**

There is no N Removal Factor available for other small grains including wheat hay. As a result, summary statistics for A/R and A-R by TR are based only on Forage grass and Oats MUs.

Figure XIII-1. Box and Whisker plots of A/Y for Hay Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

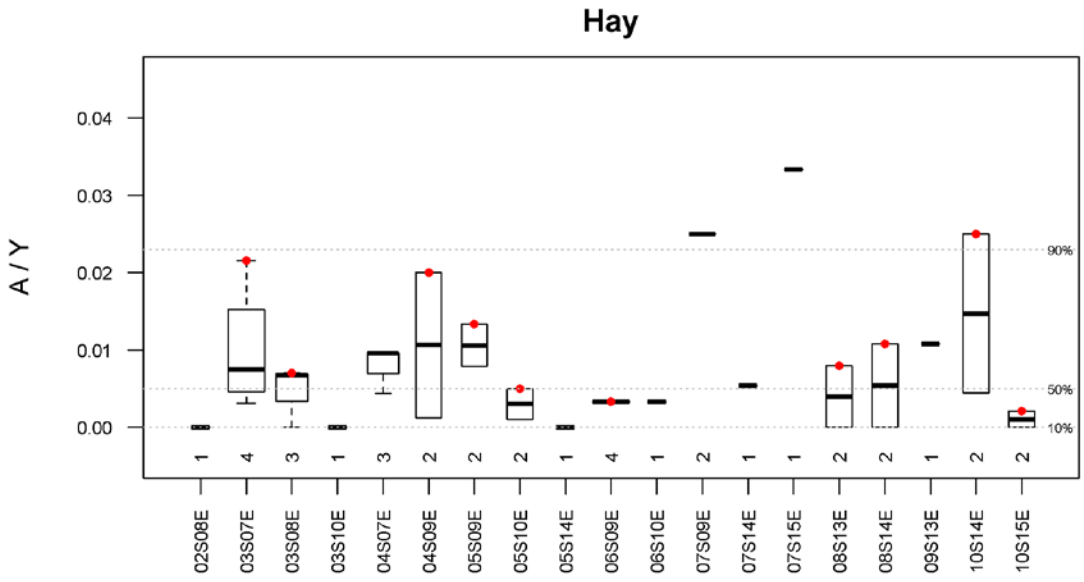


Table XIII-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Hay Management Units grouped by TR blocks.

TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Hay A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	1	9	0	0.0000	--	--	--	--	--	--
03S07E	4	223	0	0.0216	0.0040	0.0054	0.0075	0.0121	0.0178	1
03S08E	3	83	0	0.0070	0.0014	0.0034	0.0068	0.0069	0.0070	1
03S10E	1	170	0	0.0000	--	--	--	--	--	--
04S07E	3	402	0	0.0096	0.0054	0.0070	0.0096	0.0096	0.0096	0
04S09E	2	46	0	0.0200	0.0031	0.0059	0.0106	0.0153	0.0181	1
05S09E	2	45	0	0.0133	0.0084	0.0092	0.0106	0.0120	0.0128	1
05S10E	2	102	0	0.0050	0.0014	0.0020	0.0030	0.0040	0.0046	1
05S14E	1	32	0	0.0000	--	--	--	--	--	--
06S09E	4	162	0	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	1
06S10E	1	5	0	0.0033	--	--	--	--	--	--
07S09E	2	47	0	0.0250	--	--	--	--	--	--
07S14E	1	33	0	0.0054	--	--	--	--	--	--
07S15E	1	344	0	0.0333	--	--	--	--	--	--
08S13E	2	80	0	0.0080	0.0008	0.0020	0.0040	0.0060	0.0072	1
08S14E	2	162	0	0.0108	0.0011	0.0027	0.0054	0.0081	0.0097	1
09S13E	1	160	0	0.0108	--	--	--	--	--	--
10S14E	2	43	0	0.0250	0.0065	0.0096	0.0147	0.0199	0.0229	1
10S15E	2	135	0	0.0021	0.0002	0.0005	0.0011	0.0016	0.0019	1

B. Summary statistics for Hay A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	1	9.00	0.00	0.00	--	--	--	--	--	--
03S07E	4	222.54	0.11	0.82	0.25	0.45	0.79	0.80	1	1
03S08E	3	83.38	0.00	0.26	0.05	0.13	0.25	0.26	0	1
03S10E	1	170.00	0.00	0.00	--	--	--	--	--	--
04S07E	3	401.71	0.16	0.16	--	--	--	--	--	--
04S09E	2	46.00	0.05	1.84	0.23	0.50	0.95	1.39	2	1
05S09E	2	45.00	0.73	0.73	--	--	--	--	--	--
05S10E	2	101.70	0.04	0.18	0.05	0.07	0.11	0.15	0	1
05S14E	1	32.00	0.00	0.00	--	--	--	--	--	--
06S09E	4	161.79	0.12	0.12	0.12	0.12	0.12	0.12	0	1
06S10E	1	5.00	0.12	0.12	--	--	--	--	--	--
07S09E	2	47.00	0.91	0.91	--	--	--	--	--	--
07S14E	1	33.00	0.20	0.20	--	--	--	--	--	--
08S13E	2	80.20	0.00	0.00	--	--	--	--	--	--
08S14E	2	162.50	0.00	0.00	--	--	--	--	--	--
09S13E	1	160.00	1.00	1.00	--	--	--	--	--	--
10S14E	2	43.00	0.17	0.91	0.24	0.35	0.54	0.72	1	1
10S15E	2	135.00	0.00	0.08	0.01	0.02	0.04	0.06	0	1

C. Summary statistics for Hay A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	1	9	-23	-23	--	--	--	--	--	--
03S07E	4	223	-973	-17	-787	-508	-42	-30	-22	1
03S08E	3	83	-427	-141	-375	-296	-165	-153	-146	1
04S07E	3	402	-783	-783	--	--	--	--	--	--
04S09E	2	46	-407	46	-362	-294	-181	-67	0	1
05S09E	2	45	-24	-24	--	--	--	--	--	--
05S10E	2	102	-635	-449	-616	-588	-542	-495	-468	1
05S14E	1	32	-43	-43	--	--	--	--	--	--
06S09E	4	162	-142	-140	-142	-142	-142	-141	-141	1
06S10E	1	5	-142	-142	--	--	--	--	--	--
07S09E	2	47	-24	-24	--	--	--	--	--	--
07S14E	1	33	-204	-204	--	--	--	--	--	--
08S13E	2	80	-110	-110	--	--	--	--	--	--
08S14E	2	162	0	0	--	--	--	--	--	--
09S13E	1	160	-1	-1	--	--	--	--	--	--
10S14E	2	43	-401	-10	-362	-303	-205	-107	-49	1
10S15E	2	135	-299	-110	-280	-251	-204	-157	-129	1

Figure XIII-2. Box and Whisker plots of A/Y for Hay Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

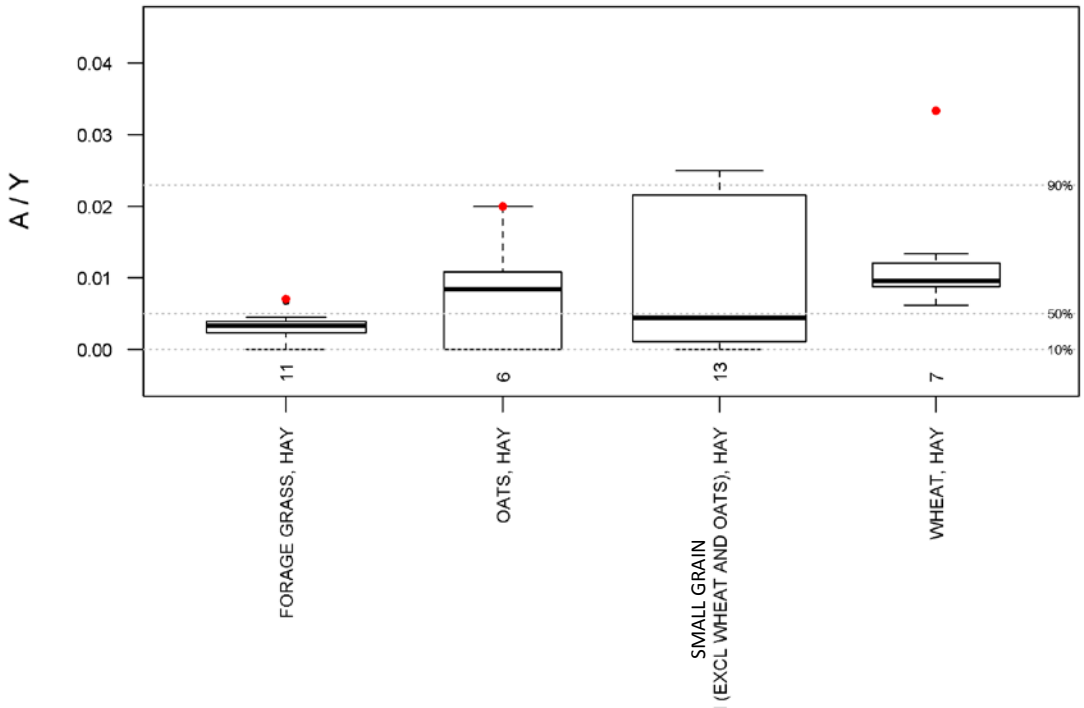


Table XIII-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Hay Management Units grouped by specific crop.

A. Summary statistics for Hay A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
FORAGE GRASS, HAY	11	336.2	0.0000	0.0070	0.0000	0.0023	0.0033	0.0039	0.0068	1
OATS, HAY	6	328.5	0.0000	0.0200	0.0000	0.0020	0.0084	0.0103	0.0154	1
SMALL GRAIN (EXCL WHEAT AND OATS), HAY	13	821.0	0.0000	0.0250	0.0000	0.0010	0.0044	0.0216	0.0250	0
WHEAT, HAY	7	797.2	0.0061	0.0333	0.0072	0.0088	0.0096	0.0121	0.0213	1

B. Summary statistics for Hay A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
FORAGE GRASS, HAY	11	336.2	0	0.26	0	0.09	0.12	0.15	0.25	1
OATS, HAY	6	328.5	0	1.84	0	0.18	0.77	0.95	1.42	1

C. Summary statistics for Hay A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
FORAGE GRASS, HAY	11	336.2	-427	-23	-407	-283	-142	-141	-140	1
OATS, HAY	6	328.5	-43	46	-34	-22	-9	0	23	1

Figure XIII-3. Scatter plot of A vs. Y for Hay crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

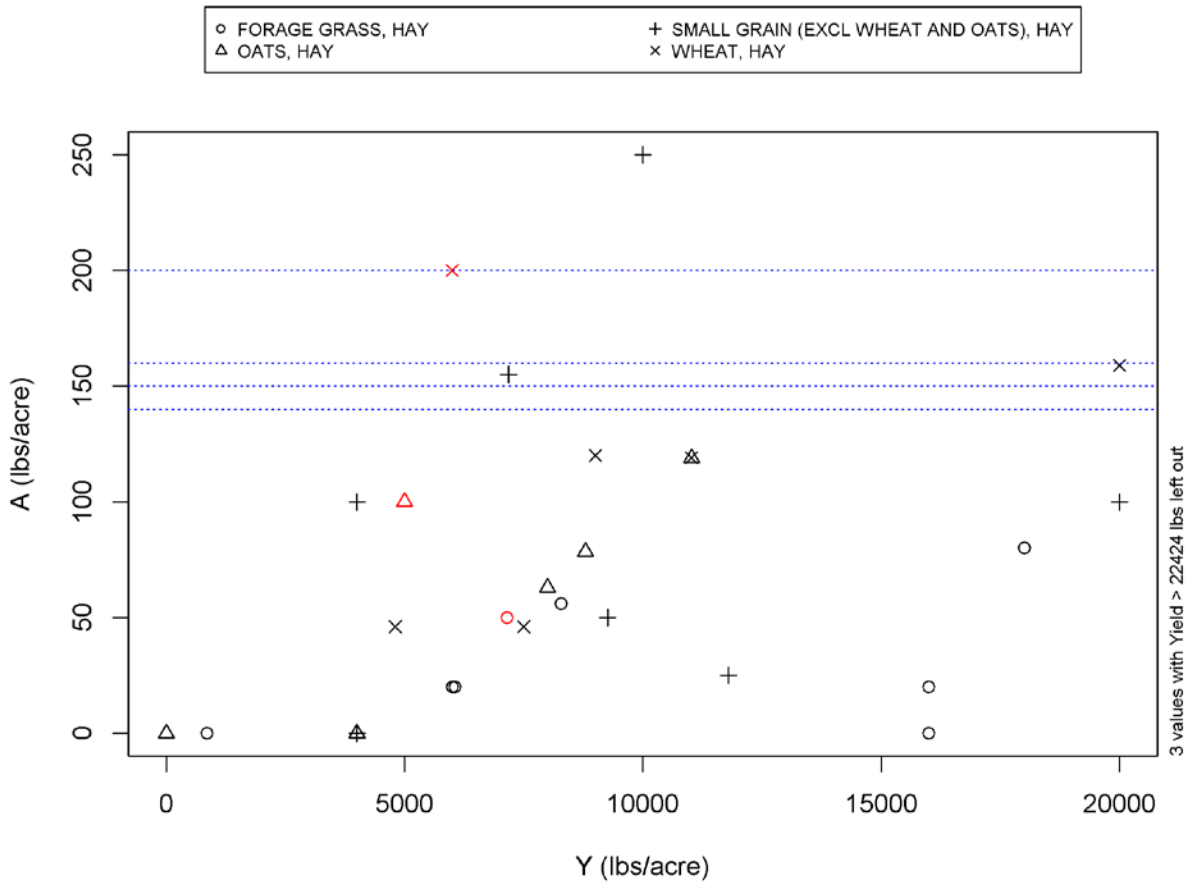


Table XIII-3. List of recommended nitrogen application values for Hay (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Hay, Small Grain		150	Values are not recommendations, but rates considered typical of a well-managed orchard. May not be applicable to all operations.	UC Davis
Sudan, Silage	60	160	Value depends on residual soil nitrogen Highest value may be used if the soil is deficient.	UC Davis
Orchard grass Hay		200	Total to be divided in three parts during the growing season. Does not include application at planting.	UC Davis
Sorghum, Silage		140	Value assumes yield of 20 tons/acre (70% moisture).	UC Davis

UC Davis - http://coststudies.ucdavis.edu/current/

XIV. HAY, ALFALFA

Important Analysis Considerations:

The calculation of N removed at harvest for ALFALFA, HAY assumes that 0.03115 lbs N/lbs at 12% moisture are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that the value can be considered a very good estimate of alfalfa hay produced in California.** However, the range probably includes sites outside the Central Valley.

Figure XIV-1. Box and Whisker plots of A/Y for Hay, Alfalfa Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

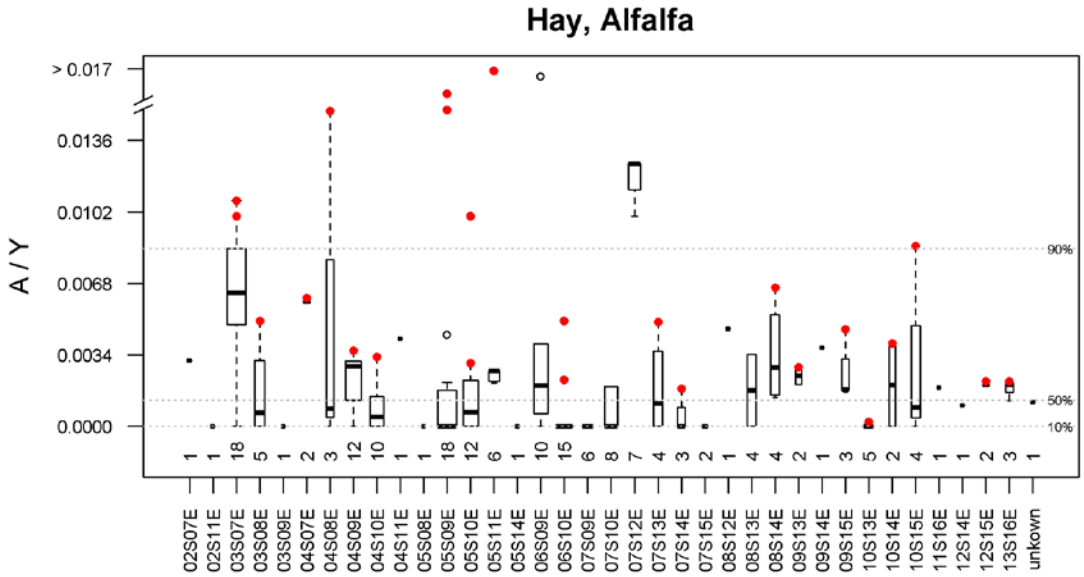


Table XIV-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Hay, Alfalfa Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Hay, Alfalfa A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S07E	1	16	0	0.0031	--	--	--	--	--	--
02S11E	1	6	0	0.0000	--	--	--	--	--	--
03S07E	18	1054	0	0.0107	0.0004	0.0049	0.0064	0.0084	0.0096	2
03S08E	5	104	0	0.0050	0.0000	0.0000	0.0006	0.0031	0.0042	1
03S09E	1	40	0	0.0000	--	--	--	--	--	--
04S07E	2	369	0	0.0061	0.0059	0.0059	0.0060	0.0060	0.0061	1
04S08E	3	226	0	0.0150	0.0002	0.0004	0.0008	0.0079	0.0122	1
04S09E	12	228	0	0.0036	0.0012	0.0012	0.0029	0.0030	0.0033	1

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S10E	10	229	0	0.0033	0.0000	0.0000	0.0005	0.0014	0.0029	1
04S11E	1	102	0	0.0042	--	--	--	--	--	--
05S08E	1	15	0	0.0000	--	--	--	--	--	--
05S09E	18	871	0	0.0158	0.0000	0.0000	0.0000	0.0015	0.0076	2
05S10E	12	290	0	0.0100	0.0000	0.0000	0.0007	0.0020	0.0030	2
05S11E	6	142	0	0.0220	0.0021	0.0023	0.0026	0.0026	0.0123	1
05S14E	1	3	0	0.0000	--	--	--	--	--	--
06S09E	10	851	0	0.0166	0.0000	0.0007	0.0020	0.0038	0.0166	0
06S10E	15	238	0	0.0050	0.0000	0.0000	0.0000	0.0000	0.0013	2
07S09E	6	183	0	0.0000	--	--	--	--	--	--
07S10E	8	398	0	0.0019	0.0000	0.0000	0.0000	0.0019	0.0019	0
07S12E	7	284	0	0.0125	0.0100	0.0112	0.0125	0.0125	0.0125	0
07S13E	4	610	0	0.0050	0.0000	0.0000	0.0011	0.0029	0.0041	1
07S14E	3	110	0	0.0018	0.0000	0.0000	0.0000	0.0009	0.0014	1
07S15E	2	89	0	0.0000	--	--	--	--	--	--
08S12E	1	532	0	0.0046	--	--	--	--	--	--
08S13E	4	635	0	0.0034	0.0000	0.0000	0.0017	0.0034	0.0034	0
08S14E	4	1031	0	0.0066	0.0014	0.0015	0.0028	0.0046	0.0058	1
09S13E	2	1342	0	0.0028	0.0021	0.0022	0.0024	0.0026	0.0027	1
09S14E	1	45	0	0.0038	--	--	--	--	--	--
09S15E	3	889	0	0.0046	0.0017	0.0017	0.0018	0.0032	0.0041	1
10S13E	5	637	0	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001	1
10S14E	2	128	0	0.0039	0.0004	0.0010	0.0020	0.0030	0.0035	1
10S15E	4	938	0	0.0086	0.0002	0.0006	0.0009	0.0029	0.0063	1
11S16E	1	227	0	0.0018	--	--	--	--	--	--
12S14E	1	230	0	0.0010	--	--	--	--	--	--
12S15E	2	160	0	0.0021	0.0019	0.0020	0.0020	0.0021	0.0021	1
13S16E	3	361	0	0.0021	0.0014	0.0016	0.0020	0.0021	0.0021	1
unknown	1	105	0	0.0012	--	--	--	--	--	--

B. Summary statistics for Hay, Alfalfa A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S07E	1	15.90	0.10	0.10	--	--	--	--	--	--
02S11E	1	5.50	0.00	0.00	--	--	--	--	--	--
03S07E	18	1053.88	0.00	0.34	0.01	0.16	0.20	0.27	0	2
03S08E	5	104.00	0.00	0.16	0.00	0.00	0.02	0.10	0	1
03S09E	1	40.00	0.00	0.00	--	--	--	--	--	--
04S07E	2	369.32	0.19	0.20	0.19	0.19	0.19	0.19	0	1
04S08E	3	226.00	0.00	0.48	0.01	0.01	0.03	0.25	0	1
04S09E	12	227.66	0.00	0.12	0.04	0.04	0.09	0.10	0	1
04S10E	10	229.25	0.00	0.11	0.00	0.00	0.01	0.05	0	1
04S11E	1	102.30	0.13	0.13	--	--	--	--	--	--
05S08E	1	15.00	0.00	0.00	--	--	--	--	--	--
05S09E	18	870.96	0.00	0.51	0.00	0.00	0.00	0.05	0	2
05S10E	12	290.00	0.00	0.32	0.00	0.00	0.02	0.06	0	2
05S11E	6	142.50	0.07	0.71	0.07	0.07	0.08	0.08	0	1
05S14E	1	2.80	0.00	0.00	--	--	--	--	--	--
06S09E	10	851.36	0.00	0.53	0.00	0.02	0.06	0.12	1	0
06S10E	15	237.77	0.00	0.16	0.00	0.00	0.00	0.00	0	2

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
07S09E	6	183.00	0.00	0.00	--	--	--	--	--	--
07S10E	8	397.77	0.00	0.06	0.00	0.00	0.00	0.06	0	3
07S12E	7	283.80	0.32	0.40	0.32	0.36	0.40	0.40	0	0
07S13E	4	609.50	0.00	0.16	0.00	0.00	0.04	0.09	0	1
07S14E	3	110.50	0.00	0.06	0.00	0.00	0.00	0.03	0	1
07S15E	2	89.00	0.00	0.00	--	--	--	--	--	--
08S12E	1	531.90	0.15	0.15	--	--	--	--	--	--
08S13E	4	635.40	0.00	0.11	0.00	0.00	0.06	0.11	0	2
08S14E	4	1030.70	0.04	0.21	0.05	0.05	0.09	0.15	0	1
09S13E	2	1341.95	0.06	0.09	0.07	0.07	0.08	0.08	0	1
09S14E	1	45.00	0.12	0.12	--	--	--	--	--	--
09S15E	3	889.20	0.05	0.15	0.05	0.05	0.06	0.10	0	1
10S13E	5	637.30	0.00	0.01	0.00	0.00	0.00	0.00	0	1
10S14E	2	127.90	0.00	0.13	0.01	0.03	0.06	0.09	0	1
10S15E	4	937.70	0.00	0.28	0.01	0.02	0.03	0.09	0	1
11S16E	1	227.00	0.06	0.06	--	--	--	--	--	--
12S14E	1	229.60	0.03	0.03	--	--	--	--	--	--
12S15E	2	160.00	0.06	0.07	0.06	0.06	0.07	0.07	0	1
13S16E	3	360.80	0.04	0.07	0.04	0.05	0.06	0.07	0	1
unknown	1	105.00	0.04	0.04	--	--	--	--	--	--

C. Summary statistics for Hay, Alfalfa A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S07E	1	16	-448	-448	--	--	--	--	--	--
03S07E	18	1054	-611	-124	-346	-320	-230	-175	-145	2
03S08E	5	104	-1096	-366	-857	-498	-448	-436	-394	1
03S09E	1	40	0	0	--	--	--	--	--	--
04S07E	2	369	-281	-267	-279	-277	-274	-271	-269	1
04S08E	3	226	-428	-194	-404	-369	-311	-252	-217	1
04S09E	12	228	-501	-167	-499	-478	-397	-396	-384	2
04S10E	10	229	-895	-249	-664	-501	-480	-401	-376	1
04S11E	1	102	-323	-323	--	--	--	--	--	--
05S08E	1	15	-370	-370	--	--	--	--	--	--
05S09E	18	871	-699	-307	-512	-462	-435	-336	-324	2
05S10E	12	290	-872	-211	-613	-511	-455	-366	-310	1
05S11E	6	142	-456	-52	-456	-456	-446	-427	-239	1
06S09E	10	851	-551	-276	-547	-531	-498	-381	-276	0
06S10E	15	238	-748	-125	-748	-748	-463	-247	-125	0
07S09E	6	183	-374	-249	-374	-358	-311	-311	-280	1
07S10E	8	398	-623	-125	-471	-369	-369	-280	-199	1
07S12E	7	284	-317	-298	-317	-308	-298	-298	-298	0
07S13E	4	610	-1121	-275	-1002	-824	-526	-401	-325	1
07S14E	3	110	-352	-352	--	--	--	--	--	--
08S12E	1	532	-339	-339	--	--	--	--	--	--
08S13E	4	635	-548	-125	-500	-428	-388	-322	-204	1
08S14E	4	1031	-459	-224	-454	-447	-398	-321	-263	1
09S13E	2	1342	-405	-291	-394	-377	-348	-320	-303	1
09S14E	1	45	-438	-438	--	--	--	--	--	--
09S15E	3	889	-697	-307	-631	-531	-364	-336	-319	1
10S13E	5	637	-530	-446	-521	-509	-488	-467	-454	1

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
10S14E	2	128	-561	-435	-548	-529	-498	-466	-448	1
10S15E	4	938	-603	-158	-556	-485	-378	-273	-204	1
11S16E	1	227	-352	-352	--	--	--	--	--	--
12S14E	1	230	-422	-422	--	--	--	--	--	--
12S15E	2	160	-456	-406	-451	-443	-431	-419	-411	1
13S16E	3	361	-540	-406	-519	-488	-437	-422	-412	1
unknown	1	105	-300	-300	--	--	--	--	--	--

Figure XIV-2. Box and Whisker plots of A/Y for Hay, Alfalfa Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

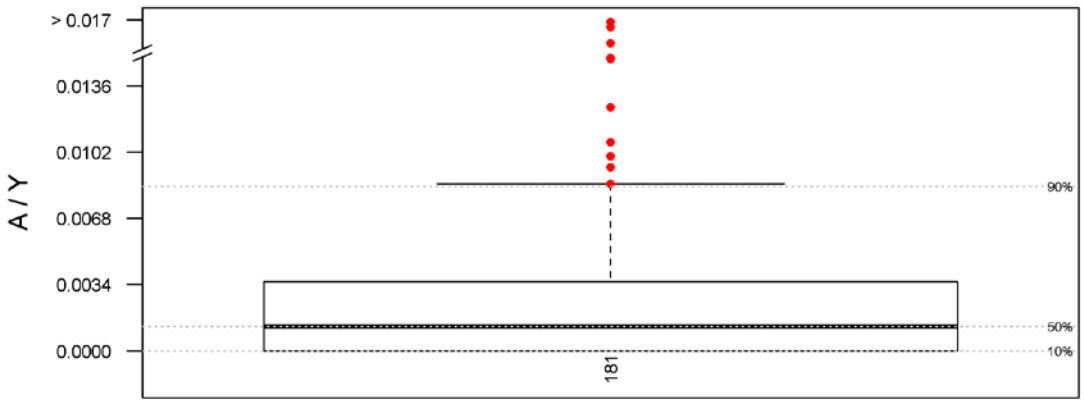


Table XIV-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Hay, Alfalfa Management Units grouped by specific crop.

A. Summary statistics for Hay, Alfalfa A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
ALFALFA, HAY	181	13717.2	0	0.022	0	0	0.0012	0.0036	0.0084	18

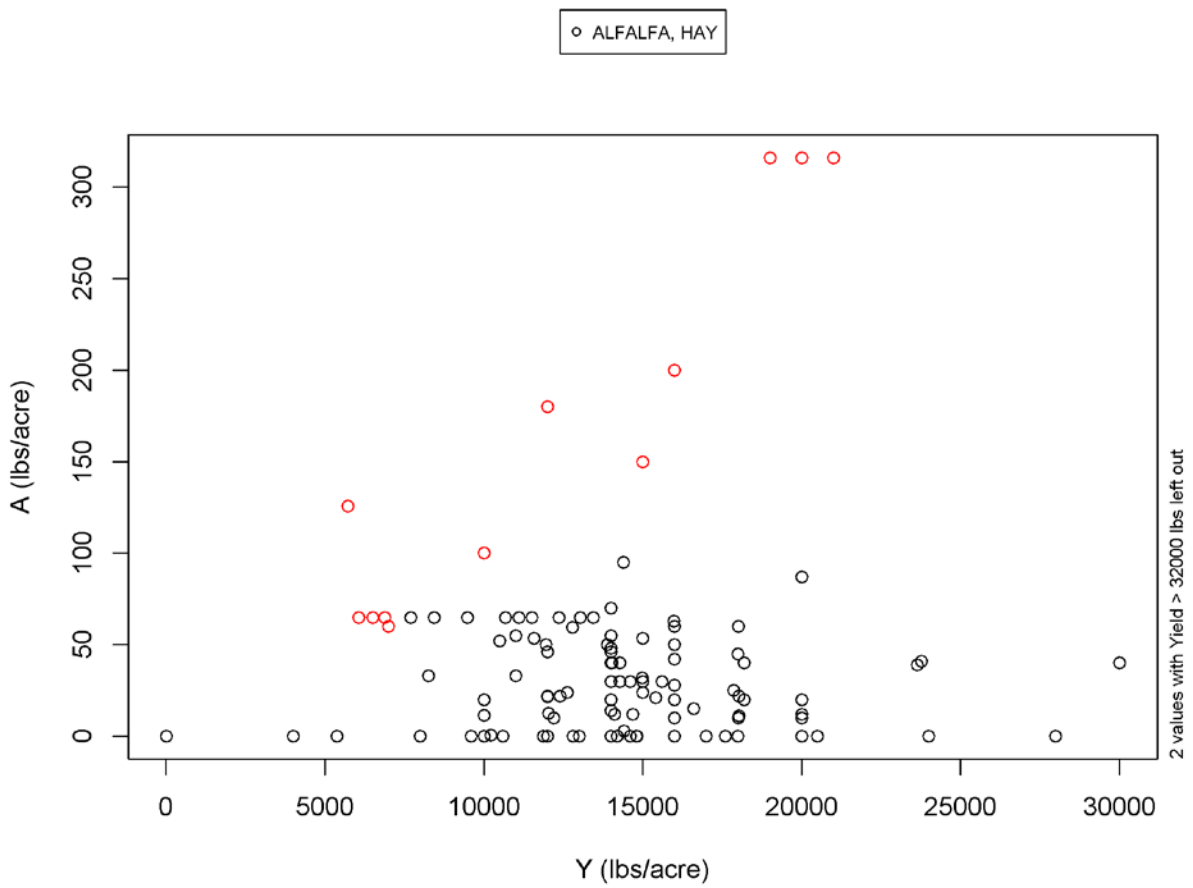
B. Summary statistics for Hay, Alfalfa A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
ALFALFA, HAY	181	13717.2	0	0.71	0	0	0.04	0.11	0.27	18

C. Summary statistics for Hay, Alfalfa A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
ALFALFA, HAY	181	13717.2	-1121	0	-551	-462	-396	-307	-198	15

Figure XIV-3. Scatter plot of A vs. Y for Hay, Alfalfa crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.



XV. HERBS

Important Analysis Considerations:

There is no N Removal Factor or recommended fertilization rates herbs in any of the sources evaluated by the Coalition. Hence, only summary statistics by A/Y are provided.

Figure XV-1. Box and Whisker plots of A/Y for Herbs Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

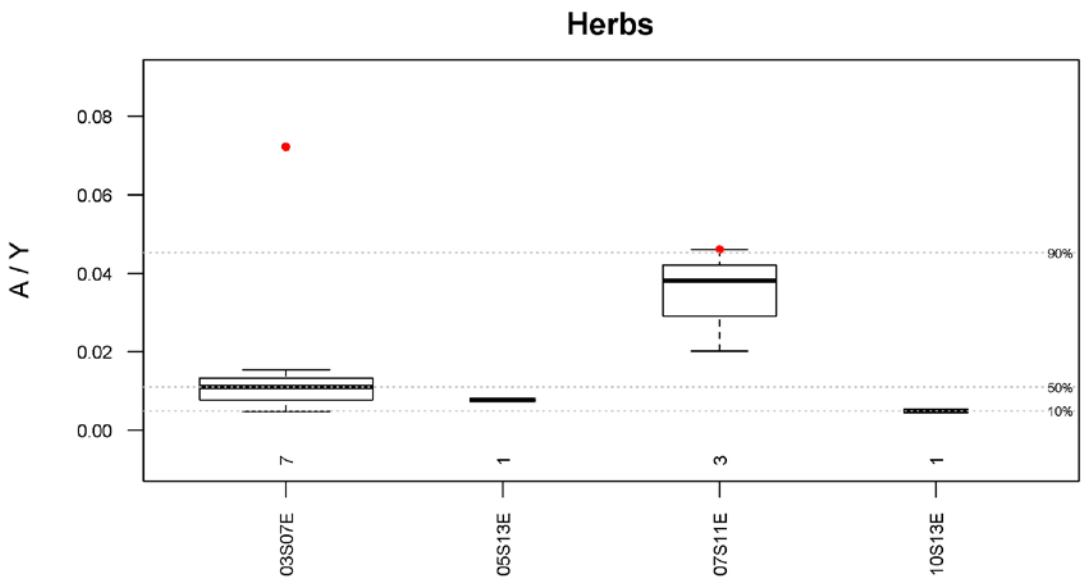


Table XV-1. Summary statistics for A/Y from Herbs Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	7	466	0	0.0722	0.0050	0.0077	0.0110	0.0132	0.0381	1
05S13E	1	22	0	0.0077	--	--	--	--	--	--
07S11E	3	64	0	0.0460	0.0237	0.0291	0.0381	0.0420	0.0444	1
10S13E	1	55	0	0.0050	--	--	--	--	--	--

Figure XV-2. Box and Whisker plots of A/Y for Herbs Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

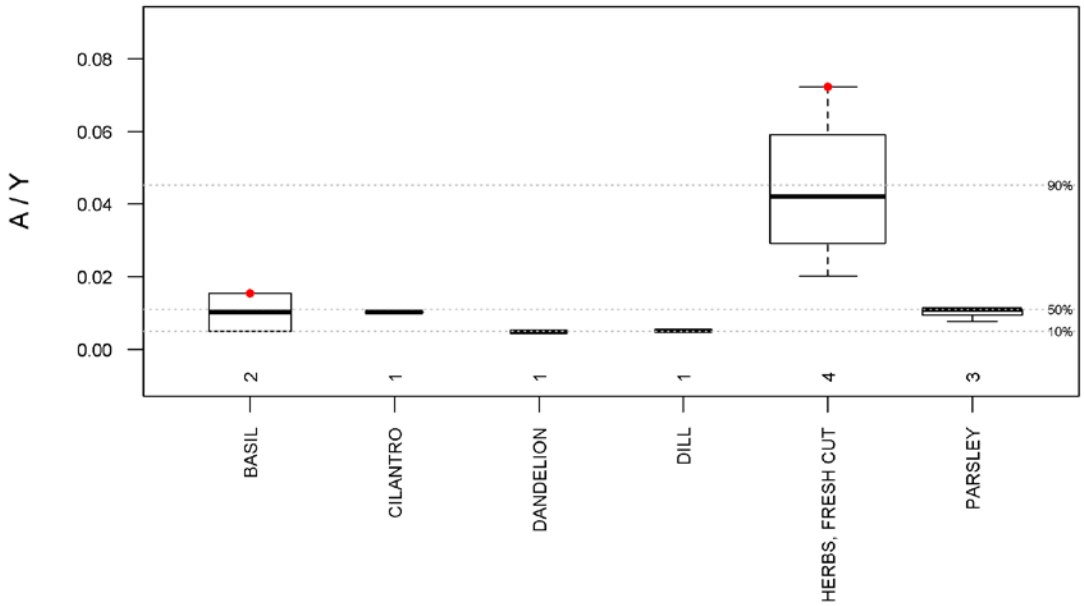
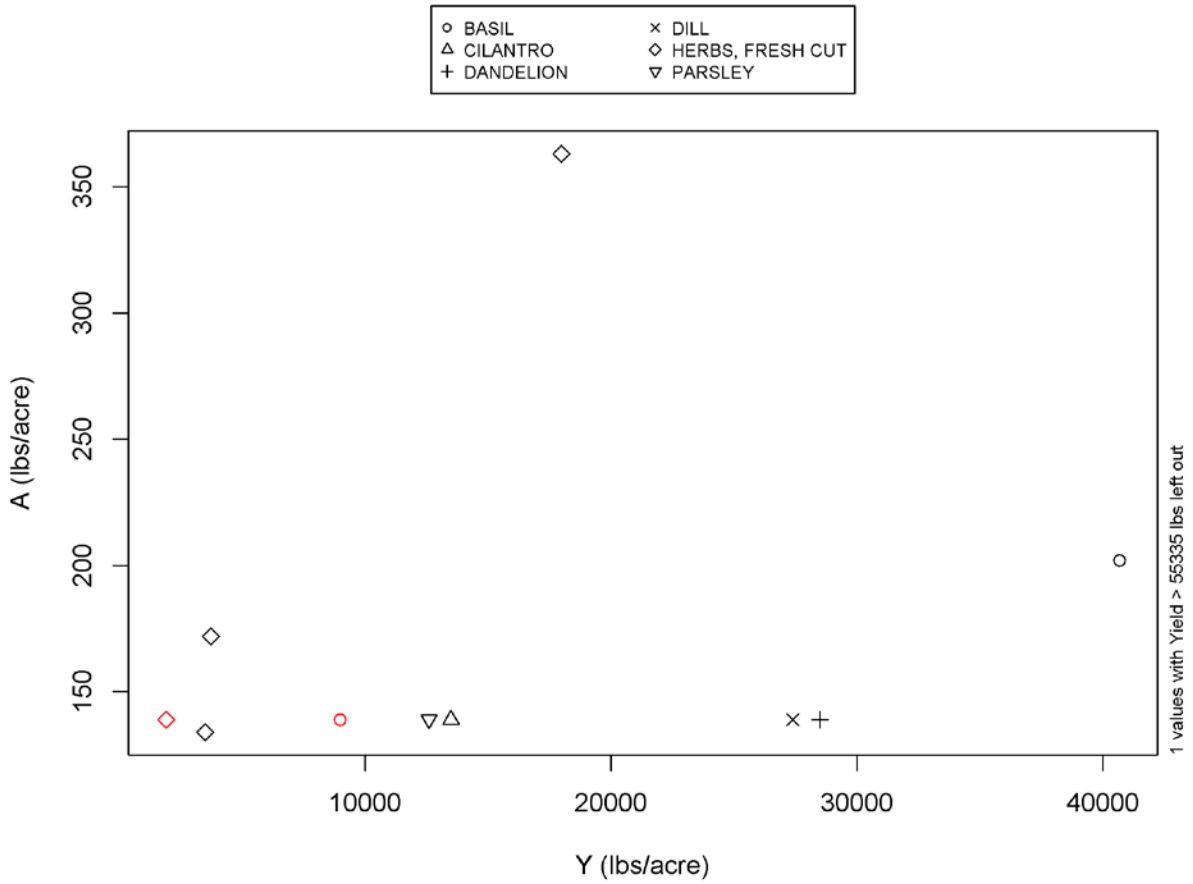


Table XV-2. Summary statistics for A/Y from Herbs Management Units grouped by specific crop.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
BASIL	2	141.0	0.0050	0.0154	0.0060	0.0076	0.0102	0.0128	0.0144	1
CILANTRO	1	179.2	0.0103	0.0103	--	--	--	--	--	--
DANDELION	1	22.4	0.0049	0.0049	--	--	--	--	--	--
DILL	1	48.6	0.0051	0.0051	--	--	--	--	--	--
HERBS, FRESH CUT	4	75.9	0.0202	0.0722	0.0255	0.0336	0.0420	0.0525	0.0643	1
PARSLEY	3	140.7	0.0077	0.0110	0.0084	0.0094	0.0110	0.0110	0.0110	0

Figure XV-3. Scatter plot of A vs. Y for Herbs crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.



XVI. PEACHES

Important Analysis Considerations:

The calculation of N removed at harvest for PEACHES assumes that 0.00113 lbs N/lbs of fruits are removed at harvest. This estimate was obtained from Geisseler (2016), and does not differentiate between fresh market and processing peaches. **Geisseler considers that the average N concentration may be a reasonable estimate of N in California peaches but needs more data from the Central Valley.**

Figure XVI-1. Box and Whisker plots of A/Y and A/R for Peaches Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

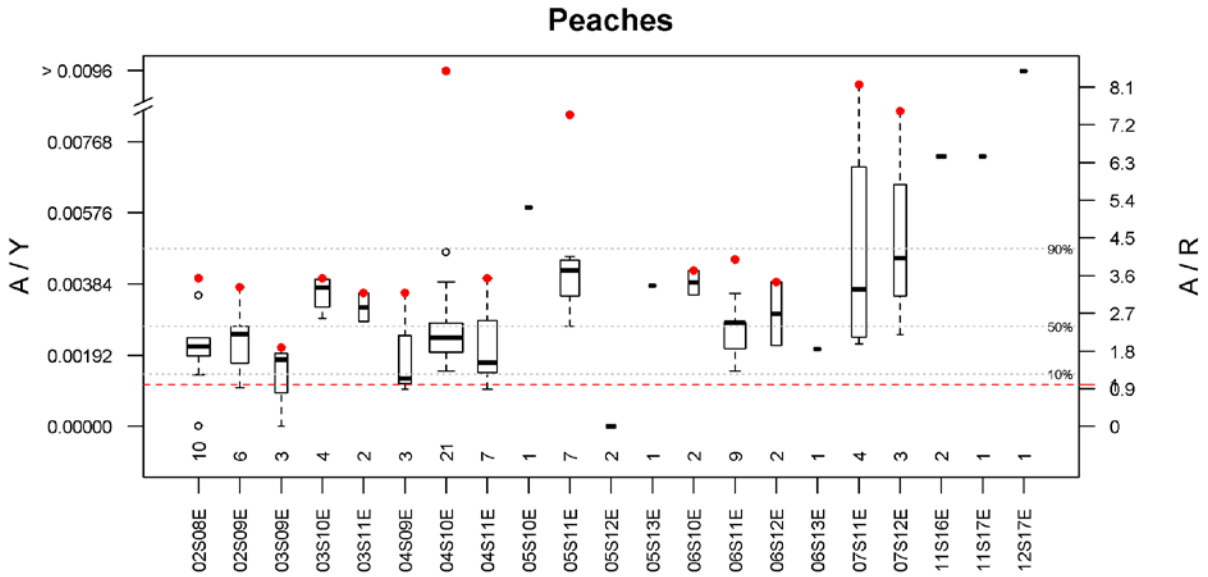


Table XVI-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Peaches Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Peaches A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	10	213	0	0.0040	0.0013	0.0019	0.0022	0.0024	0.0036	1
02S09E	6	226	0	0.0038	0.0014	0.0019	0.0025	0.0027	0.0032	1
03S09E	3	96	0	0.0021	0.0004	0.0009	0.0018	0.0020	0.0021	1
03S10E	4	214	0	0.0040	0.0031	0.0034	0.0037	0.0040	0.0040	1
03S11E	2	32	0	0.0036	0.0029	0.0030	0.0032	0.0034	0.0035	1
04S09E	3	104	0	0.0036	0.0011	0.0012	0.0013	0.0025	0.0031	1
04S10E	21	512	0	0.0260	0.0016	0.0020	0.0024	0.0028	0.0047	1
04S11E	7	275	0	0.0040	0.0012	0.0015	0.0017	0.0029	0.0037	1

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
05S10E	1	12	0	0.0059	--	--	--	--	--	--
05S11E	7	174	0	0.0084	0.0029	0.0035	0.0042	0.0045	0.0061	1
05S12E	2	42	0	0.0000	--	--	--	--	--	--
05S13E	1	145	0	0.0038	--	--	--	--	--	--
06S10E	2	16	0	0.0042	0.0036	0.0037	0.0039	0.0040	0.0041	1
06S11E	9	346	0	0.0045	0.0016	0.0021	0.0028	0.0028	0.0038	1
06S12E	2	114	0	0.0039	0.0024	0.0026	0.0030	0.0035	0.0037	1
06S13E	1	915	0	0.0021	--	--	--	--	--	--
07S11E	4	108	0	0.0092	0.0023	0.0025	0.0037	0.0059	0.0079	1
07S12E	3	108	0	0.0085	0.0029	0.0035	0.0045	0.0065	0.0077	1
11S16E	2	64	0	0.0073	--	--	--	--	--	--
11S17E	1	23	0	0.0073	--	--	--	--	--	--
12S17E	1	20	0	0.0330	--	--	--	--	--	--

B. Summary statistics for Peaches A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	10	213.06	0.00	3.54	1.12	1.73	1.90	2.10	3	1
02S09E	6	225.50	0.92	3.32	1.21	1.65	2.20	2.37	3	1
03S09E	3	96.00	0.00	1.88	0.32	0.80	1.59	1.74	2	1
03S10E	4	214.08	2.58	3.54	2.74	2.98	3.31	3.50	4	1
03S11E	2	32.00	2.50	3.19	2.57	2.67	2.85	3.02	3	1
04S09E	3	104.47	0.88	3.19	0.94	1.02	1.15	2.17	3	1
04S10E	21	511.68	1.33	23.01	1.44	1.77	2.12	2.46	4	1
04S11E	7	274.99	0.88	3.54	1.10	1.28	1.53	2.53	3	1
05S10E	1	12.00	5.22	5.22	--	--	--	--	--	--
05S11E	7	174.00	2.39	7.43	2.60	3.12	3.72	3.98	5	1
05S12E	2	42.00	0.00	0.00	--	--	--	--	--	--
05S13E	1	145.38	3.36	3.36	--	--	--	--	--	--
06S10E	2	16.00	3.14	3.72	3.20	3.28	3.43	3.58	4	1
06S11E	9	346.16	1.33	3.99	1.37	1.86	2.48	2.48	3	1
06S12E	2	113.50	1.94	3.45	2.09	2.31	2.69	3.07	3	1
06S13E	1	915.10	1.84	1.84	--	--	--	--	--	--
07S11E	4	108.50	1.97	8.15	2.07	2.22	3.27	5.22	7	1
07S12E	3	107.50	2.19	7.52	2.56	3.11	4.02	5.77	7	1
11S16E	2	64.00	6.44	6.44	--	--	--	--	--	--
11S17E	1	23.00	6.44	6.44	--	--	--	--	--	--
12S17E	1	20.00	29.17	29.17	--	--	--	--	--	--

C. Summary statistics for Peaches A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	10	213	-49	86	10	36	40	45	82	1
02S09E	6	226	-4	105	11	36	67	69	87	1
03S09E	3	96	35	47	36	38	41	44	46	1
03S10E	4	214	69	107	71	75	80	88	99	1
03S11E	2	32	51	99	56	63	75	87	94	1
04S09E	3	104	-4	74	-2	2	9	41	61	1
04S10E	21	512	7	144	32	47	59	66	115	2

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S11E	7	275	-2	82	5	17	34	59	82	1
05S10E	1	12	182	182	--	--	--	--	--	--
05S11E	7	174	93	135	96	103	117	118	125	1
05S13E	1	145	108	108	--	--	--	--	--	--
06S10E	2	16	75	95	77	80	85	90	93	1
06S11E	9	346	12	105	19	48	49	66	76	1
06S12E	2	114	34	82	39	46	58	70	78	1
06S13E	1	915	23	23	--	--	--	--	--	--
07S11E	4	108	39	207	44	52	101	161	188	1
07S12E	3	108	63	147	65	69	75	111	133	1
11S16E	2	64	221	221	--	--	--	--	--	--
11S17E	1	23	221	221	--	--	--	--	--	--
12S17E	1	20	66	66	--	--	--	--	--	--

Figure XVI-2. Box and Whisker plots of A/Y for Peaches Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

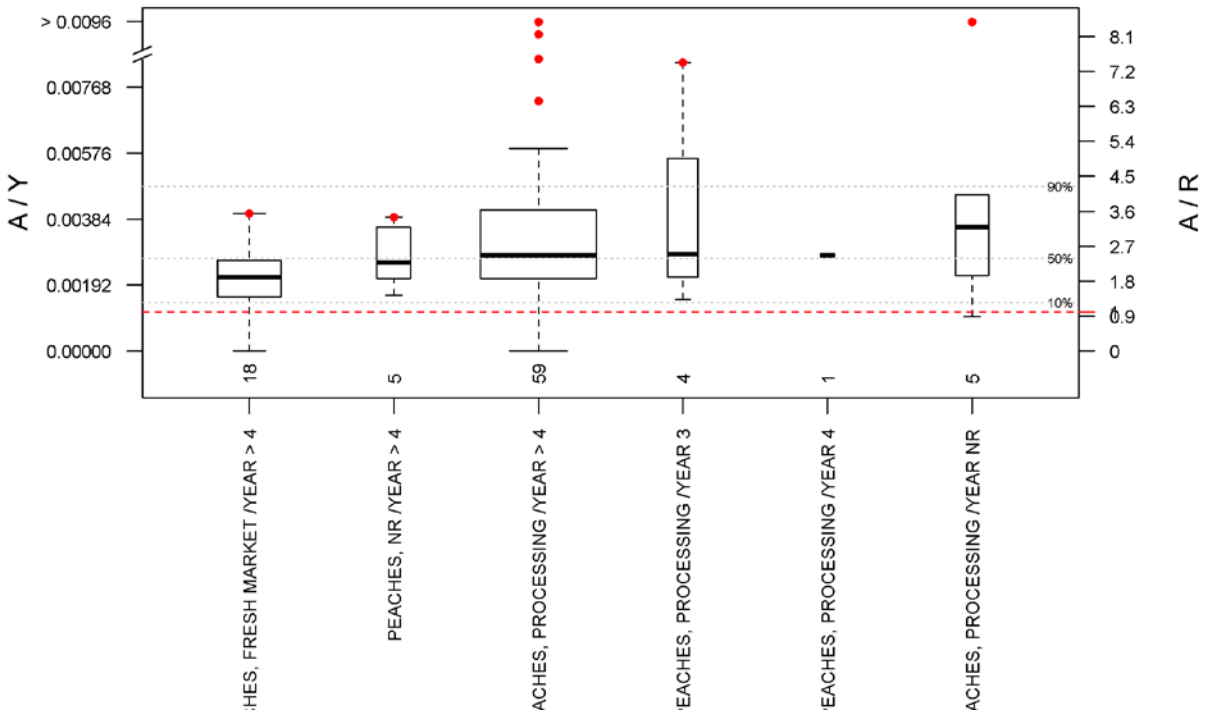


Table XVI-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Peaches Management Units grouped by specific crop.

A. Summary statistics for Peaches A/Y.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
PEACHES, FRESH MARKET /YEAR > 4	18	596.5	0.0000	0.0040	0.0000	0.0016	0.0022	0.0026	0.0037	2

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
PEACHES, NR /YEAR > 4	5	159.0	0.0016	0.0039	0.0018	0.0021	0.0026	0.0036	0.0038	1
PEACHES, PROCESSING /YEAR > 4	59	2711.9	0.0000	0.0330	0.0015	0.0021	0.0028	0.0041	0.0062	6
PEACHES, PROCESSING /YEAR 3	4	90.9	0.0015	0.0084	0.0019	0.0025	0.0028	0.0042	0.0067	1
PEACHES, PROCESSING /YEAR 4	1	9.0	0.0028	0.0028	--	--	--	--	--	--
PEACHES, PROCESSING /YEAR NR	5	191.6	0.0010	0.0260	0.0015	0.0022	0.0036	0.0045	0.0174	1

B. Summary statistics for Peaches A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
PEACHES, FRESH MARKET /YEAR > 4	18	596.5	0.00	3.54	0.00	1.39	1.91	2.29	3.25	2
PEACHES, NR /YEAR > 4	5	159.0	1.44	3.45	1.61	1.86	2.27	3.19	3.35	1
PEACHES, PROCESSING /YEAR > 4	59	2711.9	0.00	29.17	1.33	1.86	2.46	3.63	5.47	6
PEACHES, PROCESSING /YEAR 3	4	90.9	1.33	7.43	1.67	2.19	2.49	3.74	5.96	1
PEACHES, PROCESSING /YEAR 4	1	9.0	2.46	2.46	--	--	--	--	--	--
PEACHES, PROCESSING /YEAR NR	5	191.6	0.88	23.01	1.31	1.94	3.19	4.02	15.42	1

C. Summary statistics for Peaches A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
PEACHES, FRESH MARKET /YEAR > 4	18	596.5	-2	86	17	42	57	68	80	2
PEACHES, NR /YEAR > 4	5	159.0	40	104	44	51	61	74	92	1
PEACHES, PROCESSING /YEAR > 4	59	2711.9	-49	221	22	39	66	106	146	6
PEACHES, PROCESSING /YEAR 3	4	90.9	7	117	19	38	49	68	97	1
PEACHES, PROCESSING /YEAR 4	1	9.0	59	59	--	--	--	--	--	--
PEACHES, PROCESSING /YEAR NR	5	191.6	-4	115	11	34	75	99	108	1

Figure XVI-3. Scatter plot of A vs. Y for Peaches crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

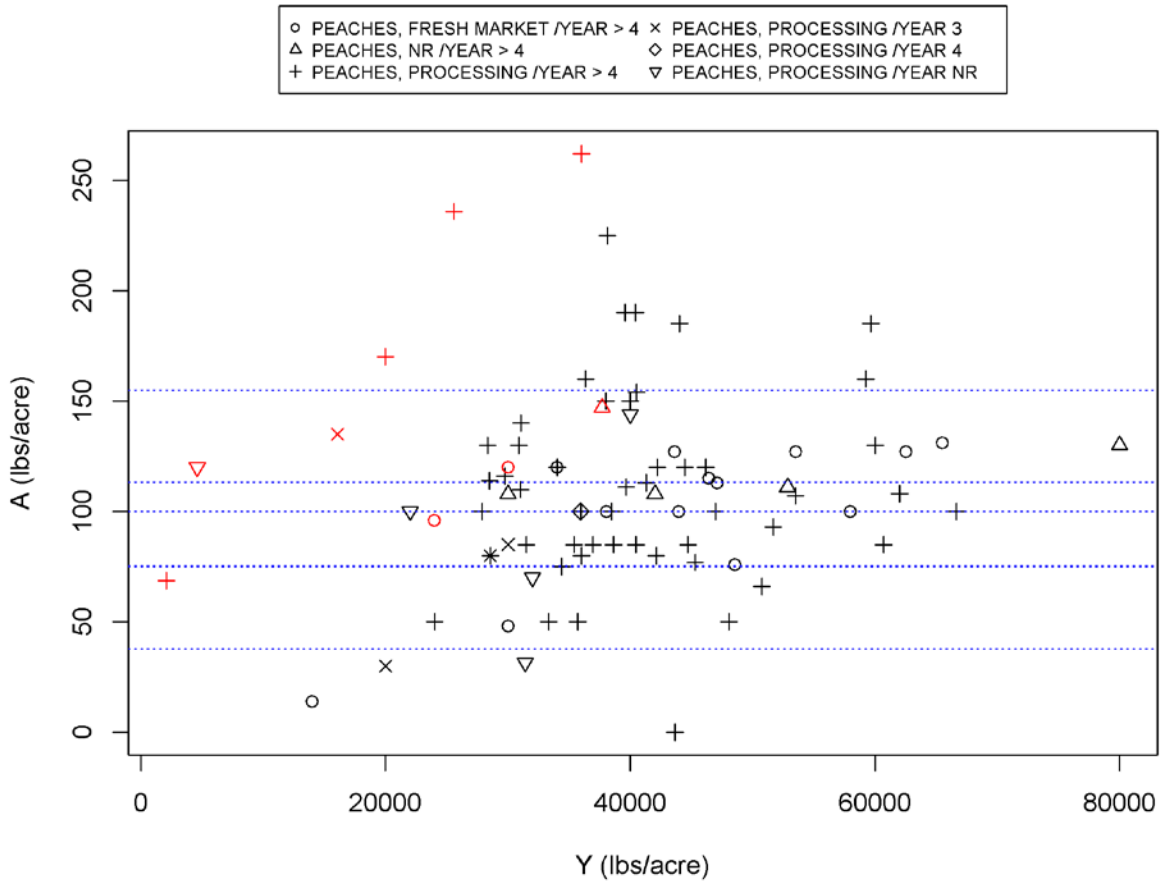


Table XVI-3. List of recommended nitrogen application values for Peaches (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Fresh market peaches and nectarines	25	75.00	Value considered enough to maintain adequate N fertility. Dependent upon the efficiency of the fertilization method.	CDFA
Processing peaches	50	100.00	Common values. Higher rates will be required for N-deficient orchards.	CDFA
Mature peach and nectarine orchards	63	155.00	Approximate requirements dependent upon the desired yield. Minimum value yields 6 tons/acre, maximum yields 30 tons/acre. Assumes that prunings are not removed from the orchard (59 lbs N/acre).	
Peaches /Year 1	0	37.75	Calculated from 4, 8, 12 oz/tree per year of age, assuming 151 trees per acre. Rate should be adjusted for the N supplied by soil and irrigation water. In some cases, these are sufficient for the first season's growth and no additional N is needed.	CDFA
Peaches /Year 2	37.75	75.50		
Peaches /Year 3	75.5	113.25		

CDFA - https://www.cdfa.ca.gov/is/ffldrs/frep/

XVII. PISTACHIOS

Important Analysis Considerations:

The calculation of N removed at harvest for PISTACHIOS assumes that 0.02805 lbs N/lbs dry yield (CPC) are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that the value is a good estimate for N removed from pistachio orchards in the Central Valley.**

Figure XVII-1. Box and Whisker plots of A/Y and A/R for Pistachios Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

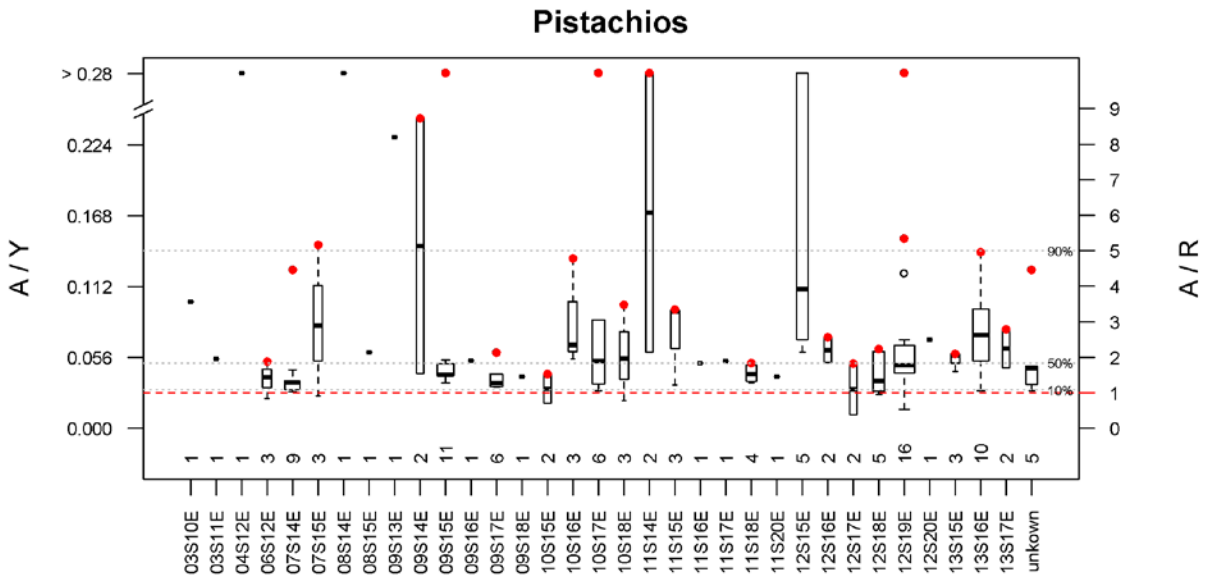


Table XVII-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Pistachios Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Pistachios A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S10E	1	9	0	0.0999	--	--	--	--	--	--
03S11E	1	96	0	0.0550	--	--	--	--	--	--
04S12E	1	18	1	0.5167	--	--	--	--	--	--
06S12E	3	35	0	0.0528	0.0270	0.0321	0.0405	0.0467	0.0503	1
07S14E	9	284	0	0.1250	0.0302	0.0305	0.0363	0.0374	0.0618	1
07S15E	3	219	0	0.1449	0.0368	0.0534	0.0810	0.1130	0.1321	1
08S14E	1	49	0	0.3575	--	--	--	--	--	--
08S15E	1	61	0	0.0603	--	--	--	--	--	--
09S13E	1	91	0	0.2299	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
09S14E	2	269	0	0.2448	0.0635	0.0937	0.1440	0.1944	0.2246	1
09S15E	11	2420	0	0.5946	0.0400	0.0416	0.0424	0.0509	0.0540	1
09S16E	1	57	0	0.0538	--	--	--	--	--	--
09S17E	6	636	0	0.0597	0.0329	0.0335	0.0357	0.0414	0.0513	1
09S18E	1	300	0	0.0407	--	--	--	--	--	--
10S15E	2	746	0	0.0430	0.0223	0.0258	0.0315	0.0373	0.0407	1
10S16E	3	100	0	0.1341	0.0571	0.0605	0.0660	0.1000	0.1205	1
10S17E	6	1210	0	0.8929	0.0325	0.0391	0.0531	0.0780	0.4892	1
10S18E	3	512	0	0.0974	0.0287	0.0387	0.0554	0.0764	0.0890	1
11S14E	2	1776	0	0.4895	0.1029	0.1674	0.2747	0.3821	0.4465	1
11S15E	3	1524	0	0.0938	0.0457	0.0631	0.0921	0.0929	0.0935	1
11S16E	1	127	0	0.0516	--	--	--	--	--	--
11S17E	1	36	0	0.0531	--	--	--	--	--	--
11S18E	4	384	0	0.0516	0.0366	0.0374	0.0430	0.0489	0.0505	1
11S20E	1	829	0	0.0408	--	--	--	--	--	--
12S15E	5	1575	0	0.3376	0.0640	0.0700	0.1100	0.3172	0.3294	1
12S16E	2	953	0	0.0719	0.0539	0.0569	0.0619	0.0669	0.0699	1
12S17E	2	354	0	0.0510	0.0150	0.0210	0.0310	0.0410	0.0470	1
12S18E	5	288	0	0.0625	0.0278	0.0294	0.0378	0.0604	0.0617	1
12S19E	17	1988	0	0.3564	0.0360	0.0454	0.0500	0.0636	0.1360	2
12S20E	1	3269	0	0.0700	--	--	--	--	--	--
13S15E	3	1251	0	0.0591	0.0477	0.0515	0.0579	0.0585	0.0589	1
13S16E	10	1561	0	0.1390	0.0455	0.0550	0.0739	0.0896	0.1312	1
13S17E	2	150	0	0.0781	0.0508	0.0554	0.0630	0.0705	0.0751	1
unknown	5	417	0	0.1250	0.0318	0.0348	0.0472	0.0490	0.0946	1

B. Summary statistics for Pistachios A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S10E	1	9.00	3.56	3.56	--	--	--	--	--	--
03S11E	1	96.00	1.96	1.96	--	--	--	--	--	--
04S12E	1	18.00	18.42	18.42	--	--	--	--	--	--
06S12E	3	34.70	0.84	1.88	0.96	1.14	1.44	1.66	2	1
07S14E	9	284.10	1.03	4.46	1.08	1.09	1.30	1.33	2	1
07S15E	3	219.00	0.92	5.17	1.31	1.90	2.89	4.03	5	1
08S14E	1	49.30	12.75	12.75	--	--	--	--	--	--
08S15E	1	61.10	2.15	2.15	--	--	--	--	--	--
09S13E	1	91.09	8.20	8.20	--	--	--	--	--	--
09S14E	2	268.93	1.54	8.73	2.26	3.34	5.14	6.93	8	1
09S15E	11	2419.72	1.28	21.20	1.43	1.48	1.51	1.82	2	1
09S16E	1	57.00	1.92	1.92	--	--	--	--	--	--
09S17E	6	636.00	1.16	2.13	1.17	1.19	1.27	1.48	2	1
09S18E	1	300.00	1.45	1.45	--	--	--	--	--	--
10S15E	2	746.25	0.71	1.53	0.80	0.92	1.12	1.33	1	1
10S16E	3	100.00	1.96	4.78	2.04	2.16	2.35	3.57	4	1
10S17E	6	1210.01	1.06	31.83	1.16	1.39	1.89	2.78	17	1
10S18E	3	511.50	0.78	3.47	1.02	1.38	1.97	2.72	3	1
11S14E	2	1776.00	2.14	17.45	3.67	5.97	9.79	13.62	16	1
11S15E	3	1524.40	1.22	3.34	1.63	2.25	3.28	3.31	3	1
11S16E	1	127.00	1.84	1.84	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
11S17E	1	36.00	1.89	1.89	--	--	--	--	--	--
11S18E	4	384.40	1.29	1.84	1.31	1.34	1.53	1.74	2	1
11S20E	1	829.00	1.45	1.45	--	--	--	--	--	--
12S15E	5	1575.00	2.14	12.03	2.28	2.50	3.92	11.31	12	1
12S16E	2	953.00	1.85	2.56	1.92	2.03	2.21	2.39	2	1
12S17E	2	353.78	0.39	1.82	0.53	0.75	1.11	1.46	2	1
12S18E	5	288.50	0.95	2.23	0.99	1.05	1.35	2.15	2	1
12S19E	17	1987.89	0.53	12.71	1.29	1.62	1.78	2.27	5	2
12S20E	1	3268.69	2.50	2.50	--	--	--	--	--	--
13S15E	3	1251.20	1.61	2.11	1.70	1.84	2.06	2.09	2	1
13S16E	10	1561.49	1.06	4.96	1.62	1.96	2.63	3.20	5	1
13S17E	2	150.00	1.70	2.79	1.81	1.97	2.24	2.51	3	1
unknown	5	417.01	1.06	4.46	1.13	1.24	1.68	1.75	3	1

C. Summary statistics for Pistachios A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S10E	1	9	69	69	--	--	--	--	--	--
03S11E	1	96	81	81	--	--	--	--	--	--
04S12E	1	18	147	147	--	--	--	--	--	--
06S12E	3	35	-8	53	-4	3	14	33	45	1
07S14E	9	284	5	49	8	8	18	38	41	1
07S15E	3	219	-15	114	4	33	81	98	108	1
08S14E	1	49	132	132	--	--	--	--	--	--
08S15E	1	61	131	131	--	--	--	--	--	--
09S13E	1	91	176	176	--	--	--	--	--	--
09S14E	2	269	31	69	35	40	50	59	65	1
09S15E	11	2420	26	147	28	38	47	61	72	1
09S16E	1	57	95	95	--	--	--	--	--	--
09S17E	6	636	15	104	16	19	30	59	85	1
09S18E	1	300	62	62	--	--	--	--	--	--
10S15E	2	746	-19	21	-15	-9	1	11	17	1
10S16E	3	100	113	135	117	123	133	134	134	1
10S17E	6	1210	7	143	20	37	69	106	127	1
10S18E	3	512	-29	152	-5	31	90	121	139	1
11S14E	2	1776	32	99	39	49	66	82	92	1
11S15E	3	1524	23	162	50	91	158	160	161	1
11S16E	1	127	81	81	--	--	--	--	--	--
11S17E	1	36	80	80	--	--	--	--	--	--
11S18E	4	384	45	86	47	50	68	84	86	1
11S20E	1	829	63	63	--	--	--	--	--	--
12S15E	5	1575	75	149	76	79	107	120	137	1
12S16E	2	953	102	145	106	113	123	134	141	1
12S17E	2	354	-56	57	-44	-28	1	29	46	1
12S18E	5	288	-7	110	-1	7	52	76	97	1
12S19E	17	1988	-59	200	3	42	91	113	149	2
12S20E	1	3269	122	122	--	--	--	--	--	--
13S15E	3	1251	62	114	66	72	82	98	108	1
13S16E	10	1561	10	292	55	95	122	142	179	1
13S17E	2	150	65	80	67	69	73	76	79	1
unknown	5	417	7	90	17	33	39	79	86	1

Figure XVII-2. Box and Whisker plots of A/Y for Pistachios Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

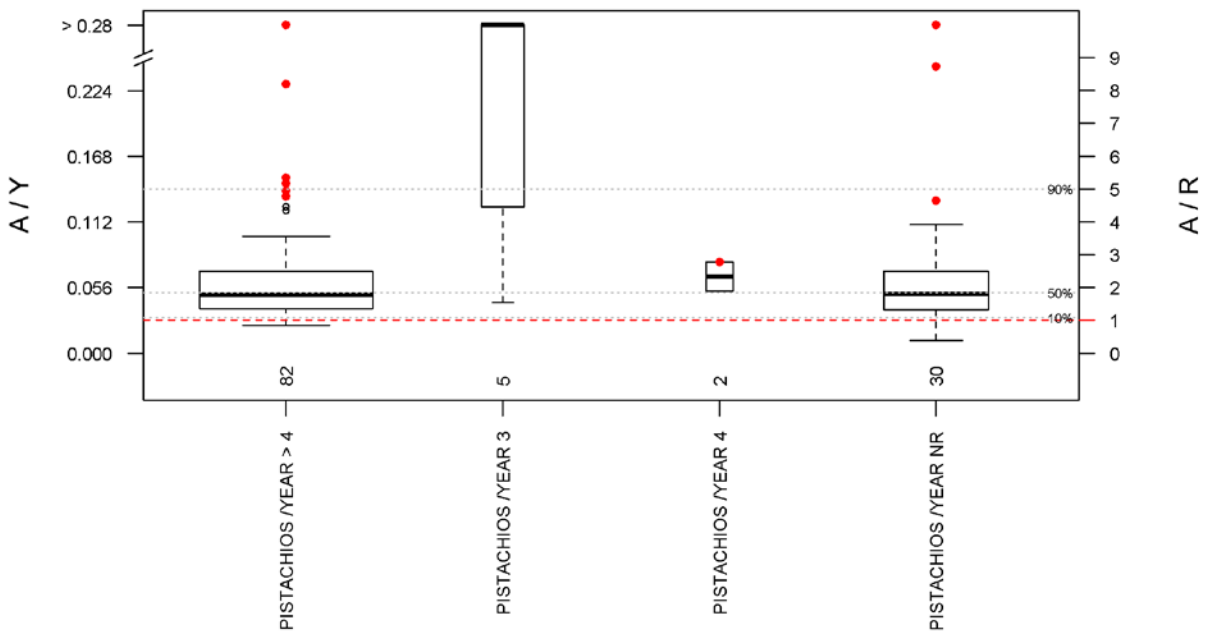


Table XVII-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Pistachios Management Units grouped by specific crop.

A. Summary statistics for Pistachios A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
PISTACHIOS /YEAR > 4	82	15802.1	0.0236	0.5946	0.0305	0.0379	0.0500	0.0690	0.1332	9
PISTACHIOS /YEAR 3	5	1752.2	0.0433	0.8929	0.0760	0.1250	0.3172	0.3376	0.6707	1
PISTACHIOS /YEAR 4	3	227.0	0.0531	0.0781	0.0556	0.0594	0.0656	0.0719	0.0756	1
PISTACHIOS /YEAR NR	30	5813.7	0.0110	0.3575	0.0218	0.0372	0.0510	0.0676	0.1120	3

B. Summary statistics for Pistachios A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
PISTACHIOS /YEAR > 4	82	15802.1	0.84	21.20	1.09	1.35	1.78	2.46	4.75	9
PISTACHIOS /YEAR 3	5	1752.2	1.54	31.83	2.71	4.46	11.31	12.03	23.91	1
PISTACHIOS /YEAR 4	3	227.0	1.89	2.79	1.98	2.12	2.34	2.56	2.70	1
PISTACHIOS /YEAR NR	30	5813.7	0.39	12.75	0.78	1.32	1.82	2.41	3.99	3

C. Summary statistics for Pistachios A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
PISTACHIOS /YEAR > 4	82	15802.1	-15	292	7	36	70	112	145	9
PISTACHIOS /YEAR 3	5	1752.2	39	79	43	48	69	75	77	1
PISTACHIOS /YEAR 4	3	227.0	80	91	80	80	80	86	89	1
PISTACHIOS /YEAR NR	30	5813.7	-59	167	-20	24	60	112	144	3

Figure XVII-3. Scatter plot of A vs. Y for Pistachios crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

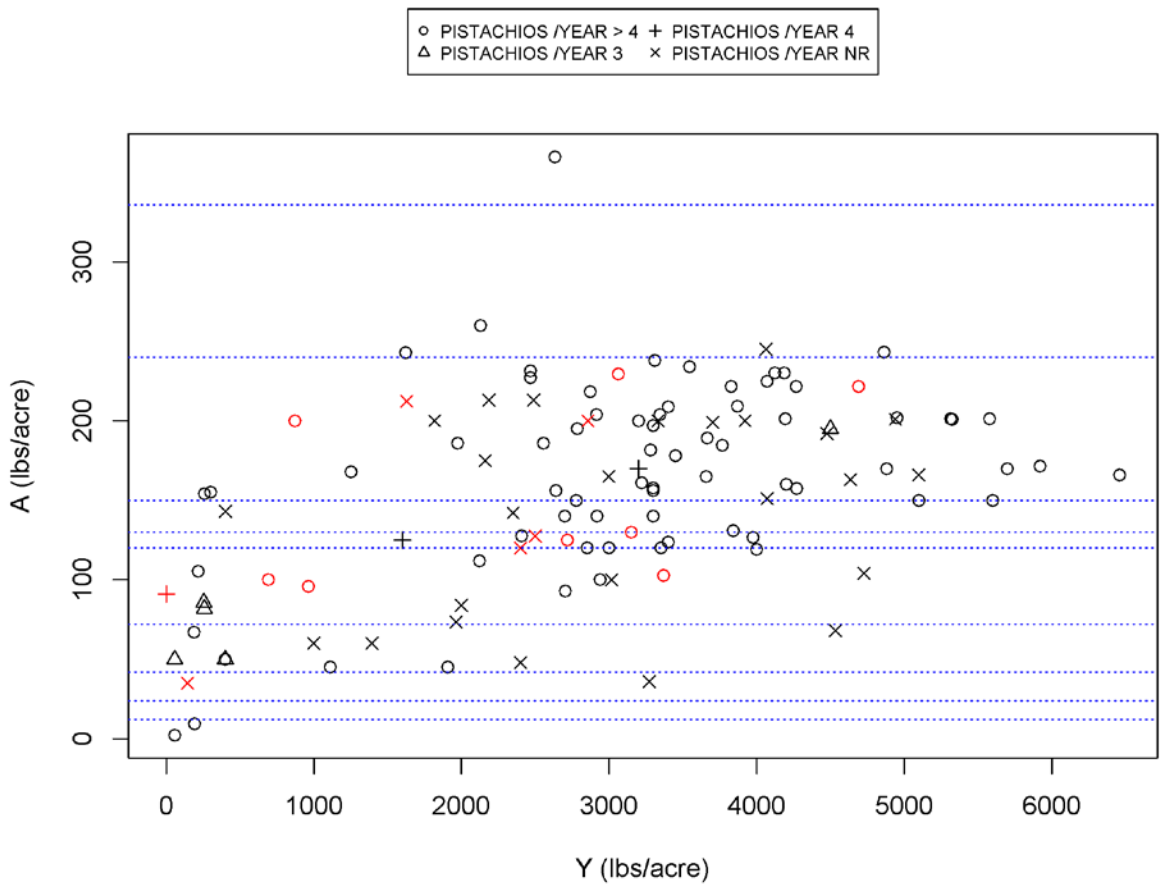


Table XVII-3. List of recommended nitrogen application values for Pistachios (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Pistachios /Year 1	0	12	Optimal leaf N concentration of 2.6-2.9% for rapidly growing immature trees. Assumes 120 trees/acre. N is best applied mid-spring and early summer.	CDFA
Pistachios /Year 2	18	24		
Pistachios /Year 3	30	42		
Pistachios /Year 4	60	72		
Pistachios /Year 5	100	120		
Pistachios /Year 6	120	130		
Pistachios /Year 7	135	150		
Pistachios /Year >9 (Drip)	40	240	Approximate N application rates based on desired yield. Minimum value is for a yield of 1000 lbs/acre; maximum produces 6000 lbs/acre.	CDFA
Pistachios /Year >10 (Furrow)	56	336		

CDFA - https://www.cdfa.ca.gov/is/ffldrs/frep/

XVIII. POTATOES

Important Analysis Considerations:

The calculation of N removed at harvest for SWEET POTATOES assumes that 0.00237 lbs N/lbs of fresh weight are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that the value is a good estimate for N removed with sweet potatoes from Central Valley fields.** The calculation of N removed at harvest for POTATOES assumes that 0.00312 lbs N/lbs of fresh weight are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that it is not possible to determine how well the dataset represents N concentrations in potatoes harvested in the Central Valley.**

Figure XVIII-1. Box and Whisker plots of A/Y and A/R for Potatoes Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

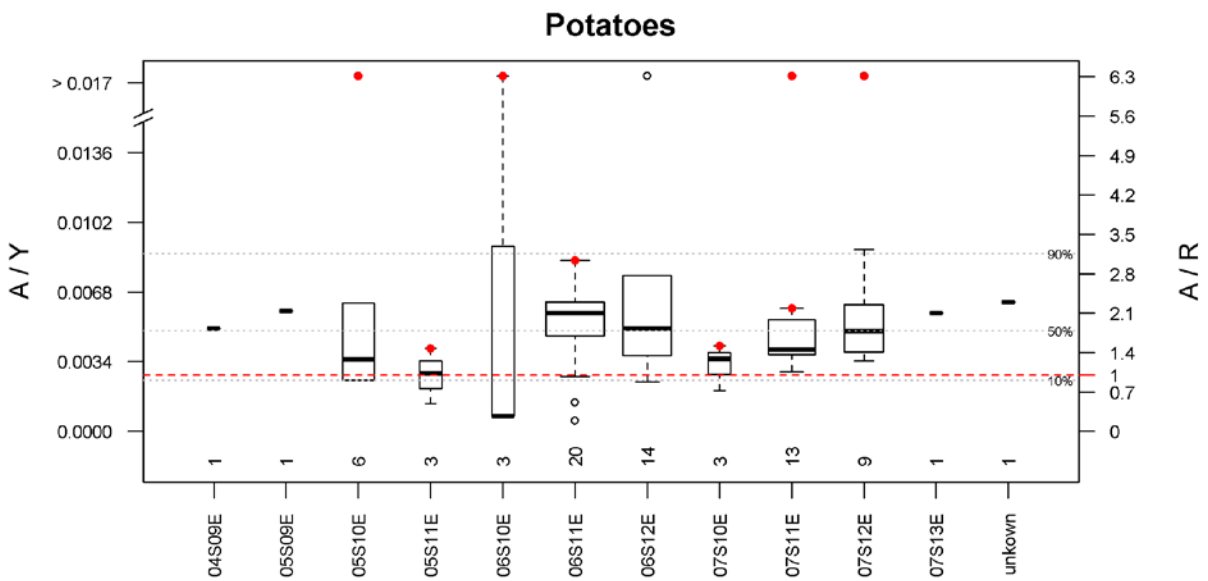


Table XVIII-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Potatoes Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Potatoes A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S09E	1	20	0	0.0050	--	--	--	--	--	--
05S09E	1	17	0	0.0059	--	--	--	--	--	--
05S10E	6	298	0	0.1300	0.0025	0.0026	0.0035	0.0057	0.0681	1
05S11E	3	195	0	0.0040	0.0017	0.0021	0.0028	0.0034	0.0038	1

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
06S10E	3	58	0	0.1100	0.0008	0.0008	0.0008	0.0554	0.0881	1
06S11E	20	727	0	0.0083	0.0025	0.0048	0.0058	0.0063	0.0063	1
06S12E	14	370	0	8.3333	0.0037	0.0040	0.0050	0.0074	5.8531	2
07S10E	3	322	0	0.0042	0.0023	0.0028	0.0035	0.0039	0.0040	1
07S11E	13	5037	0	8.3333	0.0033	0.0037	0.0040	0.0055	0.0059	2
07S12E	9	1240	0	0.0600	0.0038	0.0039	0.0049	0.0062	0.0191	1
07S13E	1	30	0	0.0058	--	--	--	--	--	--
unknown	1	17	0	0.0063	--	--	--	--	--	--

B. Summary statistics for Potatoes A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S09E	1	20.00	2.11	2.11	--	--	--	--	--	--
05S09E	1	17.00	2.48	2.48	--	--	--	--	--	--
05S10E	6	298.00	1.05	54.84	1.05	1.11	1.49	2.40	29	1
05S11E	3	195.00	0.58	1.71	0.70	0.89	1.20	1.45	2	1
06S10E	3	57.70	0.32	46.40	0.32	0.32	0.32	23.36	37	1
06S11E	20	727.38	0.22	3.52	1.08	2.02	2.44	2.66	3	1
06S12E	14	370.00	1.02	3516.17	1.56	1.67	2.11	3.11	1878	2
07S10E	3	322.40	0.84	1.76	0.97	1.17	1.49	1.63	2	1
07S11E	13	5037.23	1.22	2670.94	1.41	1.58	1.69	2.30	2	2
07S12E	9	1240.24	1.45	19.23	1.59	1.64	2.06	2.61	7	1
07S13E	1	29.80	2.43	2.43	--	--	--	--	--	--
unknown	1	17.00	2.66	2.66	--	--	--	--	--	--

C. Summary statistics for Potatoes A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S09E	1	20	105	105	--	--	--	--	--	--
05S09E	1	17	119	119	--	--	--	--	--	--
05S10E	6	298	6	157	6	12	54	113	141	1
05S11E	3	195	-44	79	-30	-8	28	53	68	1
06S10E	3	58	-130	157	-130	-130	-130	13	99	1
06S11E	20	727	-140	143	15	79	111	111	121	2
06S12E	14	370	3	200	52	59	87	120	184	2
07S10E	3	322	-26	86	-10	15	56	71	80	1
07S11E	13	5037	29	200	56	56	79	115	179	2
07S12E	9	1240	65	202	73	77	113	156	176	1
07S13E	1	30	88	88	--	--	--	--	--	--
unknown	1	17	111	111	--	--	--	--	--	--

Figure XVIII-2. Box and Whisker plots of A/Y for Potatoes Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

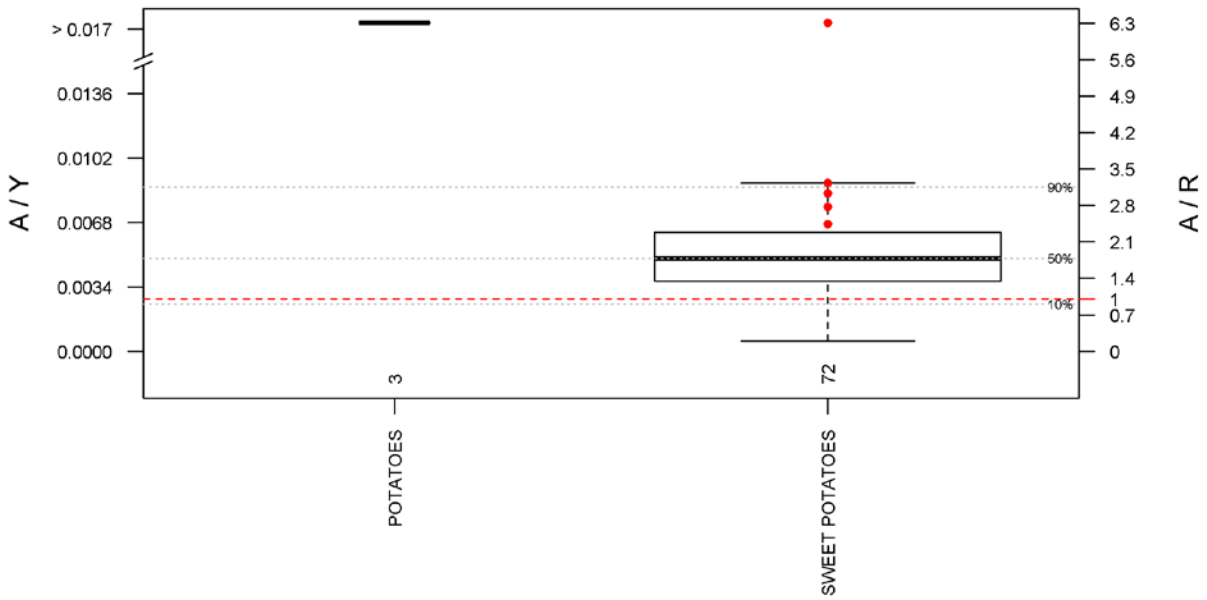


Table XVIII-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Potatoes Management Units grouped by specific crop.

A. Summary statistics for Potatoes A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
POTATOES	3	107.4	6e-02	8.3333	1.7147	4.1967	8.3333	8.3333	8.3333	0
SWEET POTATOES	72	8224.4	5e-04	8.3333	0.0025	0.0037	0.0049	0.0063	0.0067	8

B. Summary statistics for Potatoes A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
POTATOES	3	107.4	19.23	2670.94	549.57	1345.09	2670.94	2670.94	2670.94	0
SWEET POTATOES	72	8224.4	0.22	3516.17	1.05	1.56	2.06	2.64	2.81	8

C. Summary statistics for Potatoes A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
POTATOES	3	107.4	156	200	165	178	200	200	200	0
SWEET POTATOES	72	8224.4	-140	202	6	56	82	113	146	8

Figure XVIII-3. Scatter plot of A vs. Y for Potatoes crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

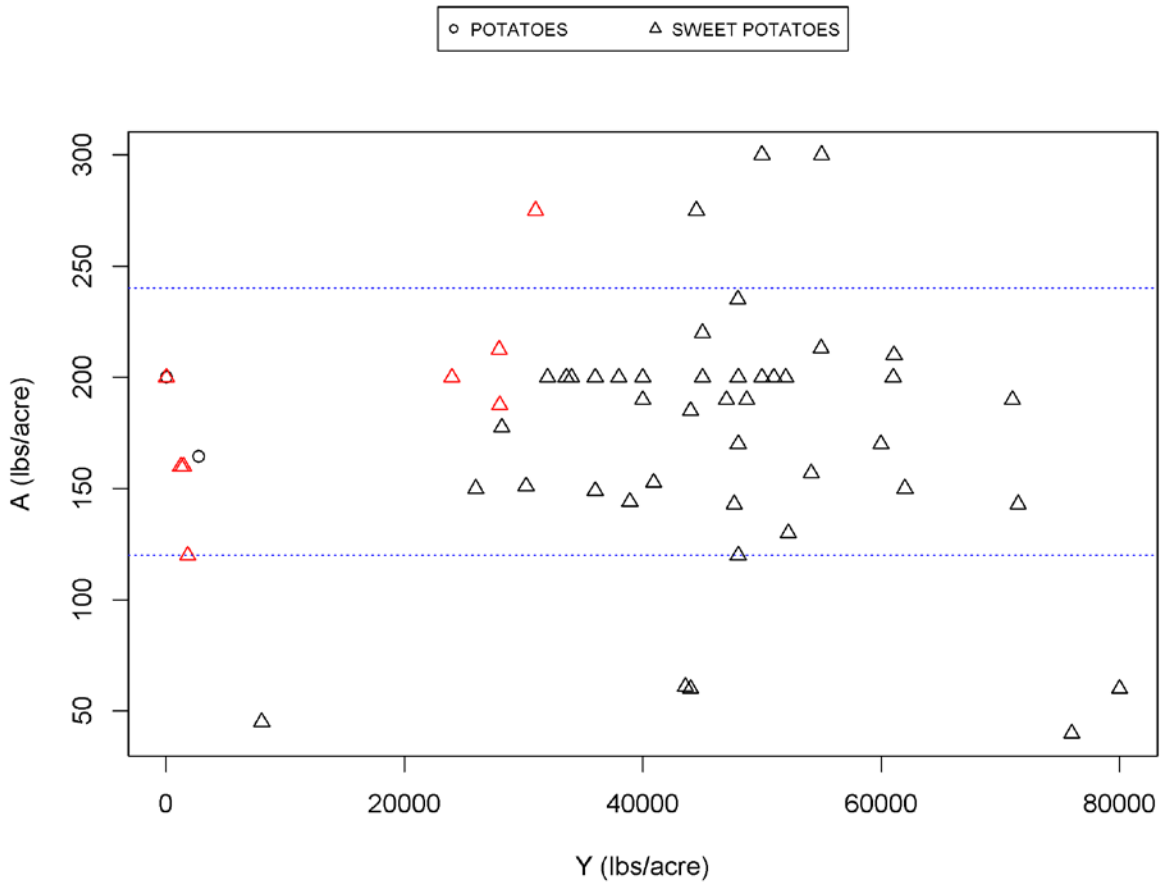


Table XVIII-3. List of recommended nitrogen application values for Potatoes (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Potatoes	160	240	For a 22.4 tons/acre crop. Includes nitrogen from all sources. Rate varies considerably with variety, growing location and year.	CDFA
Sweet Potatoes		120	Value based on typical practices to produce transplants and sweet potatoes. Not applicable to all fields. N applied with drip Irrigation.	UC Davis

UC Davis - http://coststudies.ucdavis.edu/current/

XIX. SILAGE

Important Analysis Considerations:

The calculation of N removed at harvest for WHEAT, SILAGE assumes that 0.00525 lbs N/lbs at 70% moisture are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that value is likely a good estimate of the average N concentration in wheat silage produced in the Central Valley. However, the data may not fully capture the variability among growers.**

The calculation of N removed at harvest for silage from other small grains, including oats, assumes that 0.00488 lbs N/lbs at 70% moisture are removed at harvest. This estimate is the average of triticale and wheat silage. **As the means and ranges overlap substantially, this is likely a good estimate of small grain silage N removal in the Central Valley.**

The calculation of N removed at harvest for SORGHUM/SUDAN, SILAGE assumes that 0.00367 lbs N/lbs at 65% moisture are removed at harvest. This estimate is obtained from Geisseler (2016). **The value represents the N concentration of sorghum silage and according to Geisseler, provides a good estimate of N concentrations in sorghum silage produced in the Central Valley. However, the data may not fully capture the variability.**

There is no N Removal Factor for FORAGE GRASS, SILAGE in any of the sources evaluated by the Coalition.

Figure XIX-1. Box and Whisker plots of A/Y for Silage Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

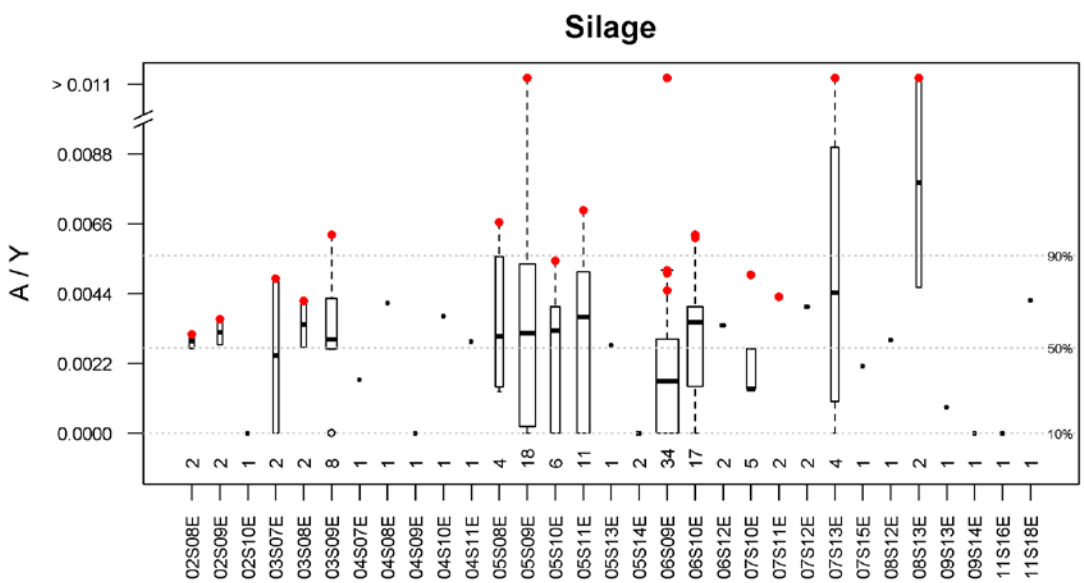


Table XIX-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Silage Management Units grouped by TR blocks.

TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Silage A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	2	30	0	0.0031	0.0027	0.0028	0.0029	0.0030	0.0031	1
02S09E	2	47	0	0.0036	0.0029	0.0030	0.0032	0.0034	0.0035	1
02S10E	1	23	0	0.0000	--	--	--	--	--	--
03S07E	2	75	0	0.0049	0.0005	0.0012	0.0024	0.0037	0.0044	1
03S08E	2	62	0	0.0042	0.0029	0.0031	0.0034	0.0038	0.0040	1
03S09E	8	245	0	0.0062	0.0019	0.0027	0.0030	0.0037	0.0056	1
04S07E	1	96	0	0.0017	--	--	--	--	--	--
04S08E	1	605	0	0.0041	--	--	--	--	--	--
04S09E	1	70	0	0.0000	--	--	--	--	--	--
04S10E	1	213	0	0.0037	--	--	--	--	--	--
04S11E	1	35	0	0.0029	--	--	--	--	--	--
05S08E	4	398	0	0.0067	0.0014	0.0015	0.0031	0.0050	0.0060	1
05S09E	18	1082	0	0.0187	0.0001	0.0005	0.0032	0.0052	0.0089	2
05S10E	6	195	0	0.0054	0.0000	0.0007	0.0032	0.0040	0.0047	1
05S11E	11	1310	0	0.0070	0.0000	0.0000	0.0037	0.0051	0.0059	1
05S13E	1	150	0	0.0028	--	--	--	--	--	--
05S14E	2	78	0	0.0000	--	--	--	--	--	--
06S09E	34	2422	0	0.6667	0.0000	0.0000	0.0017	0.0030	0.0044	4
06S10E	17	701	0	0.0062	0.0003	0.0015	0.0035	0.0040	0.0061	2
06S12E	2	58	0	0.0034	--	--	--	--	--	--
07S10E	5	181	0	0.0050	0.0014	0.0014	0.0014	0.0027	0.0041	1
07S11E	2	1278	0	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	1
07S12E	2	227	0	0.0040	--	--	--	--	--	--
07S13E	4	430	0	0.0112	0.0006	0.0015	0.0044	0.0079	0.0099	1
07S15E	1	57	0	0.0021	--	--	--	--	--	--
08S12E	1	116	0	0.0029	--	--	--	--	--	--
08S13E	2	129	0	0.0556	0.0097	0.0173	0.0301	0.0428	0.0505	1
09S13E	1	70	0	0.0008	--	--	--	--	--	--
09S14E	1	122	0	0.0000	--	--	--	--	--	--
11S16E	1	22	0	0.0000	--	--	--	--	--	--
11S18E	1	72	0	0.0042	--	--	--	--	--	--

B. Summary statistics for Silage A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	2	30.00	0.55	0.55	--	--	--	--	--	--
02S09E	2	47.00	0.57	0.74	0.59	0.61	0.65	0.69	1	1
02S10E	1	23.00	0.00	0.00	--	--	--	--	--	--
03S07E	2	75.00	0.00	1.00	0.10	0.25	0.50	0.75	1	1
03S08E	2	62.00	0.55	0.85	0.58	0.63	0.70	0.78	1	1
03S09E	8	245.24	0.00	1.10	0.22	0.54	0.55	0.57	1	1
04S07E	1	96.00	0.35	0.35	--	--	--	--	--	--
04S08E	1	605.33	0.84	0.84	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S09E	1	70.00	0.00	0.00	--	--	--	--	--	--
04S10E	1	213.00	0.76	0.76	--	--	--	--	--	--
04S11E	1	35.00	0.59	0.59	--	--	--	--	--	--
05S08E	4	398.00	0.27	1.36	0.29	0.32	0.63	1.03	1	1
05S09E	18	1082.19	0.00	1.36	0.02	0.04	0.41	0.95	1	2
05S10E	6	195.00	0.00	1.11	0.00	0.14	0.66	0.81	1	1
05S11E	11	1310.00	0.00	1.44	0.00	0.22	0.96	1.12	1	1
05S13E	1	150.00	0.57	0.57	--	--	--	--	--	--
05S14E	2	77.80	0.00	0.00	--	--	--	--	--	--
06S09E	34	2422.13	0.00	136.54	0.00	0.00	0.34	0.58	1	3
06S10E	17	701.30	0.00	1.28	0.06	0.30	0.72	0.82	1	2
06S12E	2	58.00	0.70	0.70	--	--	--	--	--	--
07S10E	5	181.16	0.29	1.02	0.29	0.29	0.29	0.55	1	1
07S11E	2	1278.00	0.88	0.88	--	--	--	--	--	--
07S12E	2	227.00	0.82	0.82	--	--	--	--	--	--
07S13E	4	430.40	0.00	2.30	0.08	0.20	0.41	1.35	2	1
07S15E	1	57.00	0.40	0.40	--	--	--	--	--	--
08S12E	1	116.30	0.56	0.56	--	--	--	--	--	--
08S13E	2	129.00	0.94	11.38	1.99	3.55	6.16	8.77	10	1
09S13E	1	70.00	0.17	0.17	--	--	--	--	--	--
09S14E	1	121.60	0.00	0.00	--	--	--	--	--	--

C. Summary statistics for Silage A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S08E	2	30	-62	-62	--	--	--	--	--	--
02S09E	2	47	-59	-28	-56	-51	-44	-36	-31	1
02S10E	1	23	-146	-146	--	--	--	--	--	--
03S07E	2	75	0	0	--	--	--	--	--	--
03S08E	2	62	-64	-26	-60	-54	-45	-35	-30	1
03S09E	8	245	-146	13	-113	-63	-62	-52	-13	1
04S07E	1	96	-95	-95	--	--	--	--	--	--
04S08E	1	605	-27	-27	--	--	--	--	--	--
04S09E	1	70	-147	-147	--	--	--	--	--	--
04S10E	1	213	-27	-27	--	--	--	--	--	--
04S11E	1	35	-49	-49	--	--	--	--	--	--
05S08E	4	398	-162	43	-150	-132	-67	1	26	1
05S09E	18	1082	-312	43	-176	-168	-116	-4	13	2
05S10E	6	195	-117	16	-97	-67	-33	-16	4	1
05S11E	11	1310	-99	40	-98	-49	-6	11	23	1
05S13E	1	150	-76	-76	--	--	--	--	--	--
06S09E	34	2422	-153	10	-146	-138	-85	-52	-21	2
06S10E	17	701	-175	44	-136	-100	-55	-15	38	2
06S12E	2	58	-30	-30	--	--	--	--	--	--
07S10E	5	181	-124	3	-124	-124	-124	-67	-25	1
07S11E	2	1278	-16	-16	--	--	--	--	--	--
07S12E	2	227	-22	-22	--	--	--	--	--	--
07S13E	4	430	-111	80	-92	-63	-15	32	61	1
07S15E	1	57	-84	-84	--	--	--	--	--	--
08S12E	1	116	-65	-65	--	--	--	--	--	--
08S13E	2	129	-16	91	-5	11	38	65	81	1

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
09S13E	1	70	-128	-128	--	--	--	--	--	--

Figure XIX-2. Box and Whisker plots of A/Y for Silage Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

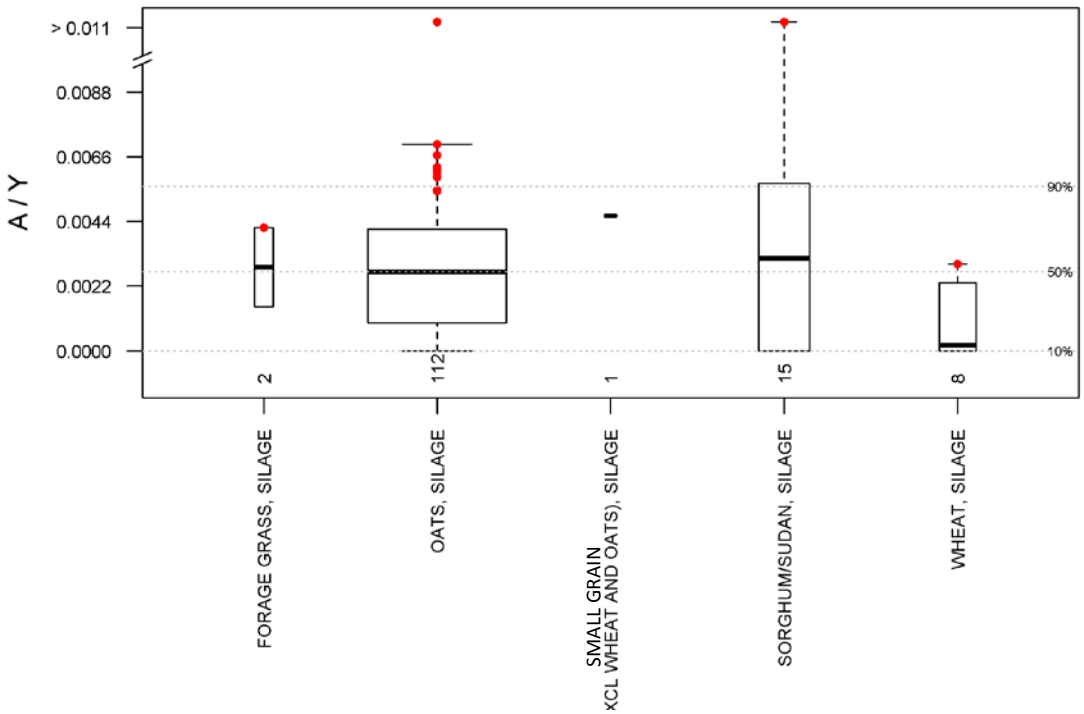


Table XIX-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Silage Management Units grouped by specific crop.

A. Summary statistics for Silage A/Y.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
FORAGE GRASS, SILAGE	2	146.7	0.0015	0.0042	0.0018	0.0022	0.0028	0.0035	0.0039	1
OATS, SILAGE	112	8404.5	0.0000	0.6667	0.0000	0.0010	0.0027	0.0041	0.0054	12
OTHER SMALL GRAIN, SILAGE	1	9.0	0.0046	0.0046	--	--	--	--	--	--
SORGHUM/SUDAN, SILAGE	15	1556.1	0.0000	0.0187	0.0000	0.0000	0.0031	0.0057	0.0112	2
WHEAT, SILAGE	8	483.9	0.0000	0.0029	0.0000	0.0000	0.0002	0.0022	0.0026	1

B. Summary statistics for Silage A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

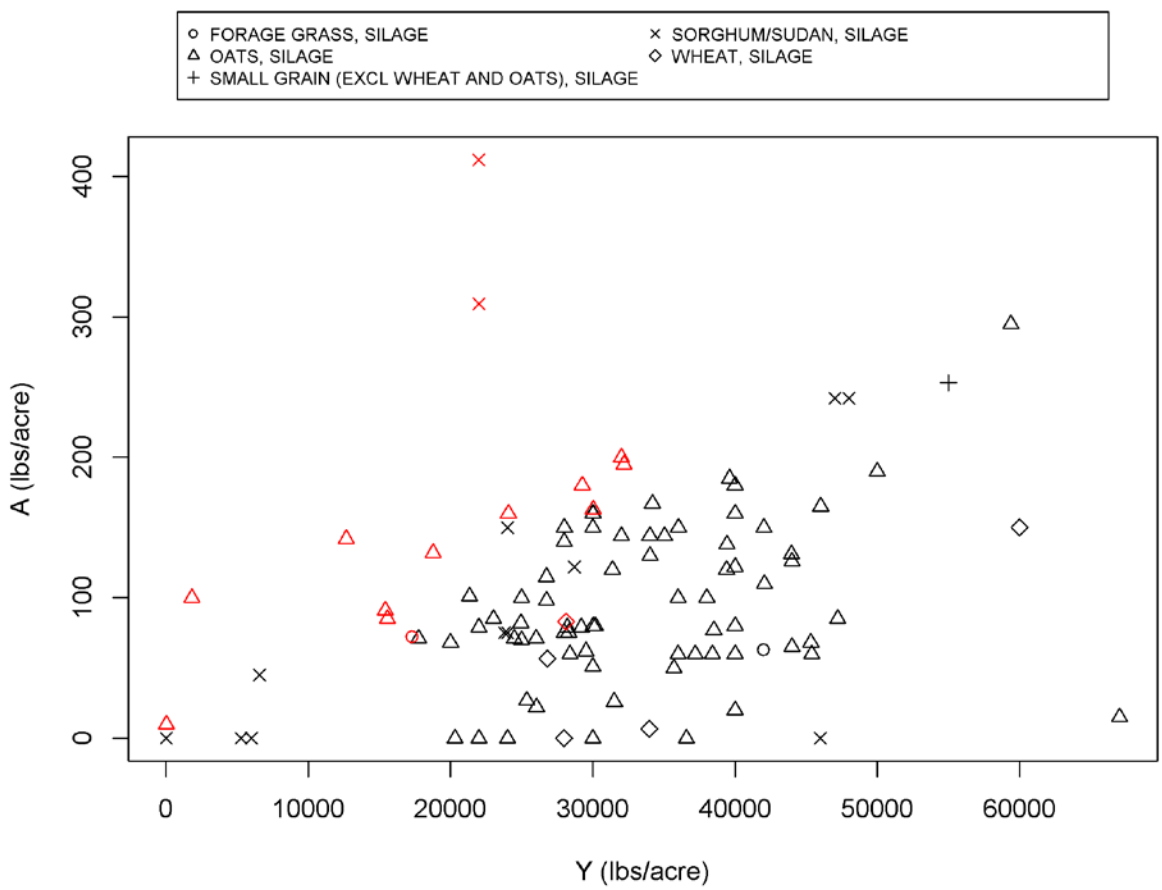
SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
OATS, SILAGE	112	8404.5	0.00	136.54	0	0.21	0.55	0.84	1.11	12

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
OTHER SMALL GRAIN, SILAGE	1	9.0	0.94	0.94	--	--	--	--	--	--
SORGHUM/SUDAN, SILAGE	15	1556.1	0.00	0.00	--	--	--	--	--	--
WHEAT, SILAGE	8	483.9	0.00	0.56	0	0.00	0.04	0.42	0.50	1

C. Summary statistics for Silage A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N Mgmnt Units	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
OATS, SILAGE	112	8404.5	-312	91	-146	-113	-56	-14	15	10
OTHER SMALL GRAIN, SILAGE	1	9.0	-16	-16	--	--	--	--	--	--
WHEAT, SILAGE	8	483.9	-172	-65	-172	-170	-156	-100	-74	1

Figure XIX-3. Scatter plot of A vs. Y for Silage crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.



XX. SILAGE, CORN

Important Analysis Considerations:

The calculation of N removed at harvest for CORN, SILAGE assumes that 0.00378 lbs N/lbs at 70% moisture are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that this value can be considered a very good estimate of Central Valley corn silage.**

Figure XX-1. Box and Whisker plots of A/Y and A/R for Silage, Corn Management Units grouped by TR blocks.
Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

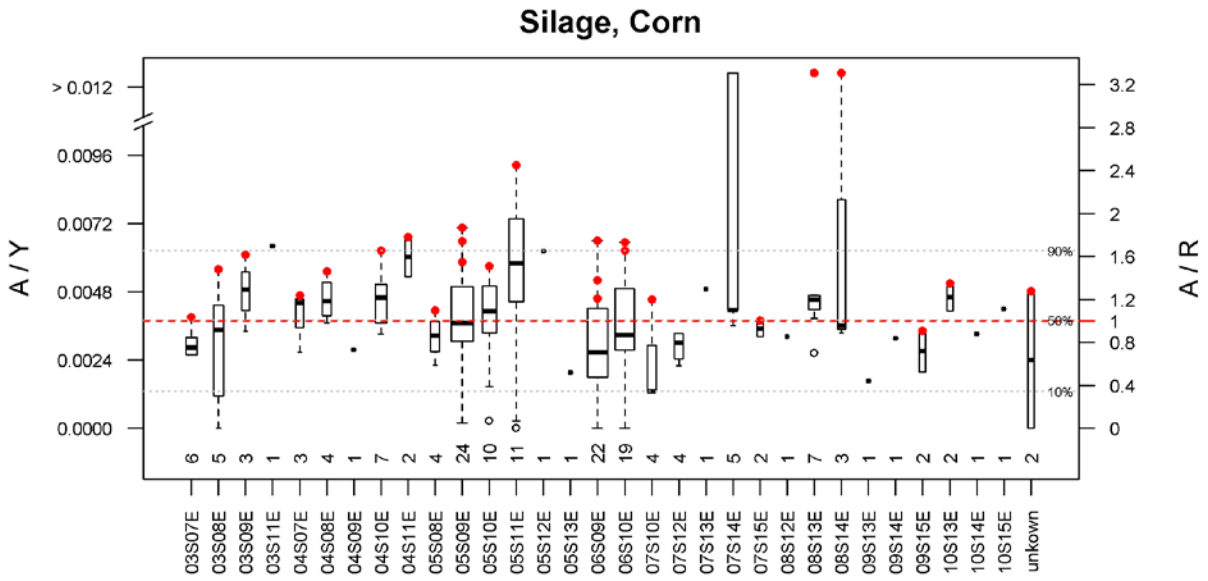


Table XX-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Silage, Corn Management Units grouped by TR blocks.
TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Silage, Corn A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	6	457	0	0.0039	0.0026	0.0026	0.0028	0.0032	0.0036	1
03S08E	5	169	0	0.0056	0.0005	0.0011	0.0035	0.0043	0.0051	1
03S09E	3	183	0	0.0061	0.0037	0.0042	0.0049	0.0055	0.0059	1
03S11E	1	141	0	0.0064	--	--	--	--	--	--
04S07E	3	470	0	0.0047	0.0030	0.0035	0.0044	0.0045	0.0046	1
04S08E	4	775	0	0.0055	0.0039	0.0041	0.0045	0.0049	0.0053	1
04S09E	1	37	0	0.0028	--	--	--	--	--	--
04S10E	7	357	0	0.0062	0.0035	0.0037	0.0046	0.0051	0.0056	1
04S11E	2	83	0	0.0067	0.0055	0.0057	0.0060	0.0064	0.0066	1

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
05S08E	4	398	0	0.0041	0.0025	0.0029	0.0033	0.0036	0.0039	1
05S09E	24	2084	0	0.0071	0.0009	0.0031	0.0037	0.0050	0.0058	3
05S10E	10	261	0	0.0057	0.0013	0.0035	0.0041	0.0048	0.0051	1
05S11E	11	917	0	0.0093	0.0003	0.0045	0.0058	0.0074	0.0082	1
05S12E	1	60	0	0.0062	--	--	--	--	--	--
05S13E	1	150	0	0.0020	--	--	--	--	--	--
06S09E	22	1509	0	0.0066	0.0000	0.0018	0.0027	0.0041	0.0045	3
06S10E	19	791	0	0.0066	0.0000	0.0028	0.0033	0.0049	0.0054	2
07S10E	4	120	0	0.0045	0.0013	0.0013	0.0013	0.0021	0.0036	1
07S12E	4	340	0	0.0033	0.0023	0.0026	0.0030	0.0033	0.0033	0
07S13E	1	292	0	0.0049	--	--	--	--	--	--
07S14E	5	133	0	0.1765	0.0038	0.0042	0.0042	0.0204	0.1140	1
07S15E	2	361	0	0.0038	0.0033	0.0034	0.0035	0.0036	0.0037	1
08S12E	1	194	0	0.0032	--	--	--	--	--	--
08S13E	7	946	0	0.0247	0.0034	0.0042	0.0045	0.0047	0.0127	1
08S14E	3	282	0	0.0207	0.0034	0.0035	0.0036	0.0122	0.0173	1
09S13E	1	71	0	0.0017	--	--	--	--	--	--
09S14E	1	83	0	0.0032	--	--	--	--	--	--
09S15E	2	398	0	0.0034	0.0021	0.0023	0.0027	0.0031	0.0033	1
10S13E	2	291	0	0.0051	0.0042	0.0044	0.0046	0.0049	0.0050	1
10S14E	1	73	0	0.0033	--	--	--	--	--	--
10S15E	1	75	0	0.0042	--	--	--	--	--	--
unknown	2	300	0	0.0048	0.0005	0.0012	0.0024	0.0036	0.0043	1

B. Summary statistics for Silage, Corn A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	6	456.93	0.68	1.03	0.68	0.69	0.75	0.83	1	1
03S08E	5	169.00	0.00	1.48	0.12	0.30	0.92	1.15	1	1
03S09E	3	183.24	0.90	1.62	0.98	1.10	1.29	1.45	2	1
03S11E	1	141.40	1.70	1.70	--	--	--	--	--	--
04S07E	3	469.71	0.71	1.24	0.80	0.94	1.17	1.20	1	1
04S08E	4	774.93	0.98	1.46	1.02	1.08	1.19	1.31	1	1
04S09E	1	36.92	0.73	0.73	--	--	--	--	--	--
04S10E	7	356.58	0.88	1.65	0.92	0.98	1.22	1.34	1	1
04S11E	2	83.40	1.41	1.78	1.45	1.50	1.59	1.69	2	1
05S08E	4	398.00	0.59	1.10	0.66	0.77	0.86	0.94	1	1
05S09E	24	2083.89	0.05	1.87	0.24	0.82	0.98	1.31	2	3
05S10E	10	260.81	0.07	1.51	0.36	0.92	1.09	1.27	1	1
05S11E	11	917.00	0.00	2.45	0.07	1.18	1.54	1.95	2	1
05S12E	1	60.00	1.65	1.65	--	--	--	--	--	--
05S13E	1	150.00	0.52	0.52	--	--	--	--	--	--
06S09E	22	1509.23	0.00	1.75	0.01	0.48	0.71	1.09	1	3
06S10E	19	791.20	0.00	1.73	0.00	0.73	0.87	1.30	1	2
07S10E	4	120.00	0.34	1.20	0.34	0.34	0.34	0.56	1	1
07S12E	4	340.00	0.58	0.88	0.62	0.68	0.80	0.88	1	2
07S13E	1	292.00	1.30	1.30	--	--	--	--	--	--
07S14E	5	132.95	0.96	46.69	1.02	1.10	1.10	5.40	30	1
07S15E	2	361.00	0.85	1.00	0.87	0.89	0.93	0.97	1	1
08S12E	1	194.10	0.85	0.85	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
08S13E	7	946.40	0.70	6.54	0.89	1.11	1.20	1.24	3	1
08S14E	3	282.50	0.89	5.49	0.90	0.92	0.96	3.22	5	1
09S13E	1	71.30	0.44	0.44	--	--	--	--	--	--
09S14E	1	83.00	0.84	0.84	--	--	--	--	--	--
09S15E	2	398.20	0.53	0.91	0.56	0.62	0.72	0.81	1	1
10S13E	2	290.70	1.09	1.35	1.12	1.16	1.22	1.29	1	1
10S14E	1	72.90	0.88	0.88	--	--	--	--	--	--
10S15E	1	75.00	1.11	1.11	--	--	--	--	--	--
unknown	2	300.00	0.00	1.28	0.13	0.32	0.64	0.96	1	1

C. Summary statistics for Silage, Corn A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
03S07E	6	457	-69	8	-69	-67	-50	-32	-11	1
03S08E	5	169	-151	119	-137	-116	-18	33	85	1
03S09E	3	183	-21	112	-3	23	66	89	103	1
03S11E	1	141	182	182	--	--	--	--	--	--
04S07E	3	470	-62	62	-45	-20	21	42	54	1
04S08E	4	775	-4	101	5	19	44	71	89	1
04S09E	1	37	-39	-39	--	--	--	--	--	--
04S10E	7	357	-8	79	-5	0	65	71	75	1
04S11E	2	83	86	194	97	113	140	167	183	1
05S08E	4	398	-141	23	-110	-64	-32	-13	9	1
05S09E	24	2084	-238	235	-108	-40	-4	64	103	3
05S10E	10	261	-197	108	-70	-19	20	51	72	1
05S11E	11	917	-197	122	-8	27	66	101	114	1
05S12E	1	60	189	189	--	--	--	--	--	--
05S13E	1	150	-137	-137	--	--	--	--	--	--
06S09E	22	1509	-159	103	-93	-87	-20	23	42	2
06S10E	19	791	-162	122	-91	-41	4	69	85	2
07S10E	4	120	-156	41	-156	-156	-156	-107	-18	1
07S12E	4	340	-90	-27	-81	-69	-44	-27	-27	0
07S13E	1	292	56	56	--	--	--	--	--	--
07S14E	5	133	-11	173	3	23	23	147	162	1
07S15E	2	361	-34	1	-31	-26	-17	-8	-3	1
08S12E	1	194	-34	-34	--	--	--	--	--	--
08S13E	7	946	-80	115	-28	23	47	49	76	1
08S14E	3	282	-25	245	-22	-19	-13	116	194	1
09S13E	1	71	-76	-76	--	--	--	--	--	--
09S14E	1	83	-37	-37	--	--	--	--	--	--
09S15E	2	398	-104	-14	-95	-82	-59	-37	-23	1
10S13E	2	291	16	58	20	26	37	48	54	1
10S14E	1	73	-19	-19	--	--	--	--	--	--
10S15E	1	75	21	21	--	--	--	--	--	--
unknown	2	300	65	65	--	--	--	--	--	--

Figure XX-2. Box and Whisker plots of A/Y for Silage, Corn Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

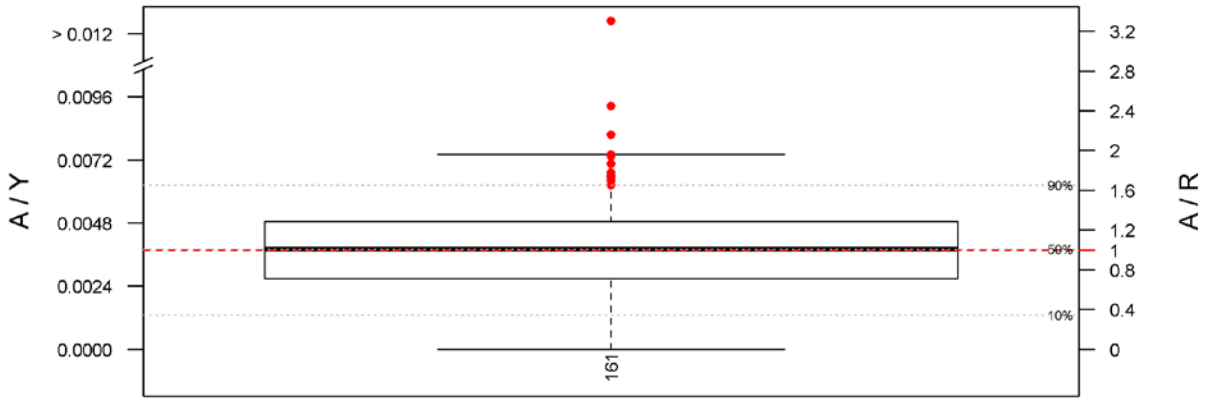


Table XX-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Silage, Corn Management Units grouped by specific crop.

A. Summary statistics for Silage, Corn A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CORN, SILAGE	161	12802.3	0	0.1765	0.0013	0.0027	0.0038	0.0049	0.0062	16

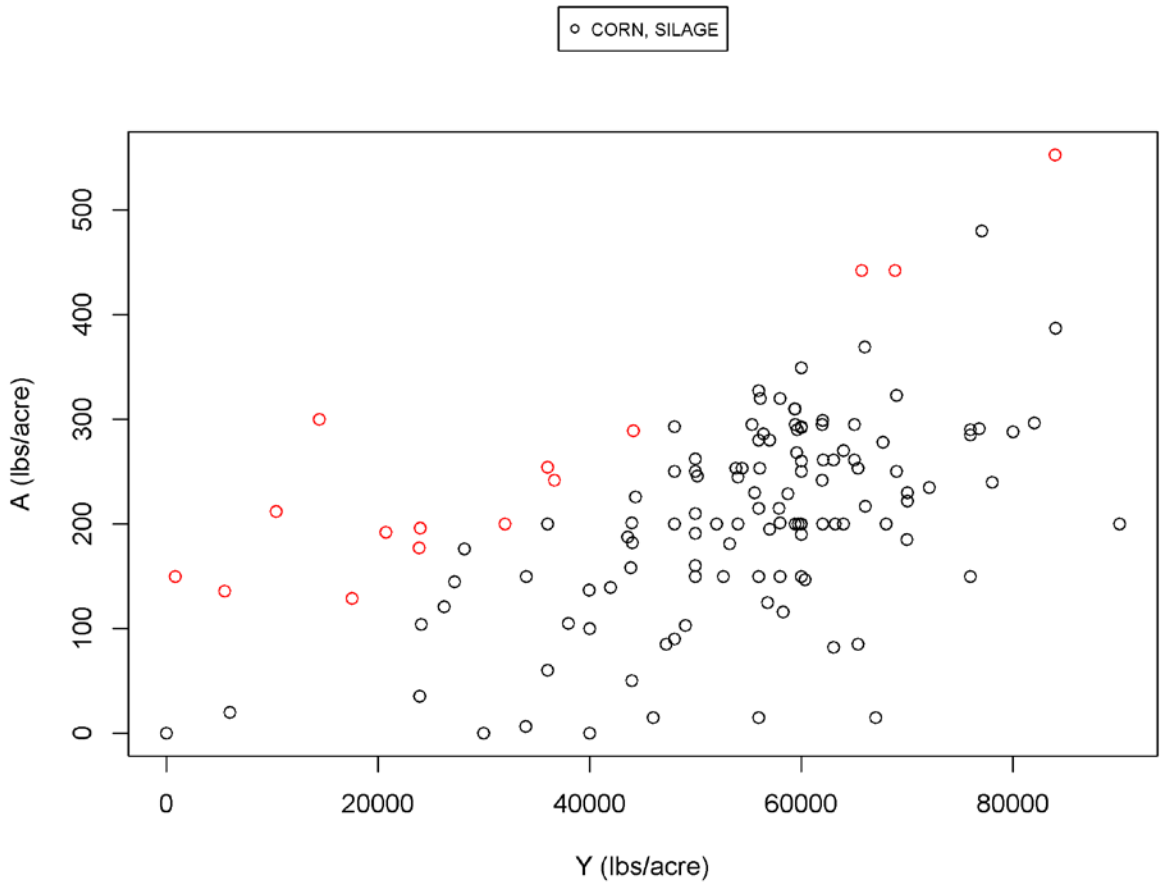
B. Summary statistics for Silage, Corn A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CORN, SILAGE	161	12802.3	0	46.69	0.34	0.71	1.01	1.29	1.65	16

C. Summary statistics for Silage, Corn A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
CORN, SILAGE	161	12802.3	-238	245	-100	-40	3	63	107	16

Figure XX-3. Scatter plot of A vs. Y for Silage, Corn crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.



XXI. TOMATOES

Important Analysis Considerations:

The calculation of N removed at harvest for TOMATOES, FRESH MARKET assumes that 0.00130 lbs N/lbs of fresh weight are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that it is not possible to determine the degree to which the dataset is representative of tomatoes harvested in the Central Valley.** The calculation of N removed at harvest for TOMATOES, PROCESSING assumes that 0.00136 lbs N/lbs of fresh weight are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that this value can be considered a very good estimate for the Central Valley.** In cases when the grower did not specify the kind of tomato harvested, the calculation of N removed is based on 0.00133 lbs N/lbs of fresh weight removed at harvest. This value is an average of N removal for fresh market and processing tomatoes. **As the two values are quite similar to each other, this is likely a good estimate for tomatoes N removal in general.**

Figure XXI-1. Box and Whisker plots of A/Y and A/R for Tomatoes Management Units grouped by TR blocks. Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

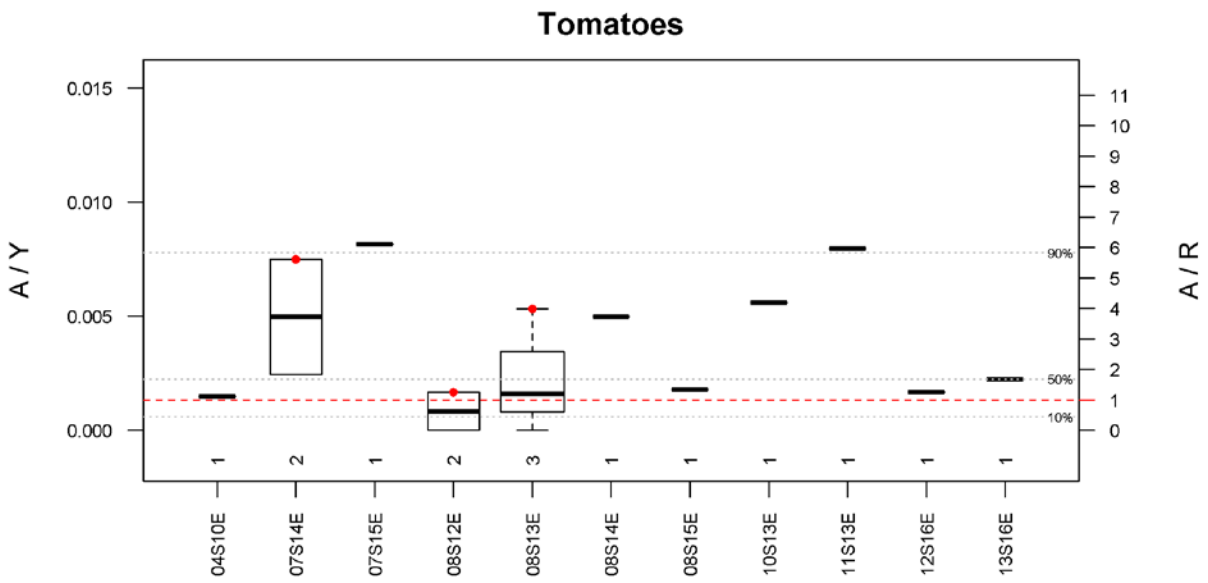


Table XXI-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Tomatoes Management Units grouped by TR blocks.

TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Tomatoes A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S10E	1	4	0	0.0015	--	--	--	--	--	--
07S14E	2	33	0	0.0075	3e-03	0.0037	0.0050	0.0062	0.0070	1
07S15E	1	28	0	0.0082	--	--	--	--	--	--
08S12E	2	450	0	0.0017	2e-04	0.0004	0.0008	0.0012	0.0015	1
08S13E	3	1915	0	0.0053	3e-04	0.0008	0.0016	0.0035	0.0046	1
08S14E	1	12	0	0.0050	--	--	--	--	--	--
08S15E	1	175	0	0.0018	--	--	--	--	--	--
10S13E	1	350	0	0.0056	--	--	--	--	--	--
11S13E	1	401	0	0.0080	--	--	--	--	--	--
12S16E	1	664	0	0.0017	--	--	--	--	--	--
13S16E	1	140	0	0.0023	--	--	--	--	--	--

B. Summary statistics for Tomatoes A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S10E	1	4.00	1.12	1.12	--	--	--	--	--	--
07S14E	2	33.00	1.80	5.75	2.20	2.79	3.77	4.76	5	1
07S15E	1	28.00	6.25	6.25	--	--	--	--	--	--
08S12E	2	449.92	0.00	1.22	0.12	0.30	0.61	0.91	1	1
08S13E	3	1914.55	0.00	4.08	0.23	0.58	1.17	2.62	3	1
08S14E	1	12.00	3.73	3.73	--	--	--	--	--	--
08S15E	1	175.00	1.34	1.34	--	--	--	--	--	--
10S13E	1	350.10	4.29	4.29	--	--	--	--	--	--
11S13E	1	401.00	6.11	6.11	--	--	--	--	--	--
12S16E	1	664.00	1.28	1.28	--	--	--	--	--	--
13S16E	1	140.00	1.65	1.65	--	--	--	--	--	--

C. Summary statistics for Tomatoes A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
04S10E	1	4	2	2	--	--	--	--	--	--
07S14E	2	33	81	124	85	92	102	113	120	1
07S15E	1	28	190	190	--	--	--	--	--	--
08S12E	2	450	-85	27	-74	-57	-29	-1	16	1
08S13E	3	1915	-53	148	-38	-15	24	86	123	1
08S14E	1	12	133	133	--	--	--	--	--	--
08S15E	1	175	57	57	--	--	--	--	--	--
10S13E	1	350	166	166	--	--	--	--	--	--
11S13E	1	401	211	211	--	--	--	--	--	--
12S16E	1	664	54	54	--	--	--	--	--	--
13S16E	1	140	107	107	--	--	--	--	--	--

Figure XXI-2. Box and Whisker plots of A/Y for Tomatoes Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

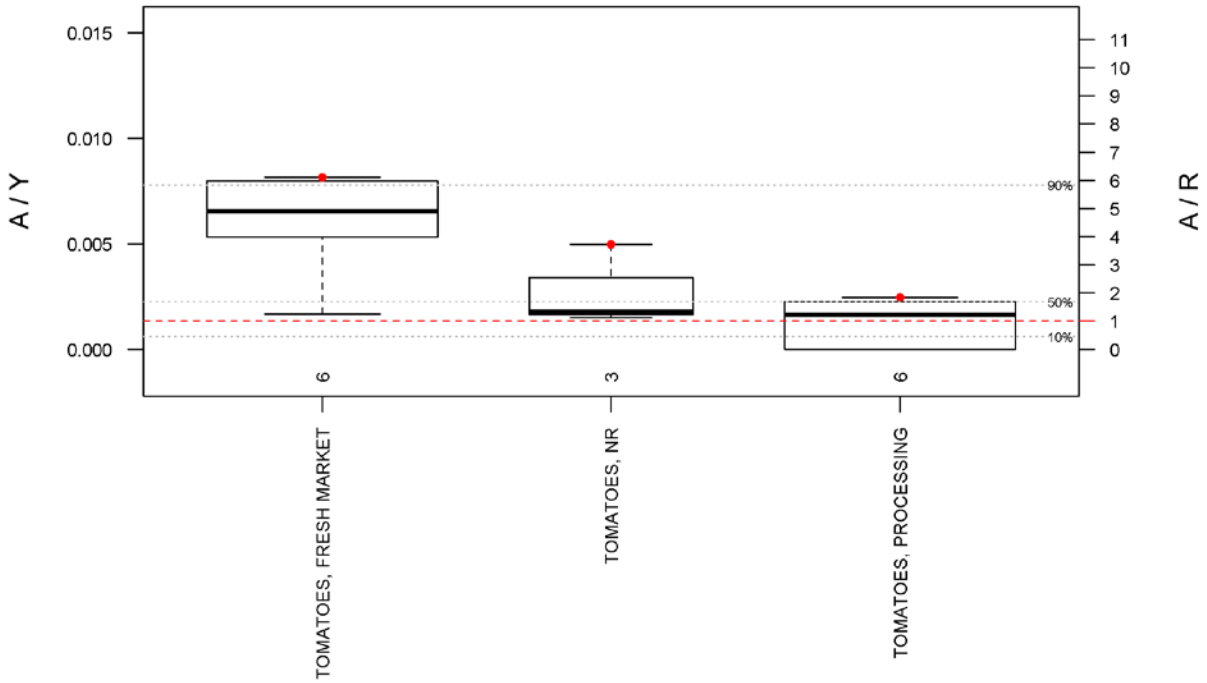


Table XXI-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Tomatoes Management Units grouped by specific crop.

A. Summary statistics for Tomatoes A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
TOMATOES, FRESH MARKET	6	2086.6	0.0017	0.0082	0.0035	0.0054	0.0066	0.0079	0.0081	1
TOMATOES, NR	3	191.0	0.0015	0.0050	0.0016	0.0016	0.0018	0.0034	0.0043	1
TOMATOES, PROCESSING	6	1894.0	0.0000	0.0025	0.0000	0.0004	0.0016	0.0021	0.0024	1

B. Summary statistics for Tomatoes A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
TOMATOES, FRESH MARKET	6	2086.6	1.28	6.25	2.68	4.13	5.02	6.02	6.18	1
TOMATOES, NR	3	191.0	1.12	3.73	1.17	1.23	1.34	2.53	3.25	1
TOMATOES, PROCESSING	6	1894.0	0.00	1.80	0.00	0.29	1.19	1.54	1.73	1

C. Summary statistics for Tomatoes A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
TOMATOES, FRESH MARKET	6	2086.6	54	211	89	130	157	184	200	1
TOMATOES, NR	3	191.0	2	133	13	29	57	95	118	1
TOMATOES, PROCESSING	6	1894.0	-85	107	-69	-34	25	68	94	1

Figure XXI-3. Scatter plot of A vs. Y for Tomatoes crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

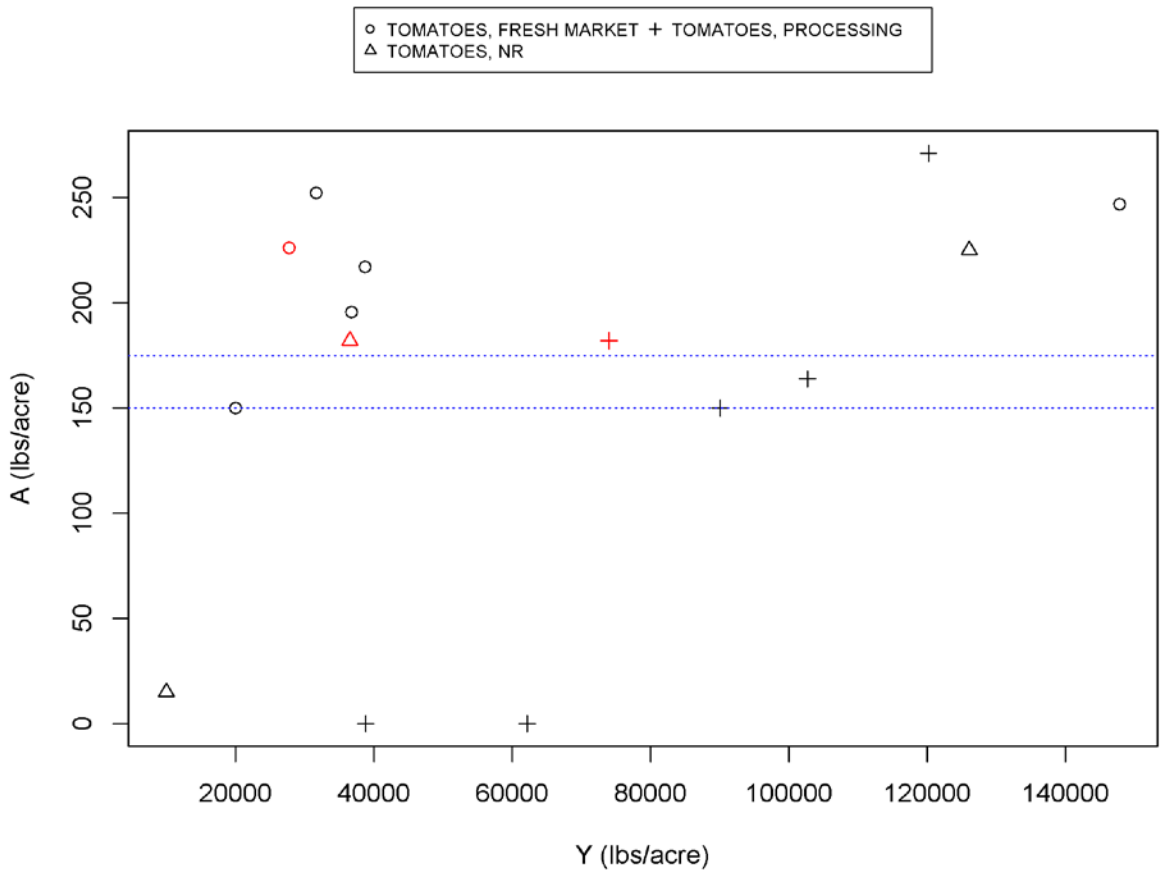


Table XXI-3. List of recommended nitrogen application values for Tomatoes (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Tomatoes, Processing	150	175	For drip-irrigated processing tomatoes, a seasonal rate of approximately 175 lbs N/acre is adequate to maximize fruit yields in most soils.	CDFA
Tomatoes, Processing	100	150	Value based on studies of response to N fertilization. In the responsive fields, no significant yield increase with sidedress N application rates above 100 lbs/acre was observed. The total available N in these fields, which included the pre-sidedress nitrate-N in the top 2 feet of the profile and the sidedress N, averaged 170 lbs/acre.	CDFA

CDFA - https://www.cdfa.ca.gov/is/ffldrs/frep/

XXII. WALNUTS

Important Analysis Considerations:

The calculation of N removed at harvest for WALNUTS assumes that 0.01595 lbs N/lbs with shells are removed at harvest. This estimate is obtained from Geisseler (2016). **Geisseler considers that the average can be considered a good estimate of N removed with walnuts. However, the data range may not fully capture the variability in the Central Valley.**

Figure XXII-1. Box and Whisker plots of A/Y and A/R for Walnuts Management Units grouped by TR blocks. Numbers at the bottom indicate the number of Management Units within each TR. The width of the box is proportional to the sample size. Horizontal grey dashed lines represent the 10%, 50% (median), and 90% percentiles for all TRs together. Red dots highlight local outliers (A/Y > 90% percentile within each TR).

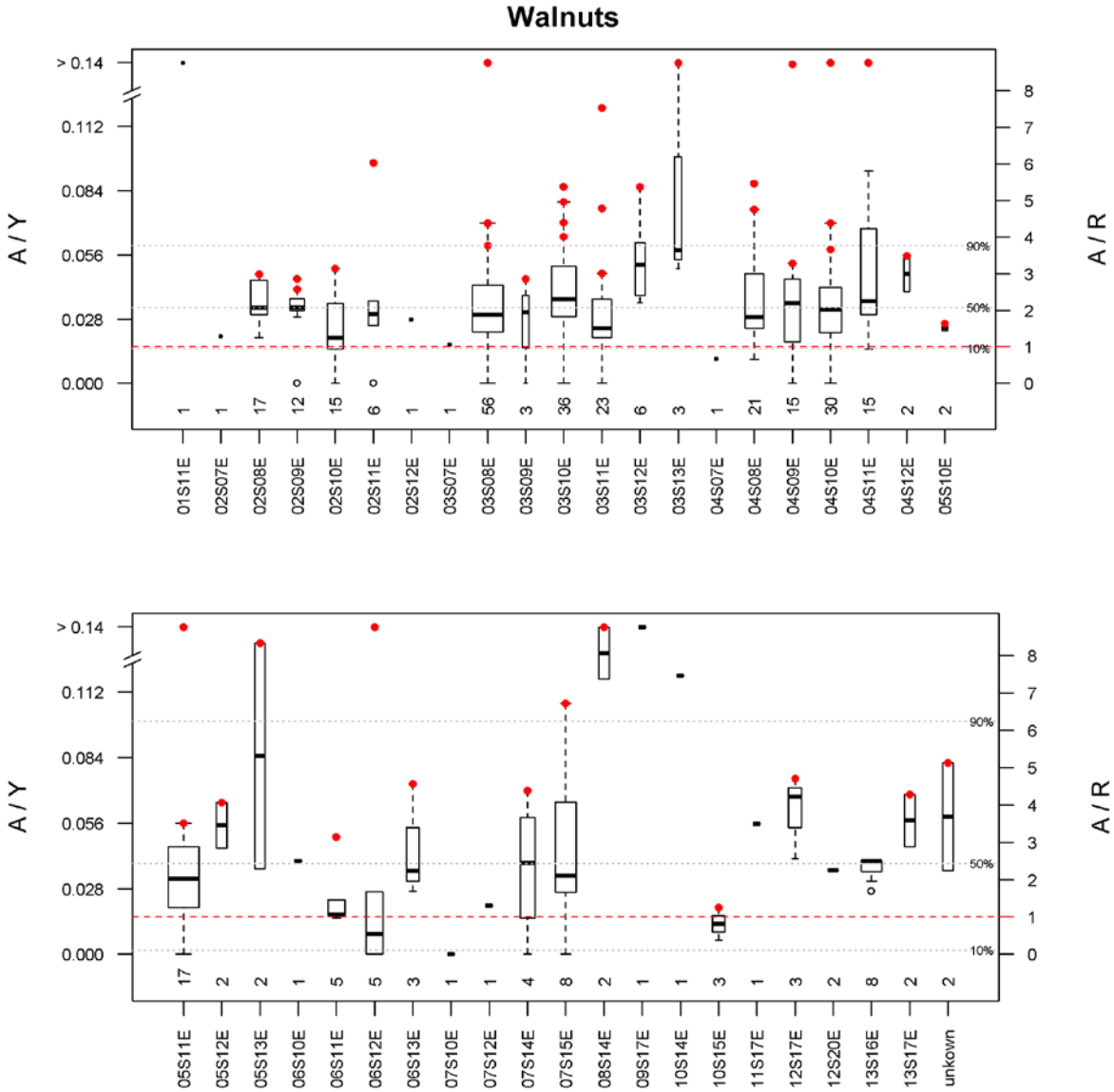


Table XXII-1. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Walnuts Management Units grouped by TR blocks.

TR blocks with only one Management Unit (Count = 1) have no summary statistics because a range of values is necessary to estimate percentiles. Management Units that split across multiple TR blocks are assigned to the TR that contains the largest portion of the Management Unit acreage.

A. Summary statistics for Walnuts A/Y.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
01S11E	1	60	0	0.1600	--	--	--	--	--	--
02S07E	1	35	0	0.0206	--	--	--	--	--	--
02S08E	17	598	0	0.0475	0.0200	0.0299	0.0331	0.0449	0.0449	1
02S09E	12	256	0	0.0456	0.0291	0.0322	0.0333	0.0367	0.0407	2
02S10E	15	1114	0	0.0500	0.0040	0.0150	0.0200	0.0349	0.0411	1
02S11E	7	574	0	0.0960	0.0126	0.0254	0.0302	0.0355	0.0659	1
02S12E	1	75	0	0.0280	--	--	--	--	--	--
03S07E	1	20	0	0.0168	--	--	--	--	--	--
03S08E	56	1408	0	0.1510	0.0141	0.0227	0.0300	0.0425	0.0586	6
03S09E	3	60	0	0.0456	0.0062	0.0155	0.0311	0.0383	0.0427	1
03S10E	36	2013	0	0.0856	0.0232	0.0295	0.0366	0.0511	0.0620	4
03S11E	23	909	0	0.1200	0.0140	0.0200	0.0240	0.0368	0.0470	3
03S12E	6	790	0	0.0857	0.0367	0.0402	0.0516	0.0605	0.0736	1
03S13E	3	206	0	0.6200	0.0516	0.0540	0.0580	0.3390	0.5076	1
04S07E	1	25	0	0.0107	--	--	--	--	--	--
04S08E	22	1003	0	0.0870	0.0164	0.0240	0.0288	0.0478	0.0588	2
04S09E	15	522	0	0.1390	0.0125	0.0182	0.0350	0.0455	0.0509	2
04S10E	30	1125	0	0.5373	0.0184	0.0229	0.0323	0.0413	0.0562	3
04S11E	15	391	0	0.3448	0.0225	0.0300	0.0360	0.0674	0.1373	2
04S12E	2	420	0	0.0556	0.0416	0.0439	0.0478	0.0517	0.0541	1
05S10E	2	25	0	0.0260	0.0232	0.0237	0.0244	0.0252	0.0257	1
05S11E	17	594	0	0.2100	0.0000	0.0200	0.0322	0.0460	0.0521	2
05S12E	2	84	0	0.0648	0.0474	0.0503	0.0551	0.0600	0.0629	1
05S13E	2	267	0	0.1331	0.0462	0.0606	0.0848	0.1089	0.1234	1
06S10E	1	18	0	0.0397	--	--	--	--	--	--
06S11E	5	184	0	0.0500	0.0160	0.0167	0.0168	0.0233	0.0393	1
06S12E	5	223	0	0.2000	0.0000	0.0000	0.0088	0.0266	0.1306	1
06S13E	3	573	0	0.0727	0.0286	0.0312	0.0356	0.0542	0.0653	1
07S10E	1	8	0	0.0000	--	--	--	--	--	--
07S12E	1	78	0	0.0208	--	--	--	--	--	--
07S14E	4	197	0	0.0700	0.0093	0.0233	0.0390	0.0527	0.0631	1
07S15E	8	660	0	0.1071	0.0182	0.0267	0.0337	0.0575	0.0881	1
08S14E	2	34	0	0.4808	0.1540	0.2084	0.2992	0.3900	0.4445	1
09S17E	1	100	0	0.2814	--	--	--	--	--	--
10S14E	1	240	0	0.1190	--	--	--	--	--	--
10S15E	3	687	0	0.0200	0.0074	0.0095	0.0130	0.0165	0.0186	1
11S17E	1	72	0	0.0557	--	--	--	--	--	--
12S17E	3	139	0	0.0750	0.0462	0.0541	0.0673	0.0712	0.0735	1
12S20E	2	101	0	0.0359	--	--	--	--	--	--
13S16E	8	335	0	0.0401	0.0299	0.0374	0.0397	0.0401	0.0401	0
13S17E	2	142	0	0.0682	0.0482	0.0516	0.0571	0.0627	0.0660	1
unknown	2	227	0	0.0818	0.0404	0.0473	0.0588	0.0703	0.0772	1

B. Summary statistics for Walnuts A/R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
01S11E	1	60.00	10.03	10.03	--	--	--	--	--	--
02S07E	1	35.00	1.29	1.29	--	--	--	--	--	--
02S08E	17	598.50	1.25	2.98	1.25	1.87	2.08	2.81	3	1
02S09E	12	256.15	0.00	2.86	1.82	2.02	2.09	2.30	3	2
02S10E	15	1114.33	0.00	3.13	0.25	0.94	1.25	2.19	3	1
02S11E	7	573.50	0.00	6.02	0.79	1.59	1.90	2.22	4	1
02S12E	1	75.00	1.76	1.76	--	--	--	--	--	--
03S07E	1	20.00	1.05	1.05	--	--	--	--	--	--
03S08E	56	1407.66	0.00	9.46	0.89	1.43	1.88	2.66	4	6
03S09E	3	60.00	0.00	2.86	0.39	0.97	1.95	2.40	3	1
03S10E	36	2012.73	0.00	5.37	1.46	1.85	2.30	3.20	4	4
03S11E	23	908.80	0.00	7.52	0.88	1.25	1.50	2.31	3	3
03S12E	6	790.50	2.19	5.37	2.30	2.52	3.24	3.80	5	1
03S13E	3	206.00	3.13	38.87	3.23	3.39	3.64	21.25	32	1
04S07E	1	25.00	0.67	0.67	--	--	--	--	--	--
04S08E	22	1002.69	0.66	5.45	1.03	1.50	1.81	3.00	4	2
04S09E	15	521.90	0.00	8.72	0.78	1.14	2.19	2.85	3	2
04S10E	30	1125.09	0.00	33.69	1.15	1.44	2.03	2.59	4	3
04S11E	15	391.34	0.94	21.62	1.41	1.88	2.26	4.23	9	2
04S12E	2	420.00	2.51	3.49	2.61	2.75	3.00	3.24	3	1
05S10E	2	25.00	1.44	1.63	1.46	1.48	1.53	1.58	2	1
05S11E	17	594.30	0.00	13.17	0.00	1.25	2.02	2.88	3	2
05S12E	2	84.00	2.85	4.06	2.97	3.15	3.46	3.76	4	1
05S13E	2	267.00	2.29	8.34	2.89	3.80	5.32	6.83	8	1
06S10E	1	17.50	2.49	2.49	--	--	--	--	--	--
06S11E	5	184.00	0.97	3.13	1.00	1.04	1.05	1.46	2	1
06S12E	5	223.00	0.00	12.54	0.00	0.00	0.55	1.67	8	1
06S13E	3	573.00	1.68	4.56	1.79	1.96	2.23	3.40	4	1
07S10E	1	8.00	0.00	0.00	--	--	--	--	--	--
07S12E	1	78.00	1.31	1.31	--	--	--	--	--	--
07S14E	4	197.00	0.00	4.39	0.58	1.46	2.45	3.31	4	1
07S15E	8	659.72	0.00	6.72	1.14	1.68	2.12	3.61	6	1
08S14E	2	34.00	7.38	30.14	9.65	13.07	18.76	24.45	28	1
09S17E	1	100.00	17.64	17.64	--	--	--	--	--	--
10S14E	1	240.00	7.46	7.46	--	--	--	--	--	--
10S15E	3	687.01	0.38	1.26	0.46	0.60	0.82	1.04	1	1
11S17E	1	72.00	3.50	3.50	--	--	--	--	--	--
12S17E	3	139.00	2.56	4.70	2.90	3.39	4.22	4.46	5	1
12S20E	2	101.00	2.25	2.25	--	--	--	--	--	--
13S16E	8	335.00	1.68	2.51	1.88	2.34	2.49	2.51	3	0
13S17E	2	142.00	2.88	4.28	3.02	3.23	3.58	3.93	4	1
unknown	2	227.07	2.24	5.13	2.53	2.96	3.69	4.41	5	1

C. Summary statistics for Walnuts A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
01S11E	1	60	72	72	--	--	--	--	--	--

TR	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
02S07E	1	35	22	22	--	--	--	--	--	--
02S08E	17	598	24	130	24	74	94	113	130	0
02S09E	12	256	48	116	57	77	89	98	102	1
02S10E	15	1114	-48	176	-20	-2	32	85	156	2
02S11E	7	574	23	183	30	39	60	142	173	1
02S12E	1	75	73	73	--	--	--	--	--	--
03S07E	1	20	5	5	--	--	--	--	--	--
03S08E	56	1408	-93	188	1	35	78	115	146	6
03S09E	3	60	-32	116	-6	33	98	107	112	1
03S10E	36	2013	-24	168	35	62	81	113	157	4
03S11E	23	909	-52	167	-18	22	34	66	95	3
03S12E	6	790	51	109	59	69	73	92	103	1
03S13E	3	206	38	121	50	67	95	108	116	1
04S07E	1	25	-32	-32	--	--	--	--	--	--
04S08E	22	1003	-21	151	3	41	74	101	118	3
04S09E	15	522	-27	131	-1	18	85	104	125	2
04S10E	30	1125	-61	191	10	36	70	101	151	3
04S11E	15	391	-4	171	29	71	94	141	155	2
04S12E	2	420	107	120	108	110	114	117	119	1
05S10E	2	25	58	73	59	62	66	69	72	1
05S11E	17	594	4	184	23	58	88	131	165	2
05S12E	2	84	108	264	124	147	186	225	248	1
05S13E	2	267	65	111	69	76	88	100	107	1
06S10E	1	18	83	83	--	--	--	--	--	--
06S11E	5	184	-2	102	0	4	4	14	67	1
06S12E	5	223	-58	48	-44	-24	9	29	40	1
06S13E	3	573	31	80	40	53	75	78	79	1
07S10E	1	8	-64	-64	--	--	--	--	--	--
07S12E	1	78	23	23	--	--	--	--	--	--
07S14E	4	197	0	98	23	58	82	90	95	1
07S15E	8	660	16	68	18	25	40	54	66	1
08S14E	2	34	86	121	90	95	104	112	117	1
09S17E	1	100	169	169	--	--	--	--	--	--
10S14E	1	240	217	217	--	--	--	--	--	--
10S15E	3	687	-36	25	-30	-21	-5	10	19	1
11S17E	1	72	138	138	--	--	--	--	--	--
12S17E	3	139	71	154	79	90	110	132	145	1
12S20E	2	101	56	56	--	--	--	--	--	--
13S16E	8	335	64	150	79	107	114	125	133	1
13S17E	2	142	31	134	42	57	83	108	124	1
unknown	2	227	68	145	76	87	107	126	137	1

Figure XXII-2. Box and Whisker plots of A/Y for Walnuts Management Units grouped by specific crop types or tree age.

Numbers at the bottom indicate the number of Management Units within each specific crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/Y > 90% percentile within each crop).

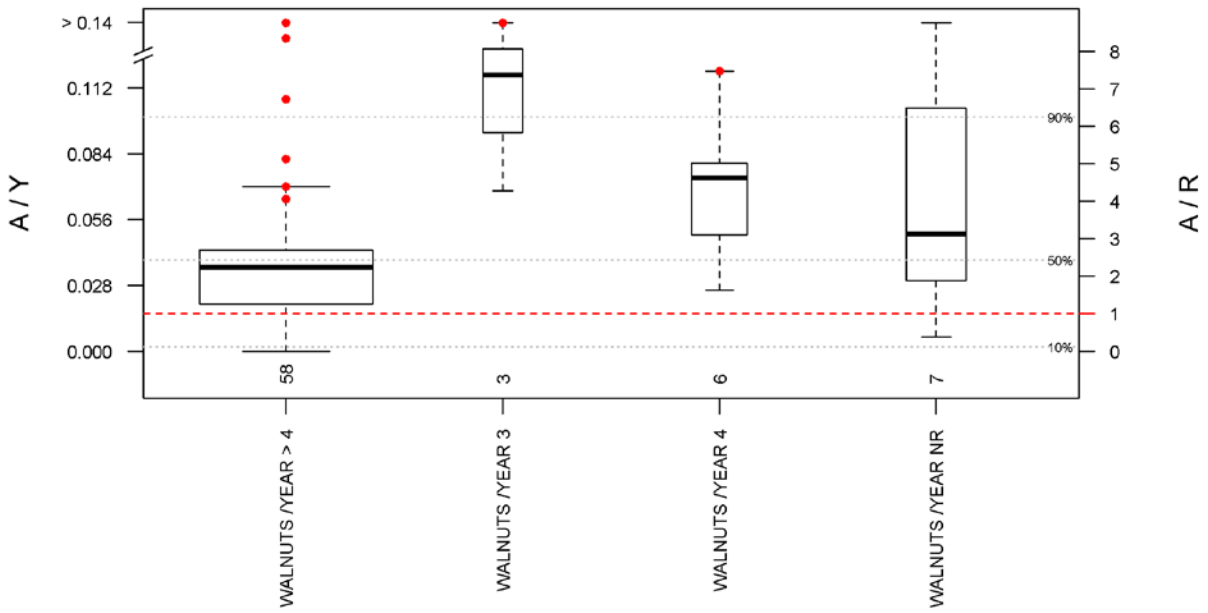


Table XXII-2. Summary statistics for A/Y (A), A/R (B), and A-R (C) from Walnuts Management Units grouped by specific crop.

A. Summary statistics for Walnuts A/Y.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
WALNUTS /YEAR > 4	284	13641.2	0.000	0.4808	0.0126	0.0221	0.0330	0.0431	0.0555	29
WALNUTS /YEAR 3	8	538.0	0.017	0.6200	0.0372	0.0550	0.0776	0.1586	0.3830	1
WALNUTS /YEAR 4	14	582.0	0.015	0.5373	0.0217	0.0319	0.0775	0.1432	0.1649	2
WALNUTS /YEAR NR	37	1830.6	0.000	0.2100	0.0146	0.0227	0.0333	0.0560	0.0841	4

B. Summary statistics for Walnuts A/R. See **the "Important Analysis Considerations" section** at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A/R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
WALNUTS /YEAR > 4	284	13641.2	0.00	30.14	0.79	1.38	2.07	2.71	3.48	29
WALNUTS /YEAR 3	8	538.0	1.07	38.87	2.33	3.45	4.87	9.94	24.01	1
WALNUTS /YEAR 4	14	582.0	0.94	33.69	1.36	2.00	4.86	8.98	10.34	2
WALNUTS /YEAR NR	37	1830.6	0.00	13.17	0.92	1.42	2.09	3.51	5.27	4

C. Summary statistics for Walnuts A-R. See the "Important Analysis Considerations" section at the beginning of this section for information about the N Removal Factors and limitations in the calculation of A-R.

SpecificCrop	N MgmntUnits	Sum Acres	Min	Max	10%	25%	50%	75%	90%	N Outliers
WALNUTS /YEAR > 4	284	13641.2	-93	264	3	37	79	108	142	28
WALNUTS /YEAR 3	8	538.0	2	169	23	46	61	95	135	1
WALNUTS /YEAR 4	14	582.0	-1	217	12	17	71	142	171	2
WALNUTS /YEAR NR	37	1830.6	-52	186	-2	22	68	96	138	4

Figure XXII-3. Scatter plot of A vs. Y for Walnuts crops with all TR together.
Each dot represents one Management Unit. Red dots represent regional outliers (A/Y > 90% for all TR together). Blue lines represent recommended N application rates as described in the Table below.

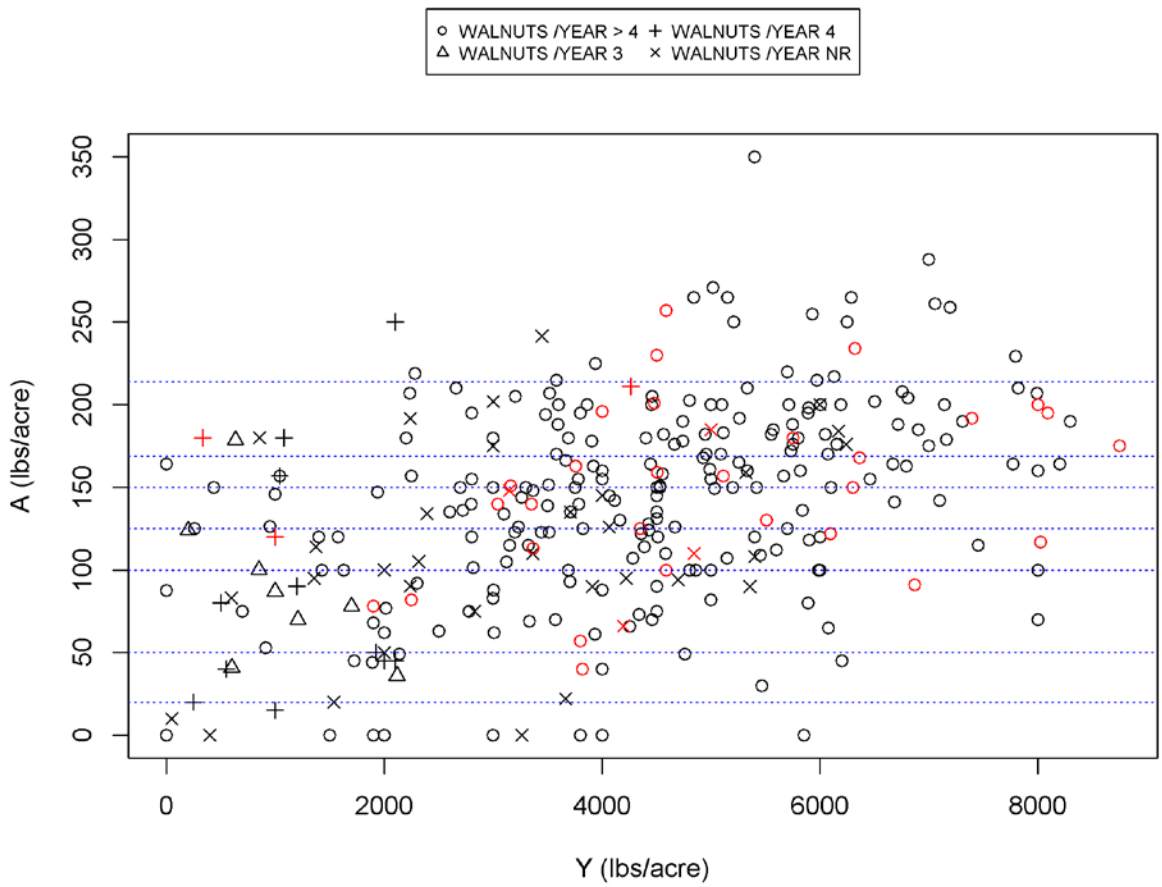


Table XXII-3. List of recommended nitrogen application values for Walnuts (in lbs/acre).

Crop	Min	Max	Study Specifics	Source
Walnuts /Year 1	10	20	Nitrogen application rates for young walnut trees. The lower rates refer to fertile soils and when the N is applied through the drip or microsprinkler irrigation system. On fertile soils, N fertilization can be reduced or even omitted during the first year or two.	CDFA
Walnuts /Year 2	25	50		
Walnuts /Year 3	50	100		
Walnuts /Year 4	63	125		
Walnuts /Year 5	75	150		
Walnuts /Year > 5		169	Value for fertigation. N application rates dependent on Yield. This value is for 2.5 tons (5000 lbs) of projected yield.	CDFA
Walnuts /Year > 5		214	Value for split broadcast. N application rates dependent on Yield. This value is for 2.5 tons (5000 lbs) of projected yield.	CDFA

CDFA - https://www.cdfa.ca.gov/is/ffldrs/frep/

XXIII. OTHER CROPS

Table XXIII-1Summary statistics for crops with limited representation in the ESJWQC region.
Crops with only one Management Unit with complete data (Count = 1) or more than one Management Units with identical values have no summary statistics because a range of values is necessary to estimate percentiles.

SpecificCrop	N MgmntUnits	Sum Acres	Parameter	Min	Max	10%	25%	50%	75%	90%	N Outliers
APPLES /YEAR > 4	6	484	A/Y	0.000	0.072	0.000	0.000	0.000	0.000	0	1
APRICOTS /YEAR > 4	1	1	A/Y	0.016	0.016	--	--	--	--	--	--
BEETS	1	115	A/Y	0.004	0.004	--	--	--	--	--	--
BERRY, BLUEBERRY /YEAR > 3	2	81	A/Y	0.000	0.010	0.001	0.002	0.005	0.008	0	1
BERRY, BLUEBERRY /YEAR NR	2	23	A/Y	0.018	0.025	0.019	0.020	0.022	0.023	0	1
STRAWBERRIES	2	174	A/Y	0.004	0.066	0.010	0.019	0.035	0.050	0	1
BOK CHOY	2	66	A/Y	0.004	0.100	0.014	0.028	0.052	0.076	0	1
BOK CHOY, BABY	1	70	A/Y	0.005	0.005	--	--	--	--	--	--
CABBAGE	4	239	A/Y	0.004	0.005	0.004	0.005	0.005	0.005	0	1
CARROT	2	617	A/Y	0.002	0.194	0.021	0.050	0.098	0.146	0	1
CELERY ROOT	1	23	A/Y	0.003	0.003	--	--	--	--	--	--
CHESTNUTS /YEAR > 4	1	14	A/Y	0.000	0.000	--	--	--	--	--	--
ENDIVE	1	14	A/Y	0.007	0.007	--	--	--	--	--	--
ESCAROLE	1	15	A/Y	0.010	0.010	--	--	--	--	--	--
RADICCHIO	5	421	A/Y	0.006	0.009	0.006	0.006	0.006	0.006	0	1
FENNEL	1	9	A/Y	0.032	0.032	--	--	--	--	--	--
GARLIC	3	499	A/Y	0.011	0.014	0.012	0.012	0.013	0.014	0	1
WHEAT, GREENCHOP	1	287	A/Y	0.004	0.004	--	--	--	--	--	--
KIWIFRUIT /YEAR > 4	1	18	A/Y	0.013	0.013	--	--	--	--	--	--
KOHLRABI	1	31	A/Y	0.005	0.005	--	--	--	--	--	--
LEEKS	1	53	A/Y	0.007	0.007	--	--	--	--	--	--
MELONS, NR	1	6	A/Y	0.008	0.008	--	--	--	--	--	--
MELONS, WATERMELON	2	62	A/Y	0.001	0.001	0.001	0.001	0.001	0.001	0	1
NECTARINES /YEAR > 4	4	60	A/Y	0.000	0.010	0.001	0.001	0.005	0.008	0	1
OLIVES /YEAR > 4	5	413	A/Y	0.000	0.014	0.000	0.000	0.004	0.006	0	1
OLIVES /YEAR 3	1	80	A/Y	0.000	0.000	--	--	--	--	--	--
OLIVES /YEAR 4	2	94	A/Y	0.000	0.012	0.001	0.003	0.006	0.009	0	1
OLIVES /YEAR NR	1	28	A/Y	0.004	0.004	--	--	--	--	--	--
ONIONS, BULB	1	315	A/Y	0.009	0.009	--	--	--	--	--	--
ONIONS, NR	2	28	A/Y	0.440	0.847	0.481	0.542	0.644	0.746	1	1
PECANS /YEAR > 4	3	13	A/Y	0.000	0.022	0.000	0.000	0.000	0.011	0	1
PEPPERS, BELL	1	44	A/Y	0.002	0.002	--	--	--	--	--	--
PERSIMMONS /YEAR > 4	1	18	A/Y	0.008	0.008	--	--	--	--	--	--
PERSIMMONS /YEAR 4	1	5	A/Y	0.023	0.023	--	--	--	--	--	--
PERSIMMONS /YEAR NR	2	6	A/Y	0.000	0.000	--	--	--	--	--	--
PLUMS /YEAR > 4	2	7	A/Y	0.002	0.016	0.003	0.005	0.009	0.012	0	1
POMEGRANATES /YEAR > 4	8	559	A/Y	0.000	0.014	0.000	0.000	0.001	0.008	0	1
PRUNES /YEAR > 4	7	1597	A/Y	0.010	0.068	0.012	0.016	0.030	0.033	0	1
PUMPKINS	2	62	A/Y	0.000	0.012	0.001	0.003	0.006	0.009	0	1
DAIKON	1	20	A/Y	0.002	0.002	--	--	--	--	--	--
SAFFLOWER	1	570	A/Y	0.053	0.053	--	--	--	--	--	--
ALFALFA, HAYLAGE	2	293	A/Y	0.002	0.007	0.002	0.003	0.004	0.006	0	1
SQUASH, SUMMER	1	1	A/Y	0.038	0.038	--	--	--	--	--	--

SpecificCrop	N MgmntUnits	Sum Acres	Parameter	Min	Max	10%	25%	50%	75%	90%	N Outliers
SQUASH, WINTER	1	22	A/Y	0.002	0.002	--	--	--	--	--	--
TURNIPS	1	56	A/Y	0.007	0.007	--	--	--	--	--	--
APPLES /YEAR > 4	6	484	A/R	0.000	132.850	0.000	0.000	0.278	0.556	67	1
APRICOTS /YEAR > 4	1	1	A/R	5.611	5.611	--	--	--	--	--	--
BERRY, BLUEBERRY /YEAR > 3	2	81	A/R	0.000	7.692	0.769	1.923	3.846	5.769	7	1
BERRY, BLUEBERRY /YEAR NR	2	23	A/R	14.103	19.231	14.615	15.385	16.667	17.949	19	1
STRAWBERRIES	2	174	A/R	3.077	50.761	7.845	14.998	26.919	38.840	46	1
CARROT	2	617	A/R	1.094	117.659	12.750	30.235	59.376	88.517	106	1
GARLIC	3	499	A/R	1.493	1.908	1.536	1.600	1.707	1.807	2	1
MELONS, WATERMELON	2	62	A/R	1.007	1.799	1.086	1.205	1.403	1.601	2	1
NECTARINES /YEAR > 4	4	60	A/R	0.000	5.275	0.313	0.783	2.484	4.262	5	1
OLIVES /YEAR > 4	5	413	A/R	0.000	4.423	0.000	0.000	1.208	1.990	3	1
OLIVES /YEAR 3	1	80	A/R	0.000	0.000	--	--	--	--	--	--
OLIVES /YEAR 4	2	94	A/R	0.000	3.949	0.395	0.987	1.975	2.962	4	1
OLIVES /YEAR NR	1	28	A/R	1.158	1.158	--	--	--	--	--	--
ONIONS, BULB	1	315	A/R	4.569	4.569	--	--	--	--	--	--
PECANS /YEAR > 4	3	13	A/R	0.000	1.393	0.000	0.000	0.000	0.697	1	1
PEPPERS, BELL	1	44	A/R	1.450	1.450	--	--	--	--	--	--
PERSIMMONS /YEAR NR	2	6	A/R	0.000	0.000	--	--	--	--	--	--
PLUMS /YEAR > 4	2	7	A/R	1.131	11.024	2.120	3.604	6.078	8.551	10	1
POMEGRANATES /YEAR > 4	8	559	A/R	0.000	1.825	0.000	0.012	0.132	1.035	2	1
PRUNES /YEAR > 4	7	1597	A/R	1.786	12.175	2.107	2.878	5.366	5.897	9	1
PUMPKINS	2	62	A/R	0.000	3.397	0.340	0.849	1.698	2.548	3	1
SAFFLOWER	1	570	A/R	1.873	1.873	--	--	--	--	--	--
ALFALFA, HAYLAGE	2	293	A/R	0.125	0.577	0.170	0.238	0.351	0.464	1	1
SQUASH, SUMMER	1	1	A/R	20.436	20.436	--	--	--	--	--	--
SQUASH, WINTER	1	22	A/R	0.838	0.838	--	--	--	--	--	--
APPLES /YEAR > 4	6	484	A-R	-20.628	163.758	-19.953	-16.458	-8.000	-6.050	79	1
APRICOTS /YEAR > 4	1	1	A-R	102.724	102.724	--	--	--	--	--	--
BERRY, BLUEBERRY /YEAR > 3	2	81	A-R	-0.195	34.800	3.305	8.554	17.302	26.051	31	1
BERRY, BLUEBERRY /YEAR NR	2	23	A-R	94.800	204.400	105.760	122.200	149.600	177.000	193	1
STRAWBERRIES	2	174	A-R	135.000	152.603	136.760	139.401	143.802	148.202	151	1
CARROT	2	617	A-R	12.927	89.235	20.558	32.004	51.081	70.158	82	1
GARLIC	3	499	A-R	57.824	106.637	62.824	70.324	82.824	94.731	102	1
MELONS, WATERMELON	2	62	A-R	0.200	62.160	6.396	15.690	31.180	46.670	56	1
NECTARINES /YEAR > 4	4	60	A-R	3.243	186.300	18.316	40.927	78.611	132.455	165	1
OLIVES /YEAR > 4	5	413	A-R	-31.400	56.958	-19.964	-2.809	8.336	21.703	43	1
OLIVES /YEAR 4	2	94	A-R	92.600	92.600	--	--	--	--	--	--
OLIVES /YEAR NR	1	28	A-R	4.004	4.004	--	--	--	--	--	--
ONIONS, BULB	1	315	A-R	187.478	187.478	--	--	--	--	--	--
PECANS /YEAR > 4	3	13	A-R	22.580	22.580	--	--	--	--	--	--
PEPPERS, BELL	1	44	A-R	65.809	65.809	--	--	--	--	--	--
PLUMS /YEAR > 4	2	7	A-R	7.169	113.662	17.818	33.792	60.415	87.038	103	1
POMEGRANATES /YEAR > 4	8	559	A-R	-420.544	54.237	-247.417	-123.000	-32.696	-4.200	30	1
PRUNES /YEAR > 4	7	1597	A-R	22.000	206.320	50.104	71.420	120.496	172.707	205	1
PUMPKINS	2	62	A-R	-154.560	70.560	-132.048	-98.280	-42.000	14.280	48	1

SpecificCrop	N MgmntUnits	Sum Acres	Parameter	Min	Max	10%	25%	50%	75%	90%	N Outliers
SAFFLOWER	1	570	A-R	38.696	38.696	--	--	--	--	--	--
ALFALFA, HAYLAGE	2	293	A-R	-210.000	-146.084	-203.608	-194.021	-178.042	-162.063	-152	1
SQUASH, SUMMER	1	1	A-R	142.660	142.660	--	--	--	--	--	--
SQUASH, WINTER	1	22	A-R	-7.710	-7.710	--	--	--	--	--	--

APPENDIX II

SAMPLE NITROGEN USE EVALUATION REPORT

Analysis of Nitrogen Fertilizer Use in 2015
Information Only – No Action Required

January 26, 2017
Member name
Company Name
Address
City St Zip

Dear Member,

You submitted to the ESJWQC in Summer 2016 a Nitrogen Summary Report that contained information on the nitrogen applied to your crop in 2015. The Coalition has conducted an analysis of your information, comparing it to other members in high vulnerability areas who produce the same crop. We also compared the amount of nitrogen fertilizer you reported to the rate recommended by the University of California (UC). This data, in aggregated format, was included in a summary report submitted to the Central Valley Regional Water Board in compliance with the Irrigated Lands Regulatory Program.

Enclosed is a summary of the nitrogen use information you submitted plus an analysis of that information. The Regional Water Board requires that we indicate to members where nitrogen application rates to a field or management unit are above the average amount recommended by the UC and are considered a "statistical outlier." Further definition of "outliers" and potential follow up actions are included in the enclosed documents.

Information in this packet includes:

Section 1: Your 2015 Summary Report
Section 2: Your Nitrogen Use Evaluation (one for each crop)
Section 3: How to Interpret Your Nitrogen Use Evaluation

The Coalition is organizing crop-specific meetings in February and March; go to www.esjcoalition.org for dates, locations and times. ***Any member who has a field or management unit that is a "statistical outlier" is required to attend one of these meetings or view a video recording of the meeting.*** Meeting videos will be posted by March 30, 2017. These meetings count toward your required one Coalition event per year.

Thank you for your cooperation and please contact us if you have questions.

Thank you,

Parry Klassen

Wayne Zipser

East San Joaquin Water Quality Coalition
1201 L Street, Modesto, CA 95354
209-846-6112
www.esjcoalition.org

Section 1

Your 2015 NMP Summary Report

Member ID # xxxx

Below is the information you reported to the ESJWQC in your Nitrogen Management Plan (NMP) Summary Report.

If any of this information does not match your records, please contact the Coalition to update your information.

Management Unit				Applied-N (pounds/acre)	Applied-N/ Yield	Yield per acre		
Name	**Crop**	**Age**	**Acres**	**A**	**A/Y**	**Y**	**Units**	**Notes**
66	Almonds	> 4	16	249	0.2660	936	Pounds	–
70,71	Almonds	> 4	134	308	0.1680	1833	Pounds	–
72	Almonds	> 4	266	298	0.1790	1665	Pounds	–
73	Almonds	> 4	103	321	0.1240	2589	Pounds	–
75	Almonds	> 4	244	303	0.1080	2806	Pounds	–

Notes:
GWR = Almonds yield reported as gross weight.
NB = Non-Bearing crop.
NC = Non Crop.
NNA = Nitrogen Not Applied.
NR = Crop age not reported.
NY = No Yield harvested.
RC = Result was Confirmed or Changed since reporting based on new information from the grower.
Y = Yield is calculated from your A/Y.

Section 2

Nitrogen Use Evaluation: Almonds

Member ID # xxxx

Management Unit	Crop Age	Applied-N/ Yield-pounds	Applied-N (pounds/acre)	Removed-N (pounds/acre)	Applied-N − Removed-N
Name	**Age**	**A/Y***	**A**	**R**	**A − R****
66	> 4	266.0	249	64	185
70,71	> 4	168.0	308	125	183
72	> 4	179.0	298	113	185
73	> 4	124.0	321	176	145
75	> 4	108.0	303	191	112

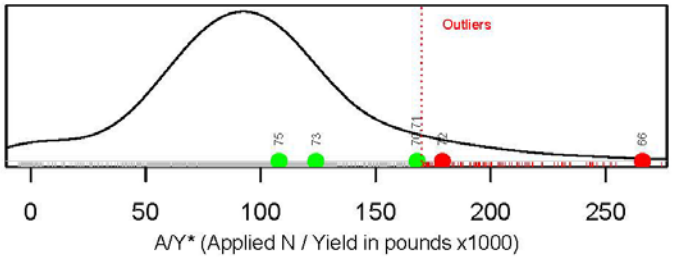
* This **A/Y*** differs from your reported A/Y because all yields were converted to units of pounds and the ratio multiplied by 1000.

** **R** estimates are based on the assumption that nitrogen removed at harvest for Almonds is 0.068 pounds of N per pound of yield.

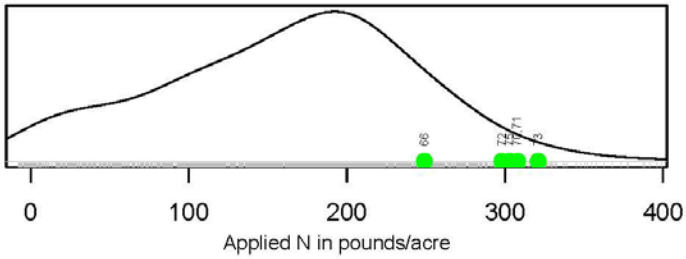
How Do Your Management Units Compare To All Other Almonds Growers?

835 Coalition members reported on **2143** Almonds Management Units.
Median A/Y* = **97** A/Y* values larger than **170** are considered outliers.
Median A = **171** pounds/acre

Your A/Y* Compared To All Other Almonds Growers



Your Applied N Compared To All Other Almonds Growers



If you have two or more Management Units with the same A/Y* or A, the points will overlap in the figures.

Section 3

How to Interpret Your Nitrogen Use Evaluation

The A/Y* ratio is your reported A/Y standardized to the following; this allows for a comparison of management units across the Coalition region:

$$\frac{A}{Y}* = \frac{A}{Y(in\ lbs)} \times 1000$$

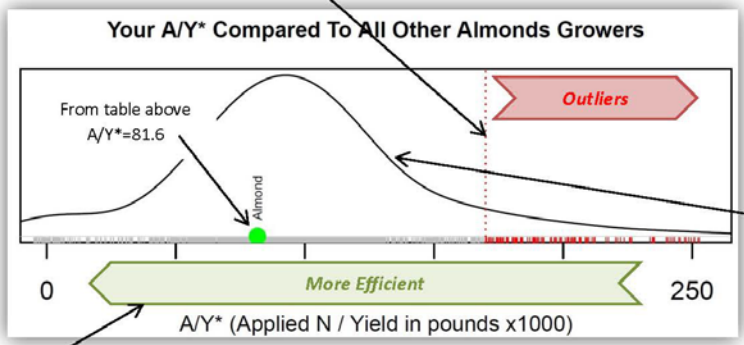
Removed-N (R) is an estimate of how much nitrogen your crop used. It is based on the Yield in pounds (Y), and the Crop Nitrogen Uptake values from the CDFA FREP site (http://apps.cdfa.ca.gov/frep/docs/N_Uptake.html).

$$R = Y \times N\ removed\ coefficeint$$

Management Unit	Crop Age	Applied-N/ Yield-pounds	Applied-N (pounds/acre)	Removed-N (pounds/acre)	Applied-N – Removed-N
Name	**Age**	**A/Y***	**A**	**R**	**A – R**
Almond	> 4	81.6	184	153	31

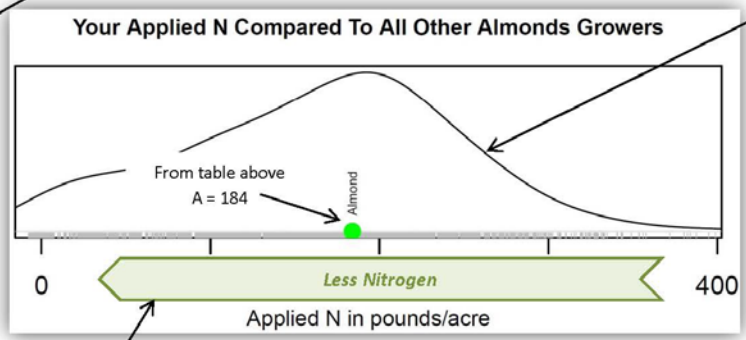
Outlier Range: A Management Unit in this range indicates inefficient nitrogen usage, and could mean that nitrogen is leaching below the root zone, and into the groundwater.

Applied minus Removed (A-R) is the difference between what was applied and what the crops used; the difference is the 'extra' N applied per acre (or under applied if the number is negative).



The **"bell" curves** represent all Coalition growers with the same crop who reported A/Y values. The peak of the "bell" is where most Management Units fall.

The further to the **left** on this curve a Management Unit falls, the more efficient the nitrogen usage—fields to the left are getting more yield per unit of nitrogen applied.



The further to the **left** on this curve a Management Unit falls, the less nitrogen was applied.

Section 3

How to Interpret Your Nitrogen Use Evaluation

Are Growers Applying Too Much Nitrogen to Their Crops?

This is a key question being asked by water quality regulators and the public. If more nitrogen is applied than the crop can use, any excess nitrogen has the potential to leach into groundwater aquifers and cause contamination. Groundwater aquifers in a high vulnerability area already have nitrates above state standards or are vulnerable to nitrate contamination due to geological characteristics.

Determining If "Excess Nitrogen" Is Applied to a Crop

Two factors must be known to determine if excess nitrogen is being applied to a crop.

1) **N Applied** - this is the pounds of nitrogen applied per acre to your crop throughout the year.
2) **Crop Yield** - this is calculated from the A/Y ratio (Applied divided by Yield) and converted to pounds per acre.

Comparing how much nitrogen is applied to how much nitrogen is removed in yield gives an indication of excess nitrogen that could potentially leach into groundwater. The amount of nitrogen removed is determined using the Crop Yield multiplied by a nitrogen removed coefficient to determine an estimate of nitrogen removed (R).

It is acknowledged that the amount of nitrogen applied and the amount of crop yield are not the only factors that affect the potential for nitrogen to leach into groundwater. Other important variables not considered in the NMP Summary Reports are: timing of nitrogen applications, amounts of nitrogen in each application, and the timing and amounts of irrigation water. However, a field's A/Y is a key indicator of the potential of excessive nitrogen applications.

Determining an "Outlier"

Using a statistical analysis, the Coalition compares the A/Y (standardized for yield in pounds) for each management unit to the A/Y of all other management units of the same crop grown in the Coalition region. Management units in the top 10% (higher A/Y than 90% of the coalition growers) are considered "outliers".

The potential reasons a Management Unit (or field) is an "outlier":

- Crop yield was lower than anticipated for the amount of nitrogen applied. Low yields could result from poor crop set, pest damage or other factors beyond a growers' control.
- More nitrogen was applied than the crop could use.

In Section 2, there is a "Nitrogen Removed" value which is calculated using the nitrogen removed coefficient multiplied by the Crop Yield. The nitrogen removed coefficient is a number developed through scientific studies evaluated by CDFA. Some crops have more information needed for calculating nitrogen removed than others; for some crops there is no available nitrogen removed coefficient available. In coming years, additional effort will be put into further refining the nitrogen removed numbers to reflect the variables of crop production in the Central Valley.

Section 3

How to Interpret Your Nitrogen Use Evaluation

What Action Is the Regional Water Board Taking Against "Outliers?"

It is not anticipated that a single season A/Y number that is considered an "outlier" will mean that the management unit or field is "out of compliance" and subject to enforcement actions. The Regional Water Board has stated that coalitions will be allowed to calculate a three-year "A/Y running average" for each field to compensate for normal seasonal variability of production and weather.

However, if a field is consistently determined to be an outlier as a result of excessive nitrogen applications, it is expected that the Regional Water Board will contact that grower and request information to justify why nitrogen applications are made above apparent crop need.

If you have a field or management unit labeled as an outlier, a first step would be to talk to Certified Crop Advisor (CCA), an agronomist or local University of California farm advisor who specializes in your crop. You should also double check the nitrogen applied information you reported to us to make sure it is correct.

At this time there is not enough information to know which A/Y or A-R indicates an optimal or acceptable nitrogen use that results in a minimal amount of nitrogen leaching to the groundwater. The "Management Practices Evaluation Program" (MPEP) is a program being implemented by the Central Valley water quality coalitions and is focusing on better understanding which crop management practices are more effective in minimizing the amount of nitrogen leached to groundwater.

Should the MPEP find that a management practice or practices lead to excess nitrogen leaching to groundwater, it will be the responsibility of the water quality coalitions, commodity groups and researchers to refine these practices, or adjust nitrogen application rates, so that the production systems used to grow a crop ensure protection of groundwater resources.

For information on crop fertilization guidelines, go to the website developed by the California Department of Food and Agriculture (CDFA) and the University of California (UC):

www.cdfa.ca.gov/go/FREPguide