A. Project Information

Report type: Final Report

Time period covered: January 1, 2016 — December 30, 2018

Project title: Developing a decision support tool for processing tomato irrigation and fertilization in the Central Valley based on CropManage

Agreement Number: 15-0410SA

Project leader:

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B. Objectives

The main objective of the project was to develop a web-based decision support tool for improved N and irrigation management of processing tomatoes. The specific objectives were:

1. Create a test version of CropManage for processing tomato production in the Central Valley based on literature data.
2. Collect soil and plant related data in commercial fields to develop robust equations and algorithms for user version of the program.

3. Compare irrigation and fertigation management recommended by the program with growers' practices in a replicated trial at UC Davis' Russell Ranch.
4. Evaluate the program in monitoring fields in close collaboration with participating growers.
5. Develop the user version of CropManage based on the data collected and feedback received in objectives 2 through 4.
6. Conduct outreach activities and organize training workshops for growers and consultants.

C. Abstract

California growers are facing increasing pressure to improve nitrogen (N) use efficiency in crop production. With stricter regulatory and reporting requirements and technological advances, which provide growers with more accurate but also increased amounts of data, computer based decision support tools are becoming a central component of farm management.

The goal of this project was to develop such a decision support tool for irrigation and N management in processing tomatoes. The tool is based on the framework of CropManage, which has been successfully developed and introduced for cool season vegetables on the Central Coast. The project also included outreach activities, such as CropManage workshops.

During the 2016 and 2017 field seasons, we collected soil and plant related data in eleven commercial fields located in Yolo, San Joaquin and Fresno counties. In 2018, an additional 12 commercial fields in the Woodland area were selected to determine the effect of planting configuration (bed with, number of plant rows per bed) on canopy development. The results from these sites were used to develop robust equations and algorithms for the user version of CropManage for processing tomatoes. In addition, a replicated trial was carried out at Campbell Tract, west of the UC Davis campus in 2017 and 2018. The trial included four irrigation and fertigation treatments, and was used to test the equations developed for CropManage. In addition, canopy development was monitored in 12 fields in the Woodland area to investigate the effects of bed width (60 vs. 80 inches) and plant rows (1 vs. 2 rows per bed) on canopy development.

Plant canopy started with a slow initial growth phase, followed by rapid growth eventually reaching its full size of 85-97% coverage, and remained relatively stable after that. The differences in canopy development among fields with the same planting configuration were pronounced, so that the differences among planting configurations were not statistically significant. Across all eleven commercial field sites, the plants contained an average of 357 lbs N/ac in the aboveground biomass by harvest, with 37% of the N being in the vines and 63% in the fruits. The fruits contained 3.1 lbs N/ton. It took approximately 40 days for the plants to accumulate 40 lbs N/ac. In the replicated trial, the average marketable yield reached 58 and 63 tons/acre in 2017 and 2018, respectively. There was no statistical yield difference between treatments with an optimal N application rate and treatments with application rates that were 50 lbs/acre

higher or lower. However, N uptake increased with increasing N application rate. Increasing irrigation from 100 to 130% of ET (calculated based on canopy cover) had no effect on yield either.

A version of CropManage for processing tomatoes was developed and is now available at https://v3.cropmanage.ucanr.edu/. In addition, a simple processing tomato N calculator has been created. It is available online at http://geisseler.ucdavis.edu/Tomato_N_Calculator.html.

D. Introduction

California growers are facing increasing pressure to improve nitrogen (N) use efficiency in crop production. To achieve high yields while reducing the risk of N losses, the time and quantity of irrigation water and fertilizer applications need to match crop demand. Adjustments to general irrigation and fertilization guidelines are generally needed on a field-by-field basis.

Processing tomatoes are an important California crop grown on about 288,000 acres in 2014. Over the last 15 years, the tomato industry saw a dramatic shift in production practices caused by a wide adoption of drip irrigation. During the same period, tomato yields increased from roughly 36 tons/acre to almost 50 tons/acre. This rapid shift from predominantly furrow irrigation to drip irrigation and the associated yield increase changed N fertilizer management considerably, with fertigation through the drip system now being most common.

With stricter regulatory and reporting requirements and technological advances, which provide growers with more accurate but also increased amounts of data, computer based decision support tools are becoming a central component of farm management.

The project proposed to develop such a decision support tool for irrigation and N management in processing tomatoes based on the framework of an existing tool, CropManage, which has been successfully developed and introduced for cool season vegetables on the Central Coast. The proposed project also includes outreach activities, such as CropManage workshops.

E. Work Description

Task 1 (objective 1): Create a test version of CropManage for processing tomatoes

Data from published and unpublished research was used to develop equations and algorithms for the test version of CropManage for drip irrigated processing tomatoes.

Based on 27 datasets from drip irrigated processing tomatoes grown in California, we calculated the average N content of tomatoes and the percent of the total aboveground N contained in the fruits. On average, tomatoes contained 2.83 lbs/N/ton and 65% of the N was in the fruits, the rest in in the vines. These data were used to predict N uptake based on expected growers' yield in the test version of CropManage. A sigmoid equation was used to predict the seasonal N uptake curve based on 9 datasets from the literature. Canopy development was based on a study carried out in the Fresno area on 60-inch beds (Hanson and May, 2006[1]). The crop coefficient k_c was calculated based on canopy coverage using the equation proposed by Hanson and May (2006).

Task 2 (objective 2): Monitor fields to generate a dataset for the calibration of CropManage

[1] Hanson, B.R., May, D.M., 2006. Crop evapotranspiration of processing tomato in the San Joaquin Valley of California, USA. Irrigation Science 24, 211–221.

Sampling sites

Six commercial processing tomato production fields using subsurface drip irrigation were selected for the study in 2016 (Table 1). Two field sites were located in Yolo County, three sites in San Joaquin County, and one site in Fresno County. In 2017, five commercial sites were selected for the study (Table 2).

Table 1: Location, transplant dates, and the plant density of the six commercial fields included in the study in 2016.

County	Site	Coordinates (rounded to the nearest 5')	Date transplanted	Density (plants/ha)
Yolo	Y 1	38°45' N 121°45' W	April 12	24278
	Y 2	38°45' N 121°45' W	April 16	24770
San Joaquin	SJ 1	37°55' N 121°10' W	May 16	22966
	SJ 2	37°45' N 121°25' W	May 12	18865
	SJ 3	37°55' N 121°25' W	May 4	21490
Fresno	FR 1	36°15' N 120°05' W	May 9	22023

Table 2: Location and transplant dates of the five commercial fields included in the study in 2017.

County	Site	Coordinates (rounded to the nearest 5')	Date transplanted	Density (plants/ha)
Yolo	Y 3	38°40' N 121°50' W	April 25	21161
	Y 4	38°35' N 121°45' W	April 17	26083
San Joaquin	SJ 4	37°45' N 121°25' W	April 28	21982
	SJ 5	37°55' N 121°25' W	April 27	21818
Fresno	FR 2	36°15' N 120°05' W	April 13	21284

In 2018, 12 sites in the Woodland area were selected for canopy measurements (Table 3). The goal of these measurements was to determine the effect of bed width (60 vs. 80 inches) and plant rows per bed (1 vs. 2 rows per bed) on canopy development. Depending on the results, CropManage will use different canopy development curves based on user input of planting configuration.

Preplant soil conditions

Preplant soil sampling began in April 2016 and 2017, subject to the planting schedule. In each field, four plots were marked and separately sampled to serve as replicates. In each plot, five random locations were sampled using a soil probe from the center and the edge of the bed. At each sampling point, two separate samples were taken from the first and second foot of the profile. These samples were used to characterize the soils prior to planting and fertilizing. Measurements included ammonium (NH_4 -N), nitrate (NO_3-N), soil moisture, total carbon (C), total N, pH, electrical conductivity (EC), and soil texture.

Approximately three weeks after transplanting, regular soil and plant sampling started. All fields were sampled throughout the season at three-week intervals. Soil was sampled from the first and second foot of the profile as described above and analyzed for total mineral N (sum of NH_4 –N and NO_3-N) and soil moisture. Soil samples were stored in plastic bags and kept in a cold room at 39 °F (4 °C) prior to analysis. Aboveground biomass was determined by harvesting entire plants.

Table 3: Location and planting configuration of the commercial fields included in the study in 2018. These fields were used to measure canopy development.

Site	Coordinates (rounded to the nearest 5')	Bed width (inches)	Plant rows per bed	Date transplanted
Y 6	38°40' N, 121°60' W	60	1	March 29
Y 7	38°45' N, 121°50' W	60	1	April 19
Y 8	38°45' N, 121°50' W	60	1	April 21
Y 9	38°45' N, 121°50' W	60	1	April 28
Y 10	38°40' N, 121°60' W	60	2	March 30
Y 11	38°45' N, 121°50' W	60	2	April 27
Y 12	38°45' N, 121°50' W	60	2	April 30
Y 13	38°40' N, 121°60' W	60	2	May 02
Y 14	38°35' N, 121°55' W	80	2	May 01
Y 15	38°35' N, 121°45' W	80	2	April 02
Y 16	38°35' N, 121°45' W	80	2	April 04
Y 17	38°35' N, 121°45' W	80	2	April 14

Soil and plant analyses

Soil samples were sieved and a 6-gram subsample was extracted with 0.5M potassium sulfate (K_2SO_4) solution for the colorimetric analysis of NH_4^+-N and NO_3^--N concentrations. Moisture content was analyzed immediately after collection by drying a subsample at 221 °F (105 °C).

Nitrogen in the aboveground biomass was determined by hand-harvesting entire plants. The plants were collected from each plot and cut at soil level. The fruit and vines were separated and weighed immediately after collection. The vines were dried and stored in a 140 °F (60 °C) oven; and a representative sample of the fruits was frozen and later freeze dried. Vines and fruits were analyzed for dry mass, as well as for total N on a Costech Elemental Analyzer.

The canopy coverage and the normalized difference vegetation index (NDVI) were monitored throughout the season. A Trimble GreenSeeker crop sensor was used to measure the NDVI. To determine canopy coverage, a Canon EOS Rebel T5i camera with a Tamron SP AF 10-24 mm infrared lens was mounted to a rig. The camera was suspended on the rig from the center of the bed of tomato crops and pictures of the plant canopy cover were taken perpendicular to the ground. Tetracam Pixelwrench2, a multispectral imaging editing software, was used to analyze the images for canopy segmentation.

Task 3 (objective 3): Replicated field trial

The trial was carried out during the 2017 and 2018 seasons. A site at Campbell Tract, just west of the UC Davis campus was selected. The drip tape was installed in early April 2017 and the tomatoes were transplanted in early May in both years.

The trial included four treatments (Table 4), each replicated five times. Each plot was 200 feet long and three beds wide.

Table 4: Treatments in the replicated trial

Description	2017		2018	
	ID	Fertigation	ID	Fertigation
Optimal N -50 lbs/acre; 100% ET	N_175	175 lbs N/ac	N_130	130 lbs N/ac
Optimal N; 100% ET	N_225	225 lbs N/ac	N_180	180 lbs N/ac
Optimal N; 130% ET	N_225h	225 lbs N/ac	N_180h	180 lbs N/ac
Optimal N +50 lbs/acre; 100% ET	N_275	275 lbs N/ac	N_230	230 lbs N/ac

The optimal N application rates were calculated using a budget approach (see Results, Table 7). Irrigation water application rates were calculated based on CIMIS weather data from the Davis station and on modeled canopy development. Prior to machine harvest (Figure 1), one plant was harvested in each plot by hand for analysis of dry matter and N content in fruits and vines.

Figure 1: Harvest of the trial on August 25, 2017.

Task 4 (objective 4): Evaluation of the tool developed in collaboration with growers

Interested growers were using the test version and their feedback was used for the development of the final version.

Task 5 (objective 5): Develop user version of CropManage for processing tomatoes

The data collected during the three seasons from 2016 to 2018 was used to develop algorithms and equations of CropManage.

Task 6 (objective 6): Organize and carry out training workshops

A workshop for UCCE farm advisors and specialists was held on January 18, 2019. Training sessions for growers and consultants will be offered beyond the projects duration depending on interest and need.

Task 7 (objective 6): Outreach activities

Results of the project have been presented at 16 meetings (see section H). An article in Progressive Crop Consultant was published in January 2019.

F. Data/Results

Soil properties in commercial fields

Properties of the soils in commercial fields monitored in both years are summarized in Table 5. Most soils had a loamy texture. The total C content ranged from 0.5 to 3.2%, with the highest value corresponding to a field in the Delta.

Moisture content fluctuated throughout the season, but tended to decrease in the first foot of the soil profile. Total mineral N (sum of ammonium N and nitrate-N) changed throughout the season, reflecting plant uptake and fertigation schedules. At the majority of the sites, the first foot of the soil had higher mineral N concentrations than the second foot. Moisture and mineral N monitoring in the commercial fields suggested that the plants were well watered and that sufficient N was available throughout the season.

Table 5: Soil type, texture, and total C in the top foot of soil profile of the commercial fields included in the study.

Year	County	Site	Soil series	Texture (%)			Total C
				Sand	Clay	Silt	(%)
2016	Yolo	Y 1	Sycamore silty clay loam	39	21	40	1.28
		Y 2	Maria silt loam	39	20	41	0.81
	San Joaquin	SJ 1	Hollenbeck silty clay	13	37	50	0.86
		SJ 2	Capay clay	12	44	44	1.19
		SJ 3	Egbert silty clay loam	18	47	35	3.17
	Fresno	FR 1	Westhaven clay loam	24	44	32	0.84
2017	Yolo	Y3	Yolo silt loam	22	17	61	1.20
		Y4	Reiff sandy loam	63	16	21	0.54
		Y 5	Yolo silt loam	23	27	50	0.80
	San Joaquin	SJ 3	Capay clay	12	44	44	1.19
		SJ 4	Egbert silty clay loam	18	47	35	3.17
	Fresno	F 1	Westhaven clay loam	24	44	32	0.84

Nitrogen in the aboveground biomass

The aboveground biomass N increased as the season progressed. At some sites, a decrease at the last sample date was observed. The seasonal changes in biomass N can be divided into three stages (Figure 2): slow initial N uptake during the first 3-4 weeks, rapid uptake phase, and leveling off during the final 3-4 weeks of the season.

Across all eleven sites, the total N in the aboveground biomass averaged 357 lbs/acre (Table 6). Of this N, 63% was in the fruits at harvest and 37% in the vines. The fruits contained 3.1 lbs N/ton. It took approximately 40 days for the plants to accumulate 40 lbs N/ac. The N concentration in the vines decreased throughout the season.

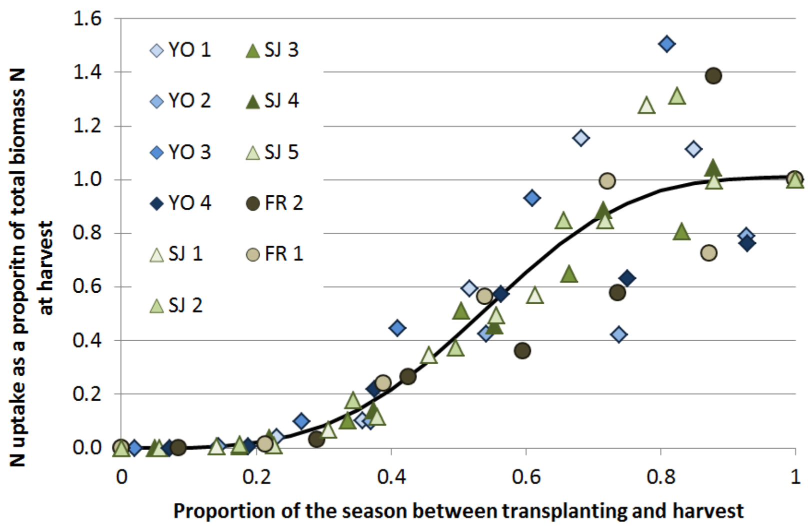

Figure 2: Measured (symbols) and modeled (line) aboveground biomass across all eleven sites in growers' fields.

Canopy coverage

Canopy development started with a slow initial growth phase, followed by rapid growth eventually reaching a full canopy, roughly at the midpoint between transplanting and harvest (Figure 3). The model explains 96% and 95% of the observed variability in 2016 and 2017, respectively. The NDVI peaked and reached its maximum midseason, after which it declined (data not shown). A preliminary analysis of the 2018 data indicated that planting configuration had no significant effect on canopy development. The differences in canopy development among fields with the same planting configuration were pronounced, so that the differences among planting configurations were not statistically significant.

Table 6: Nitrogen in the aboveground biomass of the eleven commercial fields included in the study based on hand-harvest at four locations in each field.

Year	County	Site	Crop N (lbs/ac)		
			Vine	Fruit	Whole Plant
2016	Yolo	Y 1	119	214	332
		Y 2	124	229	354
	San Joaquin	SJ 1	95	209	304
		SJ 2	115	182	297
		SJ 3	98	202	300
	Fresno	FR 1	131	187	318
2017	Yolo	Y3	113	158	271
		Y4	227	274	501
		Y 5	129	193	321
	San Joaquin	SJ 3	122	270	392
		SJ 4	265	266	531
	Fresno	F 1	119	214	332

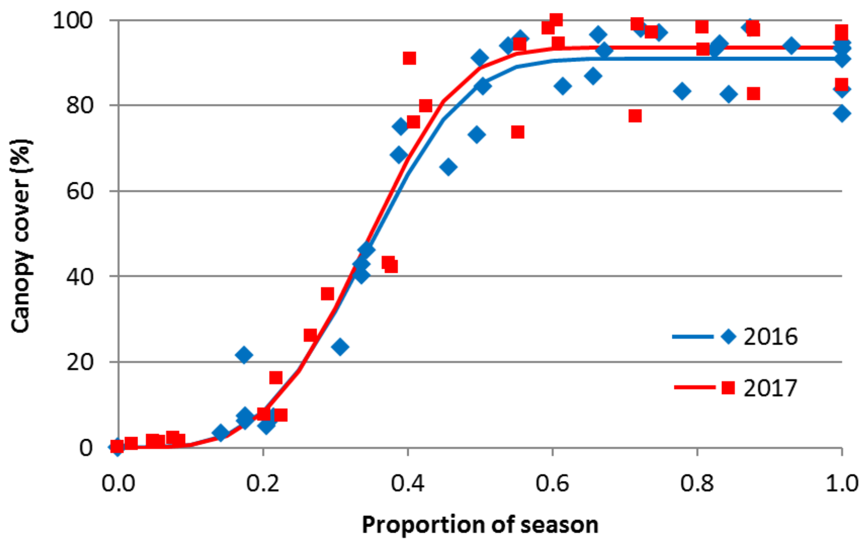

Figure 3: Measured (symbols) and modeled (lines) tomato canopy coverage across the commercial fields monitored in 2016 and 2017.

Replicated field trial

The optimal N application rate for the field trial was calculated in both years based on expected yield, residual soil nitrate level, nitrate in the irrigation water and in-season N mineralization. Results from a different study suggested that between 30 and 50 lbs/acre were likely mineralized during the growing season. In-season N mineralization was only included in 2018, as an accurate estimate was not yet available in 2017. For the N budget, we assumed that only 50% of the pre-plant soil nitrate in the top foot can be accessed by roots (Table 7). This assumption is a rough estimate which needs to be further investigated.

Table 7: Nitrogen budget for the field trial. Expected N in fruits and vines was based on the results from the 2016 season.

			2017				2018			
					lb/ac				lb/ac	
Expected yield			55	tons/ac			58	tons/ac		
Expected N in fruits	3.0	lb/ton			165				174	
Expected N in vines	33	% of total			82				87	
Expected N uptake						247				261
Residual soil nitrate	1st ft		10	mg kg^{-1}	20		12	mg kg^{-1}	24	
	2nd ft		7	mg kg^{-1}	25		10	mg kg^{-1}	35	
Irrigation water N	22 ac-in		0	mg L^{-1}	0		0	mg L^{-1}	0	
Soil N mineralization					0				40	
Non-fertilizer credits						44				99
Difference (uptake - non fertilizer N)						203				162
Fertilizer need (if efficiency = 90%)						225				180

Yield in 2017 averaged 58 tons/acre. There was no significant yield difference between the three N application rates. The average yield was again higher than expected in 2018, reaching 63 tons/ (Figure 4). Nitrogen application rate had no significant effect on yield. It may appear that the yield in the high treatment in 2018 was greater than the other treatments. However, due to some pest issues, variability across the plots was quite high. Therefore, the statistical analysis concluded that it is likely that the observed difference is simply due to chance and not because of the higher N rate. In both years, increasing the irrigation rate had no effect on yield (data not shown).

Therefore, even though the measured yield exceeded the expected yield in both years, reducing the optimal N application rate by 50 lb/ac had no effect on yield. This was mainly due to the fact that the plants adjusted N uptake based on N availability. From the low N to the high N treatment, the N application rate was increased by 100 lb/ac, while the N in the aboveground biomass increased by 87 lb/ac across both years (Table 8).

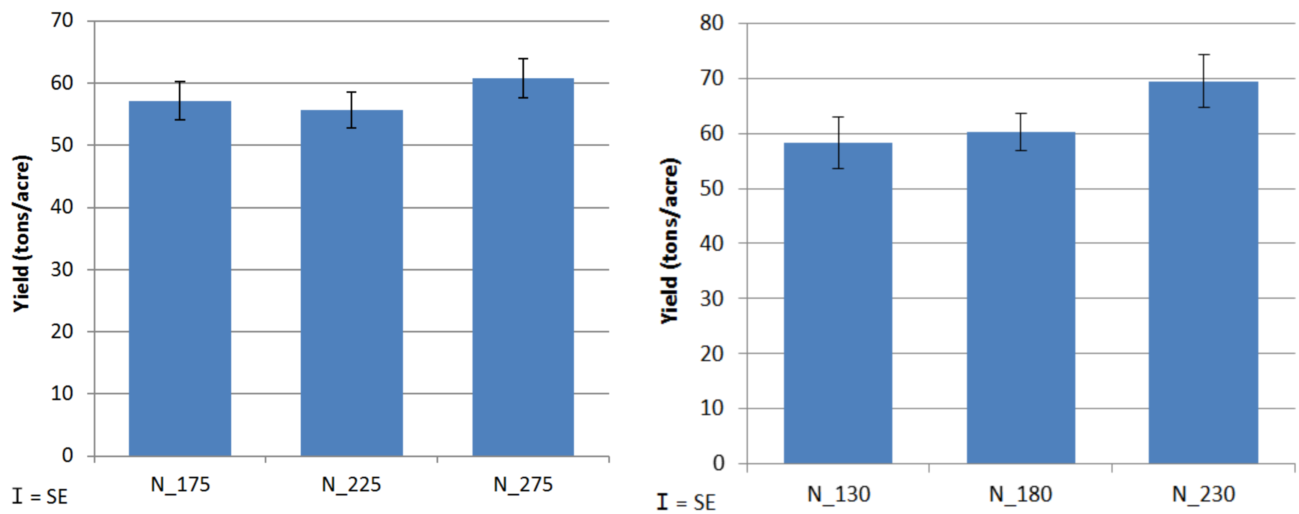

Figure 4: Yield in 2017 (left panel) and 2018 (right panel) as affected by N application rate. Only treatments irrigated at 100% ET are shown.

Table 8: Nitrogen uptake and removal in the field trial as affected by N application rate.

Treatment	Fruits	Yield	N in fruits	total uptake	N in fruits
	lbs N/ton	tons/ac	lbs/acre	lbs/acre	(% of total)
	2017				
Low N	2.62	57	149	241	62.0
Intermediate N	2.93	56	164	269	61.1
High N	3.11	61	190	338	56.2
	2018				
Low N	2.42	58	143	214	67.0
Intermediate N	2.71	60	165	242	68.1
High N	2.81	69	194	291	66.9

G. Discussion and Conclusions

Our results suggest that using a value of 3 lb/ton may overestimate N requirements and that a fruit N concentration above 2.7 lb/ac is likely the result of luxury consumption. However, the N budget is based on marketable yield and not total yield. Therefore, the use of the higher value represents an adjustment for N in non-marketable fruits.

While fertilizer N use efficiency decreased only slightly with increasing N application rate within the range of our study, the amount of N removed from the field with the harvested tomatoes only increased by 46 lb/ac when the N rate was increased by 100 lb/ac. Close to half of the increased N uptake was due to higher N contents in the vines, which were left in the field and later incorporated. The decomposition of the vines will release part of this N resulting in higher nitrate levels in the soil, increasing the risk of nitrate leaching with winter rains. While the increasing N uptake with increasing N application rates suggests that the optimal N rate can be considered a range rather than an exact number, it is still important to accurately estimate fertilizer N requirements in order to minimize the risk of nitrate leaching and to keep production costs low.

The results of this study were incorporated into CropManage (https://v3.cropmanage.ucanr.edu/) and a simple processing tomato N calculator, which is freely available online at http://geisseler.ucdavis.edu/Tomato_N_Calculator.html. The calculator is easy to use and requires few readily available input variables. However, such a simple tool cannot capture all the factors that affect growth and yield of the crop in individual fields. Factors such as: differences in soil properties, crop management, disease pressure or weather conditions. While the assumptions used in the budget presented here provide a margin of safety for commercial producers, it is crucial to monitor the fields during the growing season in order to make adjustments if needed. Soil nitrate testing and leaf analyses are valuable tools to determine N availability and N status of the crop during the season. These tools allow for adjustments when the calculated N application rates do not match the plants' demand.

H. Project impacts

This project was the first to adapt CropManage for an annual crop grown in the Central Valley. Features introduced for our processing tomato module will be useful for other crops as well. CropManage and the online N calculator allow growers managing processing tomatoes based on the latest research from California. These decision support tools make an important contribution to the environmentally safe and agronomically sound use of fertilizing materials.

I. Outreach Activities Summary

Results of the project have been presented at several meetings:

- Geisseler, D., November, 14, 2016. Decision Support Tools for Nutrient Management in Processing Tomatoes. Oral presentation. California Tomato Conference, Napa, CA. 50 Attendees.
- December 05, 2016. Geisseler, D., "Adapting CropManage to Processing Tomatoes", Invited Speaker, Vegetable Crops Program Team Meeting, Davis, CA, December 05, 2016, 25 Attendees.
- Geisseler, D., January 12, 2017. Research to Support Irrigation and Nutrient Management Decisions in Processing Tomatoes. Oral presentation. South Sacramento Valley Processing Tomato Production Meeting, Woodland, CA. 150 Attendees.
- Geisseler, D., January 25, 2017. Research to Support Irrigation and Nutrient Management Decisions in Processing Tomatoes. Oral presentation. Northern San Joaquin Valley Processing Tomato Meeting, Modesto, CA. 80 Attendees.
- Geisseler, D., February 22, 2017. Research to Support Irrigation and Nutrient Management Decisions in Processing Tomatoes. Oral presentation. UCCE Vegetable Crop Research Update, Five Points, CA. 70 Attendees.
- Geisseler, D., August, 25, 2017. Research and Outreach to Support Irrigation and Nutrient Management Decisions, Invited Speaker, Korean Ministry of the Environment Delegation visit to CDFA, Sacramento, CA, 12 Attendees.
- Geisseler, D., November 13, 2017. Site Specific Nitrogen Management in Processing Tomatoes. Oral presentation. California Tomato Conference, Napa, CA. 70 Attendees.
- Geisseler, D., December 14, 2017. Site Specific Nitrogen Management in Processing Tomatoes. Oral presentation. UCCE Vegetable Crop Research Update, Five Points, CA. 40 Attendees.

- Geisseler, D., January 11, 2018. Site Specific Nitrogen Management in Processing Tomatoes. Oral presentation. South Sacramento Valley Processing Tomato Production Meeting, Woodland, CA. 140 Attendees.
- Geisseler, D., January 24, 2018. Site Specific Nitrogen Management in Processing Tomatoes. Oral presentation. Northern San Joaquin Valley Processing Tomato Meeting, Modesto, CA. 90 Attendees.
- Geisseler, D., October 23, 2018. Developing Decision Support Tools for Processing Tomato Irrigation and Fertilization in the Central Valley Based on CropManage. Oral presentation. California Department of Food and Agriculture - Fertilizer Research & Education Program Conference, Seaside, CA. 150 Attendees.
- Geisseler, D., November 12, 2018. Developing Decision Support Tools for Processing Tomato Irrigation and Fertilization. Oral presentation. California Tomato Conference, Napa, CA. 60 Attendees.
- Geisseler, D., December 7, 2018. Developing Decision Support Tools for Processing Tomato Irrigation and Fertilization. Oral presentation. UCCE Vegetable Crop Research Update, Five Points, CA. 35 Attendees.
- Geisseler, D., January 10, 2019. Decision Support Tools for Processing Tomato Irrigation and Fertilization. Oral presentation. South Sacramento Valley Processing Tomato Production Meeting, Woodland, CA. 150 Attendees.
- Geisseler, D., January 21, 2019. Research and Outreach to Support Nutrient Management Decisions. Invited speaker. Visit of a delegation from the Agriculture Department of Shaanxi Province, China. Davis, CA. 20 Attendees.
- Geisseler, D., January 31, 2019. Decision Support Tools for Processing Tomato Irrigation and Fertilization. Oral presentation. Northern San Joaquin Valley Processing Tomato Meeting, Modesto, CA. 90 Attendees.

An article has been published in Progressive Crop Consultant

- Geisseler, D., Liang K., 2019. A Nitrogen Fertilization Tool for Drip Irrigated Processing Tomatoes. Progressive Crop Consultant January/February 2019. Online at: https://www.yumpu.com/en/document/fullscreen/62337704/pcc-jan-feb-2019

J. Factsheet

1. Project Title

Developing a decision support tool for processing tomato irrigation and fertilization in the Central Valley based on CropManage

2. Grant Agreement Number

15-0410SA

3. Project Leaders

Daniel Geisseler, CE Nutrient Management Specialist, University of California, Department of Land, Air and Water Resources, One Shields Ave., Davis, CA, 95616. (530) 754 9637, djgeisseler@ucdavis.edu

4. Start Year/End Year

2016 / 2018

5. Location

Central Valley

6. County

Yolo, San Joaquin, Fresno

7. Highlights

- Little N is taken up by processing tomatoes during the first and last month of the growing season
- Processing tomato fruits contained 3.1 lbs N/ton at harvest
- N in fruits accounted for 63% of the N in the aboveground biomass
- The results of the project were incorporated into an online N calculator and CropManage

8. Introduction

California growers are facing increasing pressure to improve nitrogen (N) use efficiency in crop production. With stricter regulatory and reporting requirements and technological advances, which provide growers with more accurate but also increased amounts of data, computer based decision support tools are becoming a central component of farm management.

The goal of this project was to develop such a decision support tool for irrigation and N management in processing tomatoes. The tool is based on the framework of CropManage, which has been successfully developed and introduced for cool season vegetables on the Central Coast.

9. Methods/Management (Summarize project activities, methods, and materials)
During the 2016 and 2017 field seasons, we collected soil and plant related data in eleven commercial fields located in Yolo, San Joaquin and Fresno counties. In 2018, an additional 12 commercial fields in the Woodland area were selected to determine the

effect of planting configuration (bed with, number of plant rows per bed) on canopy development. The results from these sites were used to develop robust equations and algorithms for the user version of CropManage for processing tomatoes. In addition, a replicated trial was carried out at Campbell Tract, west of the UC Davis campus in 2017 and 2018. The trial included four irrigation and fertigation treatments, and was used to test the equations developed for CropManage.

10. Findings

Plant canopy started with a slow initial growth phase, followed by rapid growth eventually reaching its full canopy of 85-97% coverage, and remained relatively stable from that point. Across all eleven commercial field sites, the plants contained an average of 357 lbs N/ac in the aboveground biomass by harvest, with 37% of the N being in the vines and 63% in the fruits. The fruits contained 3.1 lbs N/ton. It took approximately 40 days for the plants to accumulate 40 lbs N/ac. In the replicated trial, the average marketable yield reached 58 and 63 tons/acre in 2017 and 2018, respectively. There was no statistical yield difference between treatments with an optimal N application rate and treatments with application rates that were 50 lbs/acre higher or lower. However, N uptake increased with increasing N application rate. Increasing irrigation from 100 to 130% of ET (based on canopy cover) had no effect on yield either. A version of CropManage for processing tomatoes was developed and is now available at https://v3.cropmanage.ucanr.edu/. In addition, a simple processing tomato N calculator has been created. It is available online at http://geisseler.ucdavis.edu/Tomato_N_Calculator.html.