UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources | UC Cooperative Extension

Imperial County Agricultural Briefs

December 2023 (Volume 26 Issue 11)

Features from your Advisors

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CARROT RESPONSE TO IRRIGATION AND NITROGEN MANAGEMENT STRATEGIES

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Introduction. California fresh market and processing carrots comprise an area of 60,300 acres with a total value of nearly $685 million per year (California Agricultural Statistics Review 2020-2021, CDFA, data associated with crop season 2020). Water and nitrogen (N) management in carrots is critical for increasing efficiency of crop production by decreasing costs and nitrate leaching losses. This will become increasingly important with high fertilizer prices, and as water quality and quantity concerns continue to increase. To maximize yield and quality, carrots need a sufficient level of N in the soil. Matching N fertilizer applications with carrot N uptake, and water applied with crop water requirements can optimize N and water use efficiency, as well as crop yield and quality.

Fig. 1. A carrot field under solid set sprinkler irrigation system in the Imperial Valley, California.

Sufficient data and science-based information on water and N management may free farm managers and growers of the worry associated with the amount applied and maintaining profitability. Making changes to cultural practices is extremely difficult especially when there is a lack of scientific information.

A four-year study was conducted to develop knowledge and information on improving and promoting adoption of management practices that optimize N and irrigation water use efficiency in California carrot production systems. This article summarizes some of the findings of the two recent trials carried out in Holtville, California.

Field experiment. A two-year study (October 2021 through March 2023) was conducted at the UC Desert Research and Extension Center in Holtville, California (Fig. 2). The experiment consisted of three N fertilizer strategies (N1, N2, N3) under two irrigation regimes (I1, I2). The trials were arranged in a randomized complete block with split plot arrangement over four replications. Each sub-plot included 12 beds of 40-in. width and 60 ft. long (40 ft × 60 ft). Ten lines of Choctaw fresh market cultivar were seeded in each bed. The dates of first irrigation and harvest were October 8, 2021, and March 17, 2022, for the 21-22 trial, respectively. These dates were October 4, 2022, and March 14, 2023, for the 22-23 trial, respectively. Solid set sprinkler was used to irrigate the trials throughout both seasons. The study field of the 21-22 season had a sandy clay loam (the top 1 ft.) to sandy loam (1-3 ft.) soil texture. The soil texture of the field in in the 22-23 season was slightly different (silty loam at the top 2 ft. and sandy loam below 2 ft. depth).

Fig. 2. An aerial view of the 21-22 season trial during an irrigation event.

The water applied to the irrigation treatments was monitored throughout the irrigation events using magnetic flowmeters on a 30-minute basis (Fig. 3). Actual soil nitrate content (NO_3-N) and total N percentage in tops and roots were determined monthly through laboratory analysis. Preplant and post-harvest soil samples were taken from six depths (1-6 ft.). At other sampling dates, soil was collected from the top three depths (1-3 ft.). A composite soil sample was analyzed from each layer for NO_3-N content.Canopy images were taken on a weekly to a 15-day basis utilizing an infrared camera (NDVI digital camera) to quantify crop canopy coverage over the crop seasons.

Fig. 3. Magnetic flowmeters and data store and transfer equipment to monitor water applied to the 22-23 trial.

Plant measurement was carried out on 40-plant samples collected randomly per plot and determinations of fresh and dry weights of roots and foliage were made on a regular monthly basis during the seasons. The plant measurement was conducted on 100-plant samples per plot at harvest.

Water and nitrogen applied. The seasonal water and N applications in the different irrigation regimes and N strategies are given in Table 1. A preplant N fertilizer with monoammonium phosphate was broadcasted at a rate of 280 lbs./ac over the entire trial area in both seasons. Urea Ammonium Nitrate (UAN-32) was injected into the sprinkler system to supply the remainder amount of the N for each nitrogen treatment. The application rates varied from 140 to 235 lbs. N/ac in the 21-22 season and from 145 to 217 lbs. N/ac in the 22-23 season.

Table 1. Seasonal water and N application rates in the study seasons.

	21-22 season	22-23 season
N application (lb. N/ acre)	N1=140	N1=145
	N2=185	N2=180
	N3=235	N3=217
	N4=275	-
Water application (in)	I1=24.5	I1=23.6
	I2=30.8	I2=29.7

The amount of irrigation water was determined using the CropManage irrigation and nitrogen decision management tool (https://cropmanage.ucanr.edu) to provide 100% of crop water needs (ET or irrigation regime 1) and 25% more than crop water needs (125% ET or irrigation regime 2). The amounts of irrigation varied from 24.5 to 30.8 in. and from 23.6 to 29.7 in. in the season 21-22 and 22-23, respectively (Table 1). The trends of water and N applications per event for the 22-23 season can be found in Fig. 4

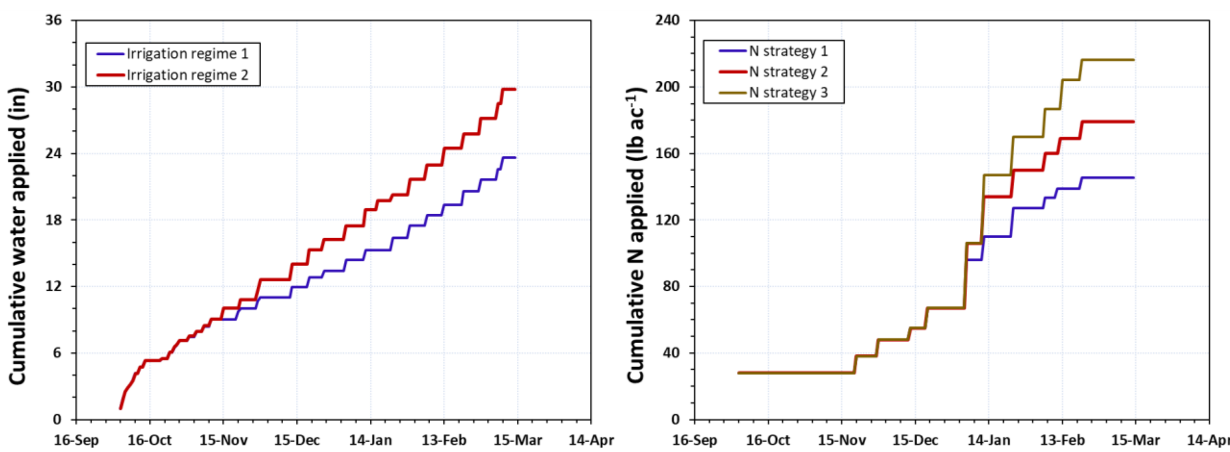

Fig. 4. Cumulative water and N applied in each of the irrigation regimes and N strategies over the 22-23 season.

Impact of water and N management on nitrogen uptake. Data of this study reported in an earlier article suggested that nearly 50% of the total N in carrots are taken up during a 50-day period, 80-130 days after seeding (Montazar et al. 2021a). This 50-day period appears to be the most critical period for N uptake, particularly in the storage roots, when carrots developed the large canopy and the extensive rooting system. The findings also demonstrated that for a 160-day crop season in the low desert of California, 22% of N uptake took place over the last 30-day before harvest (Montazar et al. 2021a).

highest N accumulation rates at harvest were associated with the N2 treatment under the I2 irrigation regime (273 lbs. ac^{-1}) and the N3 treatment under the I1 irrigation regime (281 lbs. ac^{-1}) in the 22-23 season (Fig. 5). However, nitrogen application rates had no statistically significant effect on total N uptake (roots and tops) and the N accumulated in roots. The N application rate had a clear and scientifically significant effect on increasing aboveground foliage (tops) in which could be a reason for greater nitrogen uptake at the higher rate of N applied.

The results provide evidence (p=0.01) for an overall effect of the interaction of irrigation regime and nitrogen management strategy on the total N accumulation in carrots (roots and tops) even though the irrigation regime as an individual driver had no significant effect on the N accumulation (neither the total nor tops or roots). It is likely relevant to the range of water application rates. The 25% over irrigation couldn't have a considerable impact on leaching nitrate within a silty loam soil type. A higher amount of excessive water through a more aggressive over irrigation scenario (for instance 150% ET) could influence the N uptake differently. The results of nitrogen accumulation were basically consistent within the two seasons.

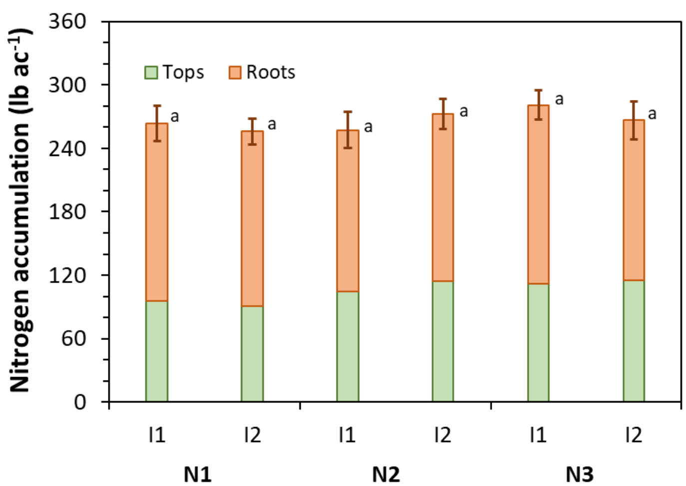

Fig. 5. Mean nitrogen uptake distribution in carrot roots and tops affected by water regimes and nitrogen application rates in the 22-23 season. The bars demonstrate the standard error of root yield values. Fresh root yields with different letters significantly differ ($p < 0.05$) by Tukey's test.

Impact of water and N management on carrot fresh roots. Although no statistically significant impacts were found from both irrigation and N application rates on the fresh root yield (*p* values of greater than 0.41) in the 22-23 season, N application statistically affected root yield (p=0.001) in the 21-22 season (Fig. 6). The lowest fresh root yield (40.8 t ac^{-1}) was observed in the I2N1 treatment (irrigation regime 2 and an N application rate of 140 lbs. ac^{-1}). A lower soil residual nitrate content could have contributed to a lower root yield in this specific treatment in the 21-22 season. A greater mineral N content in the top 2-ft of soil was determined right before planting in the 22-23 season (106 lbs. N/ac) than in the 21-22 season (77 lbs. N/ac).
Since residual soil N can contribute considerably to the N requirement in carrots, preplant soil nitrate-N assessment down to 2 ft. depth is a tool that can enable growers to improve N management and maximize yield and quality while minimizing economic and environmental costs.

The findings suggested insignificant difference of fresh root yields impacted by the interaction of irrigation regime and N strategy within the range of application rates in both seasons. Different results could be obtained in a field that is irrigated more than the I2 treatment (> 125% of CropManage recommendation), has a low residual nitrate content or/and has a sandy textured soil.

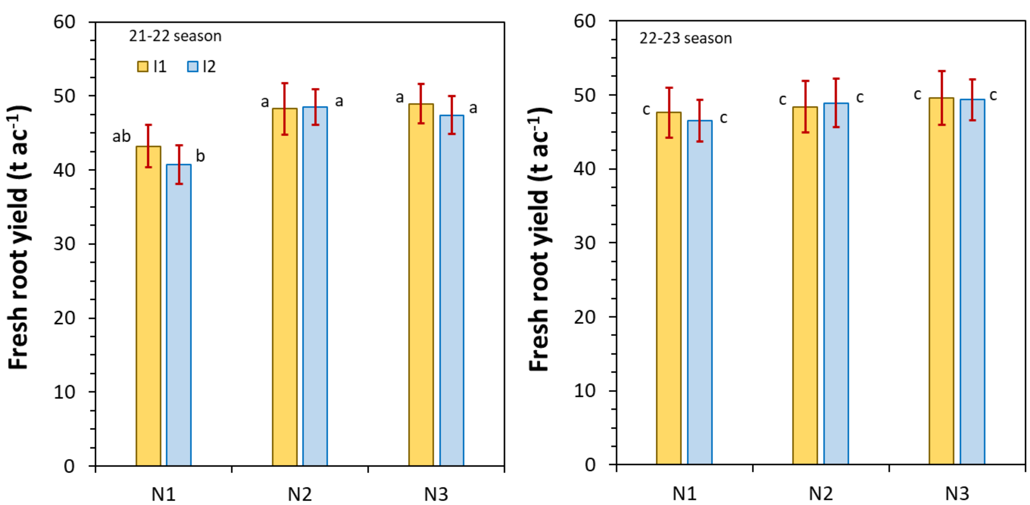

Fig. 6. Mean fresh carrot root yields as affected by water regimes and nitrogen application rates over the study seasons. The bars demonstrate the standard error of root yield values. Fresh root yields with different letters in each season significantly differ ($p < 0.05$) by Tukey's test.

Conclusions. Nitrogen and irrigation water must be effectively used in mineral soils to produce carrots with high yield and with minimal environmental impact. In the low desert of California, the majority of N is taken up during the months of December to February, and hence, proper N fertility in the effective crop root zone is essential during this period (Montazar et al. 2021b). An integrated optimal N and water management needs to be followed to achieve high N and water efficiency, and consequently overall profitability.

Positive impact of N application rate on carrot root yield was observed but statistically no significant relation was found (Montazar et al. 2021b). The findings of this study suggested that N application rates greater than 145 lbs. ac^{-1} do not have a significant impact on carrot root yield in a well-managed irrigated field with a silty loam soil texture (above 2 ft.) to sandy loam (below 2 ft.). However, the fact that more N was taken up in the crop than applied for the N1 and N2 treatments would suggest that the residual nitrate in the soil from the past season contributed to the N nutrition of the crop. Higher N rates are likely necessary in over irrigated carrot fields (receiving more than 125% of Crop ET), or fields with a low residual nitrate content. This is because improving N use efficiency is closely associated with water use efficiency. On sandy textured soils, water management can be especially important for achieving a high N use efficiency in carrots. Carrots need variable seasonal water application that depends on planting time, length of season, variety, soil types, and irrigation efficiency. In this study, we used CIMIS reference evapotranspiration data and a crop coefficient model applied through CropManage online software to estimate water requirements of carrot before each irrigation.

Growers are encouraged to try using a reduced N rate (10-20% lower than their current practice) on a small field to evaluate how it fits their specific farming practices before they adopt it on a widespread basis. Analyzing soil samples for residual soil nitrate early in the season (after the pre-irrigation) and in-season soil nitrate and leaf tissue analyses can provide confidence in the new practices and allow for corrective measures. Information on using the soil nitrate quick test can be found at: https://www.cdfa.ca.gov/is/ffldrs/frep/pdfs/NitrateQuickTestWeb.pdf. More details on the soil nitrate quick test can be also found in a blog article developed by Smith and Cahn (2019). Sufficient N availability in the crop root zone over the growing season and the lack of significant yield response to N application within the range of N application rates in this study suggested that N optimal rates could be likely less than 180 lbs. ac^{-1} in the low desert of California.

Acknowledgements. Funding for this study was provided by the California Department of Food and Agriculture (CDFA) - Fertilizer Research and Education Program (FREP) and the California Fresh Carrot Advisory Board.

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34^{th} ANNUAL UCCE FALL DESERT CROPS WORKSHOP

Ali Montazar, Oli Bachie, Cuong Nguyen, Brooke Latack

University of California Cooperative Extension - Imperial County held its 34^{th} “Fall Desert Crops Workshop” at Farm Credit West in Imperial on November 30^{th}. The workshop was run as a hybrid event with in-person and virtual speakers. At this event, 15 speakers from UC Riverside, UC Davis, UCCE Imperial and Riverside Counties, UC Kearney Agricultural Research and Extension Center, Imperial County Agricultural Commissioner Office, and water industry and private sectors came together to bring innovative ideas and solutions; and disseminate the outcomes of their recent studies and experiences in the desert region. The event was co-organized by UCCE Imperial County advisors; Ali Montazar, Oli Bachie, Cuong Nguyen, and Brooke Latack. We thank all presenters, growers, industries, and other participants for making this event successful.

Co-sponsored by
UCCE-Imperial County, and
Imperial County Farm Bureau

UC CE University of California Agriculture and Natural Resources Cooperative Extension

Grant Workshop: State Water Efficiency and Enhancement Program

UCCE-Imperial County and Imperial County Farm Bureau will host a series of workshops to provide information and assistance to growers interested in applying for a SWEEP grant. Potential applicants are encouraged to attend at least one workshop.

SWEEP provides financial assistance in the form of grants to implement irrigation systems that reduce greenhouse gases and save water on California agricultural operations.

Submission Period: December 5, 2023 - late January, 2024
Grant award: Up to $200,000

Eligible practices include:

- Irrigation Scheduling System
- Adding/Repairing a pipeline
- Installing drip line
- Microirrigation
- Improving energy efficiency
- And many more....

Scan to register

In-person meeting

Monday, Dec 18th, 2023

From 2:00- 4:00 pm

Imperial County Farm Bureau.
1000 Broadway, El Centro, CA 92243

Virtual meeting

Tuesday, Dec 19th, 2023

From 1:00- 2:30 pm

Zoom Meeting
*Find the details on the registration link

You can also contact Ana Resendiz for registration at aresendiz@ucanr.edu or (442) 265-7709

Please feel free to contact us if you need special accommodations.

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California Climate Investments Cap and Trade Dollars at Work
Imperial County California 1907

IMPERIAL VALLEY CIMIS REPORT AND UC WATER MANAGEMENT RESOURCES

Ali Montazar, Irrigation and Water Management Advisor, UCCE Imperial, Riverside, and San Diego Counties

The reference evapotranspiration (ET_o) is derived from a well-watered grass field and may be obtained from the nearest CIMIS (California Irrigation Management Information System) station. CIMIS is a program unit in the Water Use and Efficiency Branch, California Department of Water Resources that manages a network of over 145 automated weather stations in California. The network was designed to assist irrigators in managing their water resources more efficiently. CIMIS ET data are a good guideline for planning irrigations as bottom line, while crop ET may be estimated by multiplying ET_o by a crop coefficient (K_c) which is specific for each crop.

There are three CIMIS stations in Imperial County include Calipatria (CIMIS #41), Seeley (CIMIS #68), and Meloland (CIMIS #87). Data from the CIMIS network are available at: http://www.cim is.water.ca.gov. Estimates of the average daily ET_o for the period of November 1 to January 31 for the Imperial Valley stations are presented in Table 1. These values were calculated using the long-term data of each station.

Table 1. Estimates of average daily potential evapotranspiration (ET_o) in inch per day

Station	December		January		February	
	1-15	16-31	1-15	16-31	1-15	16-28
Calipatria	0.09	0.09	0.09	0.10	0.12	0.13
El Centro (Seeley)	0.10	0.09	0.10	0.11	0.13	0.15
Holtville (Meloland)	0.09	0.08	0.09	0.10	0.12	0.14

For more information about ET and crop coefficients, feel free to contact the UC Imperial County Cooperative Extension office (442-265-7700). You can also find the latest research-based advice and California water & drought management information/resources through link below:
http://ciwr.ucanr.edu/.