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NITROGEN UPTAKE VARIATIONS IN DESERT LETTUCE: RECENT RESEARCH FINDINGS

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Introduction. Various irrigation and nitrogen (N) management practices are used to produce lettuce in the low desert of California (Fig. 1). Type of lettuce, salinity management, planting time, plant density, irrigation method, and soil type and environmental conditions are the key drivers of resource use and efficiency in desert lettuce. For instance, growers typically apply more nitrogen fertilizer for lettuce fields planted in the late season than fields planted in the early season. Sprinklers are often used until the seedlings emerge and the fields are then switched to furrow irrigation for the remainder of the season. While furrow irrigation dominates irrigation systems in desert lettuce, there are growers who adopted drip irrigation and even use drip to germinate fields. The planting configurations have been modified resulting in increased plant population under drip and sprinkler irrigated lettuce on 80-in-wide beds compared with furrow irrigated lettuce on 40- and 50-in-wide beds. Different nitrogen and water use applications and efficiencies are expected under these circumstances.

Fig.1. Various irrigation methods and plant populations in California's low desert lettuce (*top-left*: iceberg lettuce in 80-in beds under drip; *top-right*: leaf lettuce in 80-in beds under sprinkler; *bottom-left*: iceberg lettuce in 40-in beds under furrow; *bottom-middle*: romaine lettuce in 50-in beds under furrow; *bottom-right*: iceberg lettuce in 80-in beds under sprinkler).

N and water management in lettuce is critical for increasing efficiency of crop production and decreasing costs and nitrate leaching losses. The overall purpose of this three-year study is to fully understand the viability and applicability of current N and irrigation management practices in the low desert lettuce production systems.

This article, as part of the findings of the study, aims to share some data on N uptake values in desert lettuce for head and romaine lettuces.

Field experiments. The experiments were conducted in five commercial fields in the Imperial and Coachella Valleys consisting of three head and two romaine lettuce trial fields (Fig. 2 and Table 1). The trial field Com-1 was germinated by drip, and sprinklers were used to germinate the other commercial trials. All trial fields were irrigated using drip the entire season after plant establishment, except trial Com-5 that switched to furrow irrigation. In addition, two head lettuce trials (40-in beds and 80-in beds) were carried out under two irrigation regimes and three N fertilizer strategies at the UC Desert Research and Extension Center (DREC) in a Randomized Complete Block Design with Split Plot Arrangement over four replications (Fig. 2 and Table 1).

The fertilizer applied was monitored throughout the crop season. The data of water applied was automatically imported and analyzed by the CropManage (CM) web-based tool in each site (Fig. 2). The actual soil nitrate content and the total N concentration in the plants were determined five times per season through laboratory analysis. Comprehensive yield quality data at harvest was collected including plant population, head weight, biomass, marketable yield, total N and dry matter concentration of head tissue.

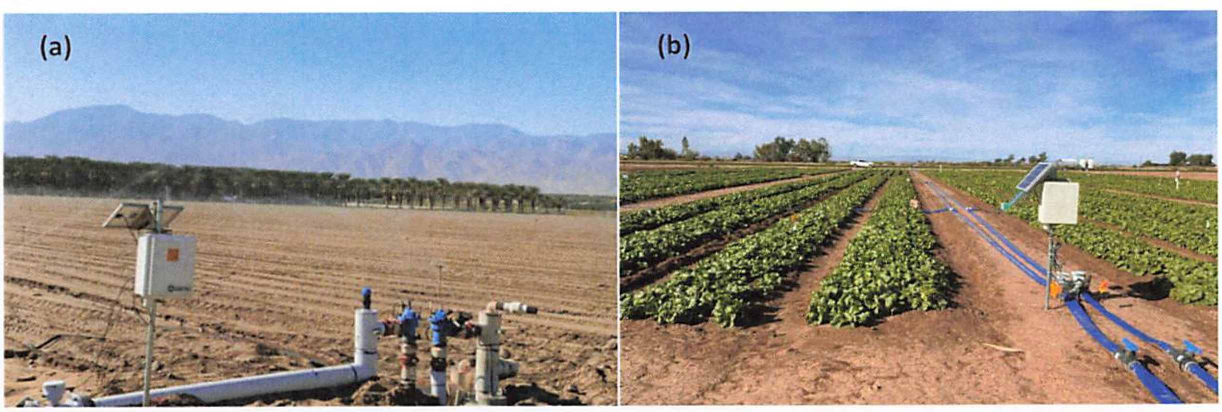

Fig. 2. A demonstration of the 40"-bed romaine lettuce trial field in the Coachella Valley (a) and the 80-in beds head lettuce trial at the DREC (b). The water applied was measured using a magnetic flowmeter attached to datalogger. The data of water applied was automatically imported and analyzed by CM tool.

Table 1. General information of the trial fields.

Trial	Soil texture	Crop/planting	Irrigation method	Wet date	Harvest date
Com-1	Silty clay	Head 80-in beds, 6 rows	Drip	29 Oct, 2022	15 Feb, 2023
Com-2	Silty clay	Romaine 80-in beds, 6 rows	Drip	5 Nov, 2022	15 Feb, 2023
Com-3	Loamy fine sand	Head 40-in beds, 2 rows	Drip	1 Nov, 2023	2 Feb, 2024
Com-4	Sandy loam	Romaine 40-in beds, 2 rows	Drip	11 Nov, 2023	15 Feb, 2024
Com-5	Silty clay	Head 40-in beds, 2 rows	Furrow	5 Oct, 2023	25 Dec, 2023
DREC-1 to DREC-6	Silty loam	Head 80-in beds, 6 rows	Drip	5 Nov, 2023	12 Feb, 2024
DREC-7 to DREC-12	Silty loam	Head 40-in beds, 2 rows	Drip	5 Nov, 2023	12 Feb, 2024

Notes: Trial fields Com-2 through Com-4 were switched to drip and trial field Com-5 to furrow irrigation after plant establishment using sprinklers. The other trials were established and irrigated using drip the entire crop season. The DREC trials were under different irrigation and nitrogen application regimes.

Plant density. A considerable difference of plant density was found across the trials ranging from 27,181 plants per acre at trial Com-5 to an average of 49,446 plants per acre at the DREC trials with 80"-bed.

Water and nitrogen applied. Variable water and N application rates were observed at the experimental sites. A substantial difference was found between the N and water application rates recommended by the CM and grower practice at the field trials with sandy soil textures. For instance, the seasonal irrigation water and N application rates were 20.3-in (115% more than the rate recommended by the CM; Fig. 3) and 285 lbs. ac^{-1} (147% more than the rate recommended by CM) at the Com-4 trial, respectively. The N unit applications varied from 90 to 160 lbs. ac^{-1} at the DREC trials and other commercial fields with heavier soil texture.

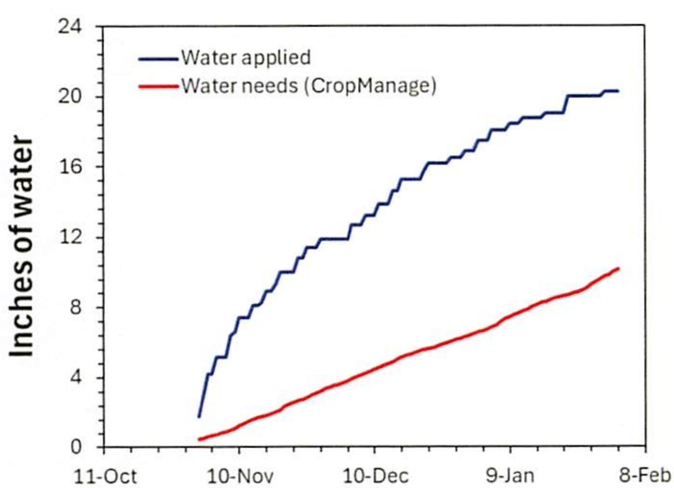

Fig. 3. A comparison of water applied versus irrigation water needs recommend by CM at trial Com-4.

Biomass yield. Overall, greater biomass yield (averagely 34%) was observed at the 80-in beds lettuce trials in comparison with the 40-in beds lettuce trials (Fig. 4). While a significant impact of N application rate on biomass yield wasn't found, a wide range of biomass yield was observed across the trials (24.5 t ac^{-1} at trial Com-3 to 48.4 t ac^{-1} at trial Com-1).

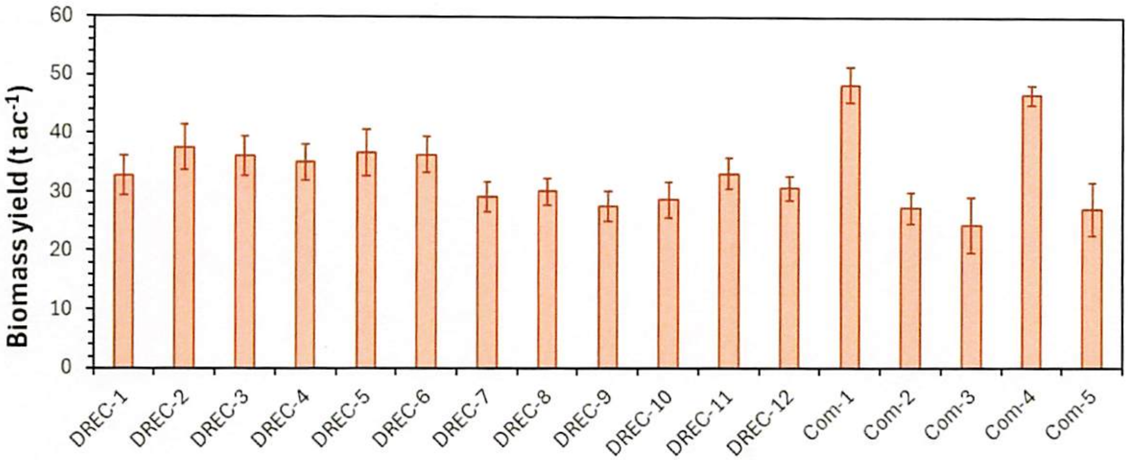

Fig. 4. Biomass yield in different trials. Standard deviation of the corresponding biomass yields is shown on the bars.

N uptake at harvest. A wide range of N uptake at harvest was determined across the experimental sites and treatments. Mean values varied from 82.1 lbs.ac^{-1} at trial Com-3 (a head lettuce field with 40-in beds) to 147.3 lbs.ac^{-1} in another head lettuce field with 80-in beds (Com-1) (Fig. 5). The results demonstrated more variations on the N uptake values than the biomass yields among the trials. For instance, there wasn't considerable biomass yield difference between trials Com-2 (27.4 t ac^{-1}) and Com-3 (24.5 t ac^{-1}), however, significant difference was found between N uptake at these trials (128.1 lbs.ac^{-1} vs. 82.4 lbs.ac^{-1}, respectively).

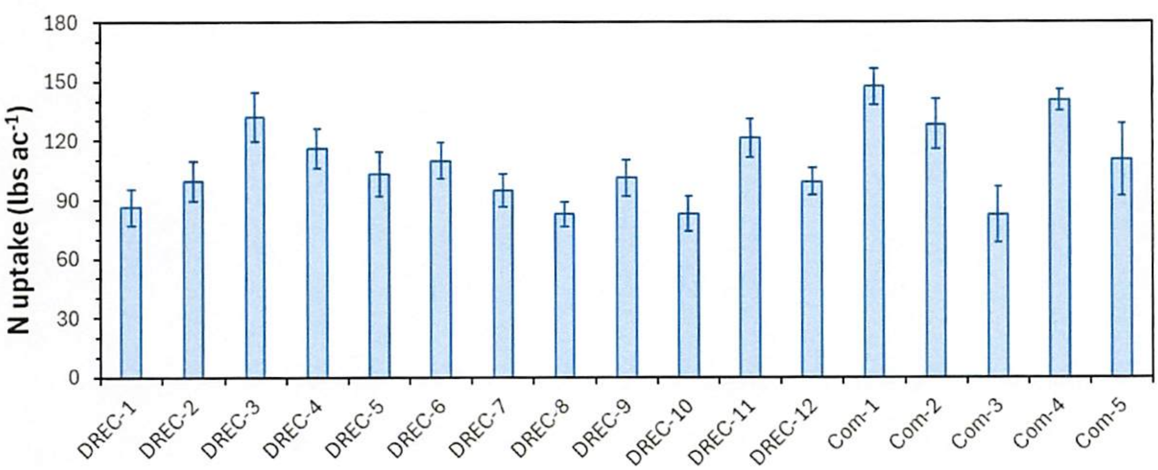

Fig. 5. N uptake values in different trials. Standard deviation of the corresponding N uptake values is shown on the bars.

Conclusions. A wide range of N uptake values was obtained in desert head and romaine lettuces across the trials reported in this article and in our 2022-2023 trials, varied from less than 80 lbs.ac^{-1} to greater than 150 lbs.ac^{-1}. The findings of this study suggested that lettuce growth could be maximized by seasonal N fertilization and irrigation water application rates below current typical practices even in drip irrigated fields. A higher potential for improvements is expected in furrow irrigated lettuce fields and fields with sand-dominated soil textures. CropManage (https://cropmanage.ucanr.edu/), as a free decision-making tool, may assist local growers to maximize lettuce production and improve the efficiency of N and water use.

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PRE-PLANT BENEFITS OF SUMMER COVER CROPS IN LOW DESERT VEGETABLE PRODUCTION

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Introduction

Vegetable production in southern desert valleys depends primarily on conventional practices, including synthetic fertilizers and pesticides. Cool-season vegetable crop residues are normally mowed and disced into the soil, and most fields are left fallow during summer months. Such practice subjects soil organic matter and beneficial microbial populations to extreme soil temperatures that can compromise overall soil health. Extreme temperatures burn soil organic matter to negligible levels and microbial activity can be negatively impacted to perform important soil ecosystem services such as decomposition and nutrient cycling. Soil conservation agricultural practices such as cover cropping and composting could address soil conservation challenges. However, cover crops for soil conservation in the low desert vegetable production is barely practiced due to 1) water limitations, 2) grower perception that cover crop planting is a waste of cropland and resources, and 3) lack of knowledge of cover crop use and agroecosystem benefits it offers. The overarching goal of this study was to shed light on summer cover crop and compost treatment benefits with an emphasis on nematode, nitrogen, and soil health

Figure 1. Cover crop stands six weeks after planting.

management in low desert vegetable production. This article highlights cover crop benefits before being terminated or before applying compost.

Materials and Methods

A field trial was conducted in the summer of 2024 at the Coachella Valley Agricultural Research Station (33°31'15.0"N 116°09'04.8"W; Fig. 1) to evaluate four cover crop species for nematode, nitrogen, and soil health management. Cowpea 'Chinese Red', sunn hemp 'Tropic Sun', brown mustard 'Pacific Gold', and Sudan grass 'Sudex' cover crop treatments were tested and compared to a fallow treatment in a randomized complete block design with 4 replications. Each experimental unit was 250 ft × 6 ft. Cover crops were direct seeded using a handheld planter in 2 seed lines on 3 ft raised beds and sprinkler irrigated for two months of establishment. Cover crop seeding rates and seed sources are specified in Table 1. Soil physical (water infiltration and soil moisture), chemical (primary and secondary nutrients, micronutrients, soil organic matter, soil pH, soil sulfate, salinity, and cation exchange capacity), and biological (nematode community and soil respiration) parameters were documented right before cover crop termination. Data were analyzed using Statistical Analytical Software version 9.4 (SAS Institute Inc., Cary, NC). Data were checked for normality using Proc Univariate in SAS, normalized using log10 (x+1) where necessary, and subjected to one-way analysis of variance using Proc GLM in SAS. Means were separated using the Waller–Duncan *k*-ratio (*k*=100) *t*-test and only true means were presented.

Table 1. Cover crop species, variety, seeding rate, and seed sources.

Cover Crop	Species	Variety	Rate	Source
Fallow	-	-	-	-
Brown mustard	*Brassica juncea*	Pacific Gold	10 lb/ac	Johnny's Selected Seeds
Cowpea	*Vigna unguiculata*	Chinese Red	40 lb/ac	Percher Seeds
Sunn hemp	*Crotalaria juncea*	Tropic Sun	40 lb/ac	Percher Seeds
Sudan grass (SG)	*Sorghum bicolorxS. bicolor*	Sudex	40 lb/ac	Johnny's Selected Seeds

Results and Discussion

Carbon to Nitrogen (C:N) ratio and plant-available nitrogen: C:N ratio of cover crops occurred in descending order of SG>BM>SH>CP, where SG and CP had the highest and lowest ratios (Table 2). C:N ratio is important to understand because soil microbes dictate the availability of N in the soil for crops. Soil microbes require C:N ratio of 25:1 or 25 to function in the soil. If the C:N ratio is above 25 as in BM and SG, N is temporarily immobilized, meaning nitrogen is briefly unavailable or slowly released in the soil for the plants to uptake. Plants may express deficiency symptoms during this brief period. It may be beneficial to supplement N fertilizer at cash crop planting to address potential N deficiency. In contrast, if the C:N ratio is below 25 as in CP and SH, microbes mineralize N held in biomass or organic form and are released into the soil in inorganic or plan-available form (e.g. nitrate) for plants to uptake. Thus, N immobilization and mineralization are dynamic processes dictated by soil microbes depending on the quality or C:N ratio of organic materials added to the soil. The plant-available nitrogen (PAN) decreased in the order of SH>CP>SG>BM. As expected with the lowest biomass production, BM had the lowest PAN as it is a cool season cover crop, and growing during the summer was challenging.

Table 2. Moisture and dry contents, total carbon (C) and nitrogen (N), C:N ratio, and plant-available N (PAN) of cover crop treatments determined at the time of termination.

Cover Crops	Moisture (%)	Dry (t/ac)	N (%)	Carbon (%)	C:N Ratio	PAN (lb/ac)
Fallow (F)	-	-	-	-	-	-
Brown mustard (BM)	63.0	3.24	0.93	44.0	47.3	30.1
Cowpea (CP)	83.3	3.98	2.69	43.2	16.1	107.1
Sunn hemp (SH)	65.9	6.35	1.95	41.2	21.1	123.8
Sudan grass (SG)	53.2	7.71	0.85	42.8	50.4	65.5

Soil physical, biological, and chemical properties: Among the soil parameters observed, significant observations were only made on soil physical and chemical properties but not on biological properties (Table 3). Water infiltration was increased by sunn hemp compared to fallow ($P \leq 0.05$). This means growing sunn hemp cover crop can improve water infiltratraion in the soil which would otherwise be lost through run-off and evaporation. Soil moisture was significantly low in sunn hemp and Sudan grass plots compared to fallow ($P \leq 0.05$). This observation is explained by the fact that established cover crop canopy blocks sprinkled irrigation water from reaching the soil compared to fallow treatment that is directly exposed to the irrigation water making it moister. Drip irrigating cover crops could address this challenge. Soil chemical properties including, soil pH, salinity, soil sulfate, and cation exchange capacity (CEC) were significantly impacted by cover crop treatments ($P \leq 0.05$). Soil pH regulates nutrient availability and sulfate affects soil acidity. All cover crop treatments reduced soil pH to an average of 7.8, closer to the optimum soil pH range of 6.5-7.5, where nutrients are freely available to plants. Soil sulfate level was high in brown mustard as it is one of the by-products of glucosinolate breakdown, a secondary compound generally found in all members of Brassicaceae including brown mustard (Waisen et al., 2020). Elevated sulfate levels in brown mustard plots could be explained by the early decomposition of its biomass that died off prematurely as it was struggling to establish during the summer. The decomposition of biomass was likely dominated by bacteria as reflected by an increase in bacterial feeding nematode population (Fig. 2A). Interestingly, the soil population density of stunt nematode (*Tylenchorynchus* spp.), the only plant-parasitic nematode present in the field, was numerically reduced and perhaps associated with the release of isothiocyanate or biofumigation (Fig. 2D). Isothiocyanate, a pungent volatile compound released along with sulfate when glucosinolate in brown mustard is enzymatically broken down, is chemically similar to active ingredient methyl isothiocyanate in Vapam (metam sodium). Soil salinization influences water and nutrient uptake and the toxicity or deficiency due to high concentrations of certain ions. Salinity was increased in brown mustard treatment. This increase could be explained by a spike in sulfate production following the decomposition of the brown mustard biomass. This is an example of a situation where addressing one challenge creates another that one must be aware of. Sunn hemp increased ($P \leq 0.05$) CEC, a measure of how many positively charged ions can be retained on the soil particle surface. This means growing cover crops like sunn hemp can increase CEC and retain cations, which would otherwise be lost through leaching or run-off. In addition, primary nutrients (nitrate-N, phosphorus, and potassium), secondary nutrients (calcium, magnesium, and sodium), and micronutrients (manganese, iron, boron, and chlorine) also responded significantly to the cover crop treatments (Table 3; $P \leq 0.05$). Soil concentrations of nitrate-nitrogen, potassium, calcium, sodium, boron, and chlorine were increased by brown mustard again due to the early decomposition of biomass while other cover crops were actively growing. It is worth noting that cowpea and sunn hemp reduced phosphorus concentration in the soil as they were actively growing and likely utilized these nutrients.

Table 3. Soil physical, biological, and chemical properties as affected by cover crop treatments at the time of termination. Means (n=4) followed by the same letter(s) across rows are not different from each other, according to the Waller–Duncan k-ratio (k=100) t-test.

Parameters	Fallow	Brown mustard	Cowpea	Sunn hemp	Sudan grass
Physical properties					
Water infiltration (inch/hr)	6.8 b	10.8 ab	8.3 ab	16.8 a	12.6 ab
Moisture (%)	7.7 a	6.2 ab	6.4 ab	5.2 b	5.5 b
Biological properties					
Solvita color (1-5)	2.2 ab	2.1 ab	2.5 a	2.4 a	1.8 b
Solvita potential N (lb/ac/yr)	29.5 ab	28.0 ab	34.3 a	33.5 a	23.8 b
Nematode count (100 cm^{-3} soil)					
-Total	47 a	49 a	45 a	54 a	30 a
-Richness	4 a	3 a	4 a	5 a	4 a
Chemical properties					
Soil organic matter (%)	0.73 a	0.85 a	0.89 a	0.85 a	0.81 a
Soil pH (1-14)	8.1 a	7.9 b	7.8 b	7.8 b	7.9 b
Salinity (dS/m)	1.5 b	3.9 a	1.4 b	2.0 b	1.8 b
Sulfate (lb/AF)	1910 b	5353 a	1745 b	2585 ab	2463 b
CEC (meq/100 g)	16.1 b	16.3 ab	16.5 ab	16.7 a	16.6 ab
Primary nutrients (lb/AF)					
-Nitrate-Nitrogen	5.6 b	15.1 a	8.1 ab	7.7 ab	4.1 b
-Phosphorus (P_2O_5)	96.4 a	89.4 a	75.6 b	75.6 b	84.8 ab
-Potassium (Sol)	94.8 b	189.8 a	84.9 b	106.5 b	85.5 b
Secondary nutrients (lb/AF)					
-Calcium (sol)	419.0 b	1283.5 a	418.3 b	572.0 ab	523.3 b
-Magnesium (sol)	108.4 b	344.3 a	111.1 b	161.8 b	149.5 b
-Sodium (sol)	824.3 b	1946.5 a	687.5 b	974.8 b	908.5 b
Micronutrients (lbs/AF)					
-Zinc	3.7 a	3.6 a	3.6 a	3.6 a	3.4 a
-Manganese	4.6 c	5.5 ab	5.9 a	5.6 ab	5.1 bc
-Iron	23.7 a	21.4 ab	22.6 a	19.4 b	21.2 ab
-Copper	5.3 a	5.1 a	5.2 a	5.2 a	5.0 a
-Boron	1.0 b	1.5 a	1.0 b	1.2 ab	1.1 ab
-Chlorine	728.0 b	1832.5 a	476.5 b	779.8 b	673.8 b

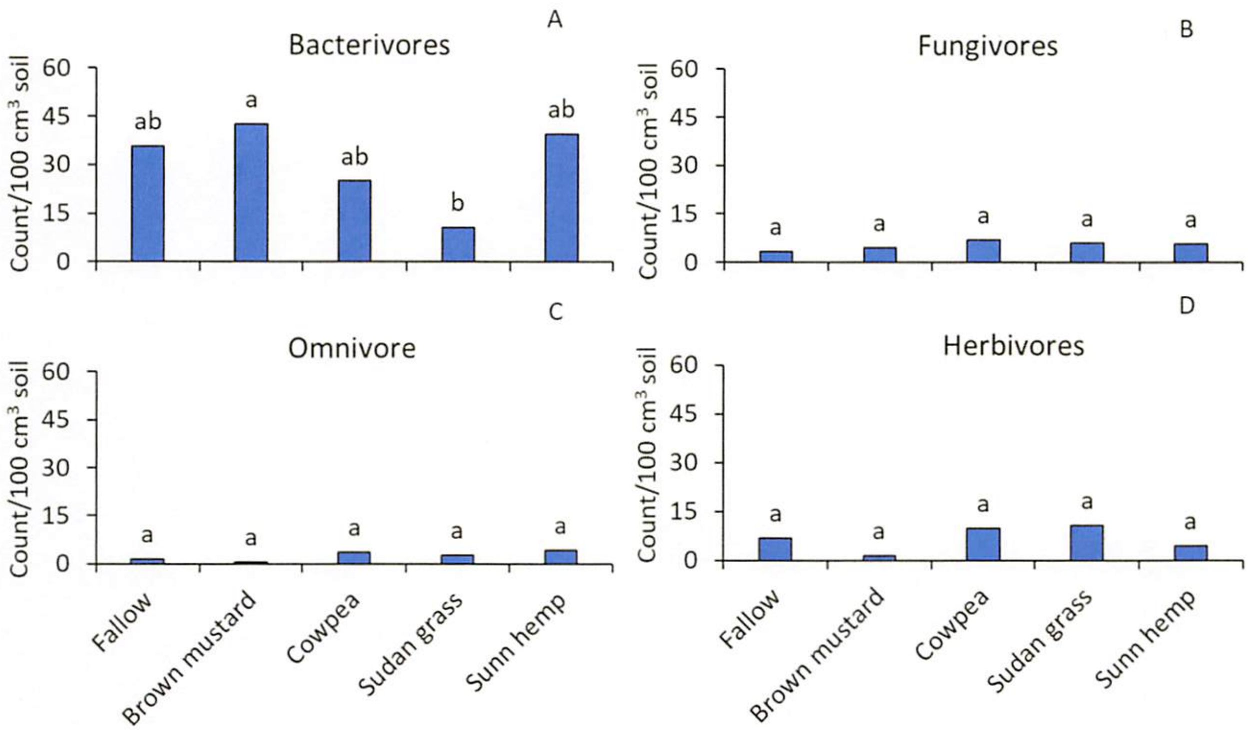

Figure 2. Soil population densities of A) bacterial-feeding nematodes, B) fungal-feeding nematodes, C) omnivorous nematodes, and D) herbivorous or plant-parasitic nematodes in the top 8 inches of the soil at the time of cover crop termination. Bars represent means (n=3) and the means are not different, according to the Waller–Duncan k-ratio (k=100) t-test.

Relationship between soil physical, biological, and chemical properties: Canonical correspondence analysis (CCA) is a multivariate analysis that combines measured variables (species and environmental variables) and draws relationships. If the response variables are on the opposite or same sides of the ordination diagram the relationship is negative or positive, and the relationship is stronger if the arrows are longer or weak if shorter. This study showed strong relationships among the variables measured, with the first two canonical axes (CCA 1 and CCA 2) in the ordination diagram explaining up to 85% of the variance (Fig. 3).

Positive relationships were observed with salinity vs. Cl and sulfate or CEC vs. Ca and Mg (Fig. 3). Soil salinization was associated with increased Cl and sulfate concentrations as salts formed from these compounds increased salinity. CEC was positively related to Ca and Mg, which means high CEC retains cations for plants to utilize. Negative relationships were observed in soil pH vs. N, Zn, Cu, Mg, CEC, and Ca or sulfate vs. herbivores (plant-parasitic nematodes; Fig. 3). Soil pH regulates nutrient availability in the soil (Hartemink and Barrow, 2023). In this field, the cover crop treatments reduced soil pH from 8.1 to 7.8 near the optimum pH 6.5-7.5 range. As such, the negative relationship was favorable as the reduction in soil pH makes N, Zn, Cu, Mg, and Ca available to plants. Soil sulfate is negatively related to herbivore or plant parasitic nematodes indicating that increased sulfate is associated with increased isothiocyanate production or biofumigation. This observation is in line with a previous study that the effect of brassica-based biofumigation increased with increased sulfate production (Waisen et al., 2020).

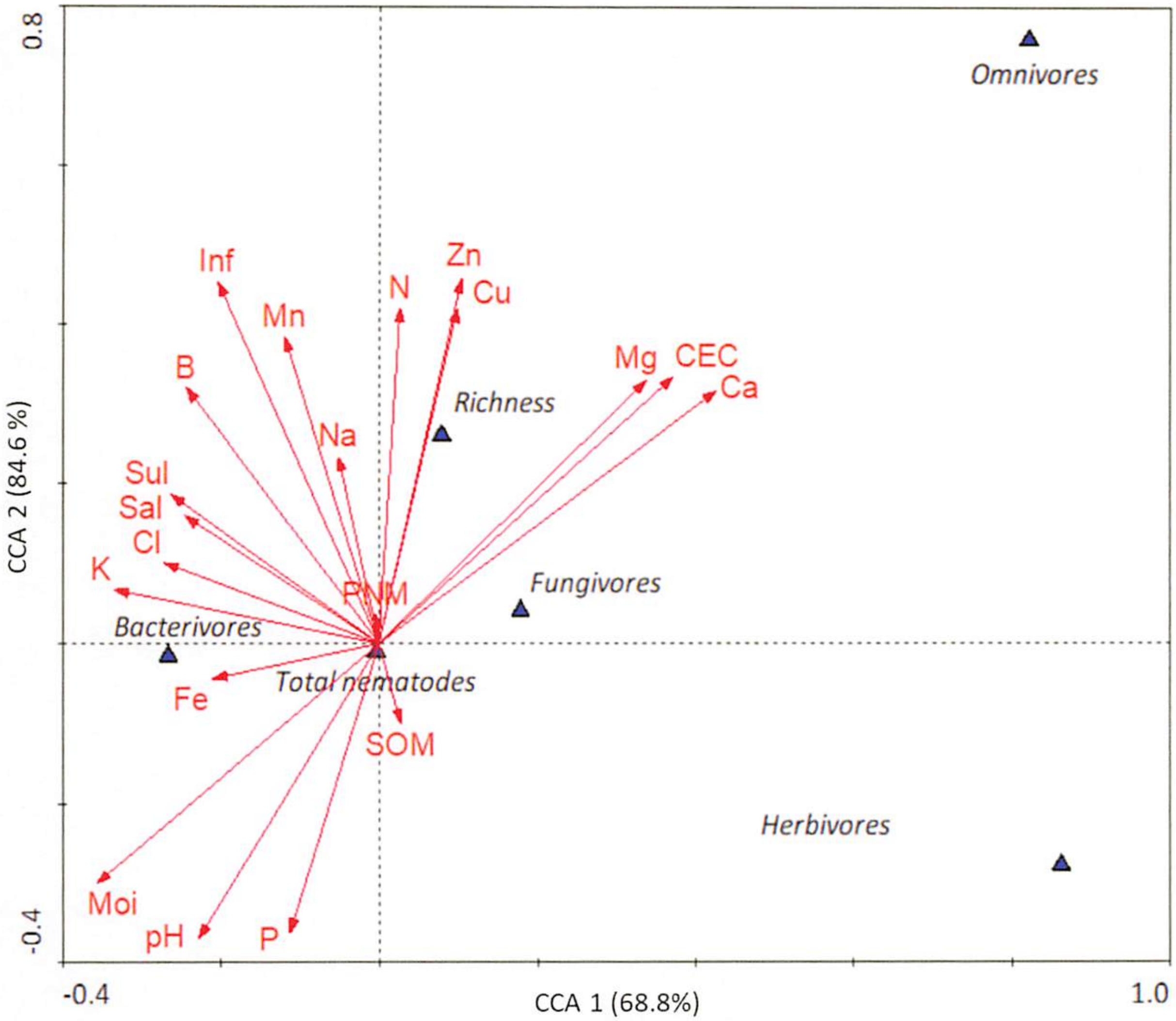

Figure 3. Canonical correspondence analysis (CCA) ordination diagram showing relationships among soil physical, biological, and chemical properties including primary nutrients, and secondary nutrients, and micronutrients as affected by cover crop treatments at the time of termination. Blue triangles represent species variables including bacterivores, fungivores, herbivores, and species richness. Red arrows represent environmental variables including soil organic matter (SOM), soil pH (pH), salinity (Sal), sulfate (Sul), cation exchange capacity (CEC), water infiltration (Inf), soil moisture (Moi), potential nitrogen mineralization (PNM), nitrate-nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), iron (Fe), boron (B), chlorine (Cl), manganese (Mn), zinc (Zn), and copper (Cu).

Conclusion

This study aimed to assess cover crop benefits at the time of cover crop termination with an emphasis on nematode, nitrogen, and soil health management in low desert vegetable growing conditions. Data presented thus far are up to cover crop termination. Stunt nematode was the only plant-parasitic nematode detected in the field. Reduction in population density of this nematode was not significant, but a numerical trend was observed in brown mustard treatment. This reduction may have been associated with increased isothiocyanate production and biofumigation as indicated by increased sulfate production. Nitrogen level in the soil was also increased by brown mustard treatment. Based on the dry biomass generated at the time of termination, plant-available nitrogen (PAN) was estimated to be in the order of SH>CP>SG>BM ranging from 30.1-123.8 lb N/ac. As expected, leguminous cover crops, sunn hemp, and cowpea contributed the highest PAN. Soil biological parameters did not show a significant difference at the time of cover crop termination. These observations might change after cover crop termination when organic matter is incorporated. In line with the goal, generating locally relevant data to guide growers make informed decisions is critical. Thus far, our preliminary findings on the benefits of cover crop are promising and will be an important reference for growers to use. Going forward, we are monitoring cover crop benefits after its termination and during subsequent okra growth.

Acknowledgments
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DRY SANITATION IN FRESH PRODUCE: COMMERCIAL APPLICATIONS AND CHEMICAL OPTIONS FOR ONIONS

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In the fresh produce industry, particularly for moisture-sensitive crops like onions, dry sanitation techniques have become increasingly important. This article focuses on commercially available dry sanitation methods, including chemical options, and their effectiveness in microbial inactivation.

Air-based cleaning systems, such as those produced by Key Technology and TOMRA, employ high-velocity air to remove food contaminants. These systems can reduce microbial loads on onion surfaces by 1-2 log CFU/g (García-Gimeno et al., 2018). Integrated mechanical brushing systems, offered by companies like Wyma Solutions and Eqraft, when combined with air cleaning resulted in microbial reductions of 1.5-2.5 log CFU/g for common pathogens (Patel et al., 2020).

UV-C light treatment systems, available from CleanLight and UV-Guard, can achieve up to 3 log reductions of microbial populations on onion surfaces with exposure times of 30 seconds to 2 minutes (Kim et al., 2019). Dry ice blasting equipment, such as that offered by Cold Jet, has demonstrated 2-3 log CFU/g reductions on various produce surfaces (Zhao et al., 2021).

Electrostatic spraying systems, like those from Electrostatic Spraying Systems (ESS), when used with appropriate dry sanitizers, have shown microbial reductions of up to 4 log CFU/g on onion surfaces (Li et al., 2022).

Chemical options for dry sanitation have also seen significant advancements. Commercially available dry sanitizers include:

1. Chlorine Dioxide Powders: Products like ICA TriNova's Selectrocide and Sabre's Vital Oxide can be applied as a dry powder or generated on-site. These have shown 3-4 log reductions in microbial populations on produce surfaces (Smith et al., 2021).
2. Peracetic Acid (PAA) Dry Formulations: Companies like Ecolab offer dry PAA formulations that can be applied electrostatically. These have demonstrated 2-3 log reductions in pathogens on onion surfaces (Johnson et al., 2022).

3. Quaternary Ammonium Compounds (QACs) in Dry Form: Products like Stepan Company's BTC 2125M can be applied as a dry powder. Studies have shown 2-4 log reductions in microbial loads on various produce surfaces (Brown et al., 2023).
4. Hydrogen Peroxide-Based Dry Sanitizers: Solvay's Proxitane AHC and Evonik's Peroxy Blend are examples of dry hydrogen peroxide formulations. These have shown efficacy in reducing microbial populations by 2-3 log CFU/g on onion surfaces (Garcia et al., 2022).
5. Essential Oil-Based Dry Sanitizers: Natural sanitizers like Biosafe Systems' SaniDate All-Purpose Dry Sanitizer, which contains a blend of essential oils, have demonstrated 1-2 log reductions in microbial populations (Lee et al., 2023).

When applying the above chemical options, it's crucial to use appropriate dispensing equipment. Companies like Birko Corporation and Spraying Systems Co. offer dry chemical dispensing systems designed for produce applications, ensuring controlled application of dry sanitizers. to monitor sanitation effectiveness,. Hygiena and 3M provide ATP testing systems that can quickly assess surface cleanliness without introducing moisture. While these dry sanitation methods are effective, it's important to note that they may not completely eliminate the need for wet cleaning in all scenarios. A study by Johnson et al. (2023) found that a strategic combination of dry and wet sanitation methods could achieve up to 5 log reductions in microbial populations on onion surfaces. The regulatory landscape continues to evolve regarding dry sanitation. The FDA has recognized the validity of certain dry sanitation methods in its guidance for the fresh produce industry, particularly for low-moisture products like onions (FDA, 2022). However, producers should always ensure if their chosen methods comply with the current food safety regulations.

In conclusion, commercially available dry sanitation technologies and chemical options offer effective solutions for maintaining the safety and quality of onions and other fresh produce. With microbial reduction capabilities ranging from 1 to 4 log CFU/g, sanitation technologies and chemical methods provide significant benefits in terms of food safety and product quality. As research continues and technologies advance, we can expect further improvements in dry sanitation efficacy, contributing to safer produce and reduced water usage in the food industry.

Industry Resources:

1. IFPA Virtual Town Hall – Dry Sanitation in the Fresh Produce Industry
2. CPS Funded Research - Cross-contamination risks in dry environments
3. CPS Funded Research - Survival of Listeria monocytogenes and Salmonella on surfaces found in the dry packinghouse environment and effectiveness of dry-cleaning processes on pathogen reduction
4. Rochester Midland Corporation - Where is Dry Sanitation appropriate or necessary?
5. Quality Assurance Magazine - Reducing Moisture to Increase Food Safety
6. Ecolab Webinar - Dry/Low Moisture Cleaning

SOILBORNE DISEASES IN GOLDEN DEW MELONS

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Description of the problem:

At the end of June 2024, some Golden Dew melons vines were observed in the Palo Verde Valley showing sudden wilt and death. Some samples were sent to the Swett Lab in the Department of Plant Pathology at UC Davis for proper identifications – **Charcoal rot** caused by ***Macrophomina phaseolina*** and **Fusarium crown and root rot** caused by ***Fusarium falciforme.***

Integrated Management Strategies to Keep in Mind

Macrophomina phaseolina and *Fusarium falciforme* are challenging to control with the available fungicides in California. To manage these diseases, consider the following:

- **Monitor for Infections**: Regularly monitor and manage infections during the vegetative growth stage.
- **Manage Plant Stress**: Carefully manage irrigation to prevent over- or under-watering and reduce soil salinity. While stress from fruit load and high temperatures is beyond control, effective irrigation management can mitigate some stress.
- **Remove Infected Tissue**: Destroy infected plant tissue before the pathogen can reproduce to prevent soil inoculum buildup.
- **Use Resistant Varieties**: Plant melon varieties resistant to the diseases or use grafted transplants with resistant rootstocks.
- **Prevent Cross-Contamination**: Steam or disinfect equipment after working in infested fields to prevent spreading pathogens. Avoid cross-contamination through workers' boots and tools by working from healthier to more diseased areas and disinfecting between them.
- **Consider Rotation**: Due to the pathogens' wide host range, crop rotation is generally impractical. If rotation is necessary, opt for at least 5 years out of host crops to lower soil inoculum.
- **Utilize Solarization**: In desert areas with high temperatures, solarization can help reduce the inoculum threshold and manage soil-borne pathogens. However, do not rely solely on this method.

References: UC IPM – Melon diseases

'FOREVER CHEMICALS' IN AGRICULTURAL PRODUCTION – CONCERNS WITH MUNICIPAL SLUDGE?

Michael D. Rethwisch, Field Crops Farm Advisor, UCCE Riverside County, Palo Verde Valley Office

Many of us have heard the term 'forever chemicals' being mentioned in the press. Just what are they, and should be concerned with them in agricultural setting in our part of the world?

Forever chemicals are often referenced by their chemical shorthand as PFAS, which is the acronym for **p**er**f**luoro**a**lkyl and **p**oly**f**lor**a**lkyl **s**ubstance class of chemistry. It is estimated that over 1,200 individual compounds exist, and they are used on a daily basis in over 13,000 items.

The United States Environmental Protection agency notes that "PFAs are a class of manufactured chemicals that have been widely used in many industrial and consumer products since the 1940s, and they are still being used today. PFAS have been or are currently being manufactured for a variety of different uses, ranging from adhesives, coatings for clothes and furniture, fire-fighting foam, and other uses. Scientific studies show that exposure to some PFAS in the environment is linked to harmful health effects in humans and animals". Other uses have included cleaning products, food packaging, cosmetics, non-stick cookware, dental floss, water-repellent clothing and stain resistance carpeting and clothing.

They are called forever chemicals because PFAS can last thousands of years and have resistance to disintegration (a characteristic noted due to their carbon-fluorine chemical bonds), even in treatment systems.

Due to the lack of elimination of PFAS in treatment systems, there is concern about using municipal sludge on agricultural fields, as thus results in PFAS in treated fields. While high temperatures in the low desert are high and can be used for solarization and sterilization of many things, these temperatures still don't reach the current required temperature of 752° degrees F to break down PFAS, thus PFAS are still expected to be present in fields that have had an application municipal sludge.

What does this mean in terms of crop production? Are resulting crops likely to contain PFAS?

PFAS in the environment can enter the food supply through plants and animals grown, raised, or processed in contaminated areas. It is also possible for very small amounts of PFAS to enter foods through food packaging, processing, and cookware. There are also some reports that indicate that a majority of crops near PFAS and component manufacturing plants test positive for PFAS, but this is thought due to the aerial contamination rather than absorbing the PFAS from the soil.

The Food and Drug Administration (FDA) has been testing a wide range of fresh and processed foods consistently since 2019 for PFAS, with nearly 1,300 samples of foods on the U.S. market tested. No PFAS were detected in over 97% (785 out of 810) of the fresh and processed foods tested from the TDS in data contained in one report. The majority of positive PFAS detections were in seafood.

Specific testing of produce specifically grown in fields treated with municipal sludge was not noted however, although over 400 samples were from foods grown, raised, or processed in known areas of contamination.

The FDA report also notes that the lack of positive PFAS results in foods may be due to several factors, including lack of PFAS uptake, lack of PFAS found in the growing and manufacturing environment, or the types of PFAS for which the FDA can currently test. In 2023 the FDA expanded their testing to include 30 types of PFAS, which was an expansion over the 20 during 2022 testing.

The FDA testing found that 19 of the positive samples were from seafood. Except for canned clams from China, none of the other PFAS exposures reported were at the levels likely to be a human health concern.

There is still much to be learned, and multiple studies involving PFAS, food, and human health are underway.

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Advances in Southwest Desert Agriculture Research, Organic Production, and Food Safety: A Research Symposium

September 19, 2024

AgWest Farm Credit, 485 Business Pkwy, Imperial, CA 92251

Registration link: https://surveys.ucanr.edu/survey.cfm?surveynumber=43407

8:30 a.m. – 11:55 a.m.

8:30 **Registration**

8:50 **Welcome & introductions – Oli G. Bachie**, *UCCE Imperial and County Director*

9:00 **Insect Pest Management in Low Desert Agriculture: A Beginner's Perspective – Arun Babu**, *Entomology Advisor, UCCE Imperial County*

9:15 **Weed management for early-stage seedling growth of guayule – Oli G. Bachie**, *Agronomy & Weed Management Advisor, UCCE Imperial, Riverside & San Diego Counties*

9:30 **Summer Cover Cropping and Composting Treatments in the Imperial Valley – Ali Montazar**, *Irrigation and Water Management Advisor, UCCE Imperial, Riverside & San Diego Counties*

9:45 **Summer Cover Crops for Managing Soilborne Disease, Nitrogen, and Soil Health in Coachella Valley – Philip Waisen**, *Vegetable Crops Advisor, UCCE Riverside and Imperial Counties*

10:00 **How effective are soil and plant sensing technologies to detect and monitor water stress in cantaloupe production? – Jairo N Diaz-Ramirez**, *Director of Desert Research and Extension Center, UC ANR*

Break (10 minutes)

10:25 **Preparing for Onion Diseases: Effective IPM Strategies - Ana Pastrana Leon**, *Plant Pathology Advisor, UCCE Imperial, Riverside & San Diego Counties*

10:40 **The nature and prediction of sugar beet cyst nematode suppressiveness in the Imperial Valley - J. Ole Becker**, *Dist. Prof. of Cooperative Extension in Nematology & Nematologist, Dept. of Nematology, UC Riverside*

10:55 **Growth performance and carcass characteristics of beef x dairy crossbred cattle in the feedlot - Brooke C. Latack**, *Livestock Advisor, UCCE Imperial, Riverside, and San Bernardino Counties*

11:10 **Overview of Food Safety Research from the Western Center for Food Safety, UC Davis - Michele Jay-Russell**, *Research Microbiologist, University of California, Davis*

11:25 **Investigating the occurrence of antibiotic-resistant bacteria in produce - Erin Leigh DiCaprio**, *Associate Professor of Cooperative Extension, Dept. of Food Science and Technology, UC Davis*

11:40 **Microbial Risk Assessment of Soil Amendments in Organic Romaine Lettuce, California's Low Desert, 2023 Season – Cuong (Jimmy) Nguyen**, *Food Safety and Organic Production Advisor, UCCE Imperial and Riverside Counties*

11:55 **Adjourn/Lunch**

For additional information on the workshop, please contact organizers Jimmy Nguyen, cgnguyen@ucanr.edu, Philip Waisen pwaisen@ucanr.edu, Ali Montazar amontazar@ucanr.edu or Oli Bachie, obachie@ucanr.edu or call us at (442) 265-7700

PENDING CEU CREDITS: CALIFORNIA DPR (1.25 hrs.) & Arizona Dept. of AG (.75 hr.)

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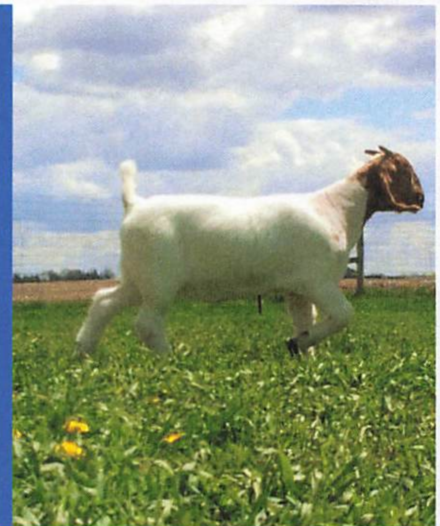
JOIN UCCE IMPERIAL COUNTY FOR A

SOUTHERN CALIFORNIA SMALL RUMINANT FAMACHA WORKSHOP



Are you concerned about the management of internal parasites in your small ruminant herd? Are you concerned about dewormers not working like they used to? Join us for a workshop on FAMACHA and internal parasite management for sheep and goats.

Dr. Rosie Busch, Sheep and Goat Herd Health and Production Specialist at UC Davis, will cover internal parasites of small ruminants, teach hands on FAMACHA techniques, and offer FAMACHA certification.

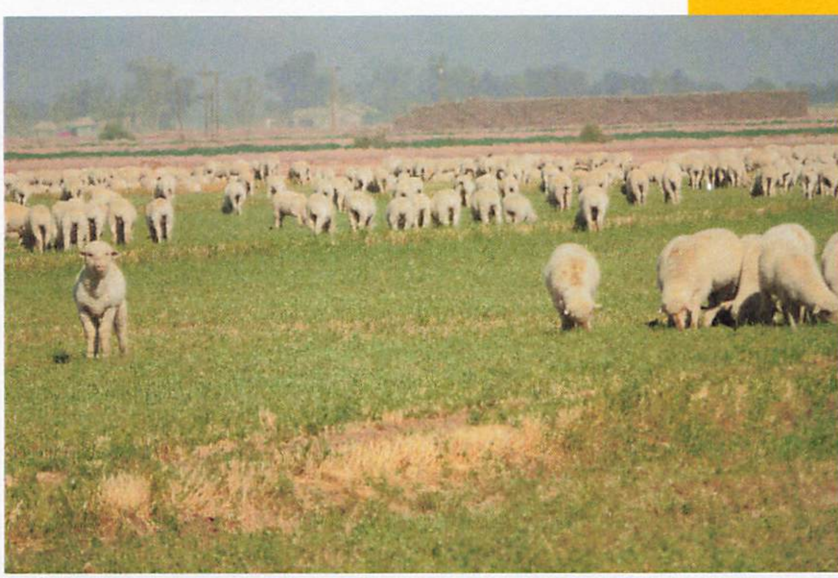
DATE, TIME, & PLACE:

NOVEMBER 15

6-8 PM

Imperial High school
517 W Barioni blvd
Imperial, CA 92251

Free unless you want FAMACHA certification. For those who want certification, the cost is $15/person



Please register at

https://ucanr.edu/socalfamacha

Questions? Reach out to Brooke Latack at 269-313-2579 or bclatack@ucanr.edu

Accommodation requests related to a disability should be made by November 1, 2024 to Brooke Latack (269-313-2579 or bclatack@ucanr.edu).

IMPERIAL VALLEY CIMIS REPORT AND UC WATER MANAGEMENT RESOURCES

Ali Montazar, Irrigation & Water Mgmt Advisor, UCCE Imperial & Riverside County

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 is 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 including Calipatria (CIMIS #41), Seeley (CIMIS #68), and Meloland (CIMIS #87). Data from the CIMIS network are available at: http://www.cimis.water.ca.gov. Estimates of the average daily ET_o for the period of September 1 to November 30 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 inches per day

Station	September		October		November	
	1-15	16-30	1-15	16-31	1-15	16-30
Calipatria	0.26	0.23	0.21	0.18	0.13	0.11
El Centro (Seeley)	0.26	0.25	0.22	0.18	0.14	0.12
Holtville (Meloland)	0.26	0.24	0.20	0.16	0.13	0.11

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/.