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BEST WATER AND NITROGEN MANAGEMENT PRACTICES IN DRIP-IRRIGATED DESERT LETTUCE

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Introduction. A significant proportion of the U.S. winter lettuce supply is produced in California's low desert, especially the Imperial and Coachella Valleys. Lettuce is the leading winter leafy green vegetable crop in the region, growing nearly 45,000 acres with gross sales of nearly $465 million per year. Effective irrigation and nitrogen (N) management are crucial for maximizing both the yield and quality of lettuce. In response to increasing water quality regulations, water conservation demands, rising fertilizer prices, and the challenges of defining site-specific irrigation and N optimization strategies due to varying practices and conditions in desert lettuce production, local growers are continually seeking new tools and practices to enhance resource use efficiency and improve crop productivity.

Growers employ diverse irrigation and fertilization strategies using various applications and delivery techniques in desert lettuce. Some common practices are 40-in-wide beds in iceberg and romaine lettuce under furrow irrigation, 80-in-wide beds in iceberg and romaine lettuce under drip irrigation (three driplines per bed with six plant rows) or sprinkler irrigation, 40-in-wide beds in iceberg and romaine lettuce under drip irrigation (one dripline with two plant rows), 80-in-wide beds in leaf lettuce under sprinkler irrigation, and germinating fields using both sprinkler and drip irrigation. The overall purpose of this study was to develop detailed information on N and water requirements and best management practices for lettuce grown under drip irrigation, a promising irrigation technique primarily used in romaine and iceberg lettuce production systems in the region.

Field experiments. The field experiments were conducted at the University of California Desert Research and Extension (DREC) Center over three cropping seasons. In the first two seasons (2022-23 and 2023-24), iceberg lettuce was grown, and in the final season (2024-25), romaine lettuce, all on 80-in-wide raised beds with six crop rows and three drip lines per bed (Figure 1). The field lie fallow during the summer of 2022, while Sudangrass was grown as a cover crop and incorporated into the soil in the summers of 2023 and 2024. The soil is sandy clay loam with 70.1% sand, 9.7% silt, and 20.2% clay in the top 30 cm; an average pH of 8.2, an organic matter content of 0.90%, and an average bulk density of 1,754 kg m^{-3}. Monoammonium phosphate was broadcasted as a preplant N fertilizer at a rate of 300 lbs. ac^{-1} before bed shaping over the entire trial area in each season. Urea Ammonium Nitrate (UAN-32) was injected into the drip system after the plant establishment phase to supply the remainder of the N for each N treatment.

Three N fertilizer scenarios of (1) 100% of the N amount recommended by the CropManage decision support tool (CM) (N2), (2) approximately 80% N2 (N1), and (3) approximately 120% N2 (N3) were assessed under two irrigation regimes:100% crop ET (I1) and 125% (I2) crop evapotranspiration (ET). CropManage (https://cropmanage.ucanr.edu) is an irrigation and nitrogen decision tool developed to help growers in making daily decisions on fertilization and irrigation on a field-by-field basis [3,4]. CropManage was used to determine 100% crop ET (I1). In each trial, irrigation strategy (as the primary factor) and N management (as the secondary factor) were evaluated in a randomized complete block design with a split-plot arrangement and four replications.

Comprehensive yield quality evaluation was conducted at harvest, including plant population, head weight, biomass, and marketable yield. Canopy cover images were collected using an infrared digital camera, modified to take NDVI photographs on a weekly basis beginning at 25 days after planting (DAP) to quantify crop canopy coverage over the crop season. Canopy coverage data was used as input for the CM to verify and, if necessary, adjust the canopy coverage curve developed. In addition, nitrate-N (NO_3-N) data from laboratory analyses and the Soil Nitrogen Quick Test (SNQT) in early and within the season were incorporated into the CM to improve the accuracy of N recommendations.

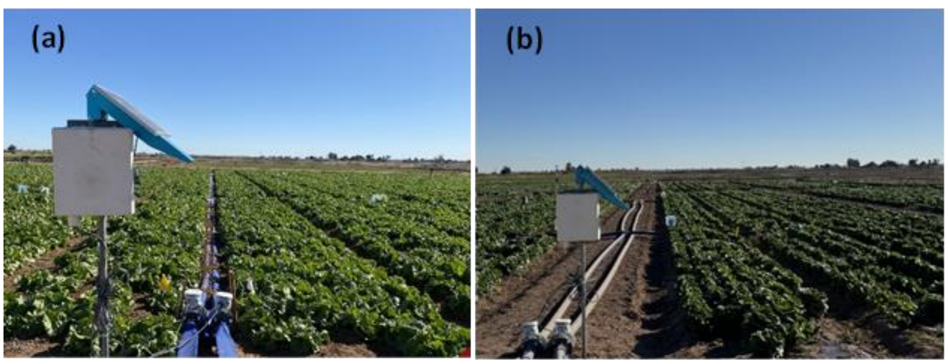

Figure 1. A demonstration of trials in the 2023-24 season (a), iceberg lettuce, and the 2024-25 season (b), romaine lettuce. The water applied was measured using magnetic flowmeters attached to a datalogger. The data on water applied was automatically imported and analyzed by the CM tool.

Biomass marketable and dry matter yields at harvest, and N uptake values were statistically compared using a generalized linear mixed model (GLMM) implemented via the GLIMMIX procedure in SAS 9.4 (maintenance release M9) for the replicated trials. Multiple means comparisons were performed using Tukey's HSD test when main effects were found to be significantly different at the $p < 0.05$ level.

Water and N applied. Total applied water across treatments ranged from 9.1-11.3 inches in the 2022-23 season, 7.8-10.0 inches (plus 1.0 in. rainfall) in the 2023-24 season, and 9.6 -12.0 inches in the 2024-25 season. These values include the total water applied during plant establishment and post-establishment, while excluding the water applied for leaching salts in summer, a common practice to sustain soil productivity and control salinity in the desert cropping systems. The N application rates within the season ranged from 90-134 lbs. ac^{-1}, 88-128 lbs. ac^{-1}, and 86-130 lbs. ac^{-1} during the respective seasons, respectively.

Effects of irrigation and nitrogen management on yields. The statistical analysis suggested insignificant impacts of applied water, N application rates, and interaction between irrigation and nitrogen rates on fresh biomass yields (p values ≥ 0.075 in the study seasons) (Figures 2a-c). This confirms that applying additional water in the 125% ET treatment (I2), as well as increasing or decreasing N application rates by 20% (N3 and N1) relative to CM-recommended level, did not enhance crop growth or yield. The mean biomass yield ranged from 31.2 t ac^{-1} (treatment I1N1 in the 2022–23 season) to 36.6 t ac^{-1} (treatment I2N1 in the 2024–25 season) across treatments and seasons.

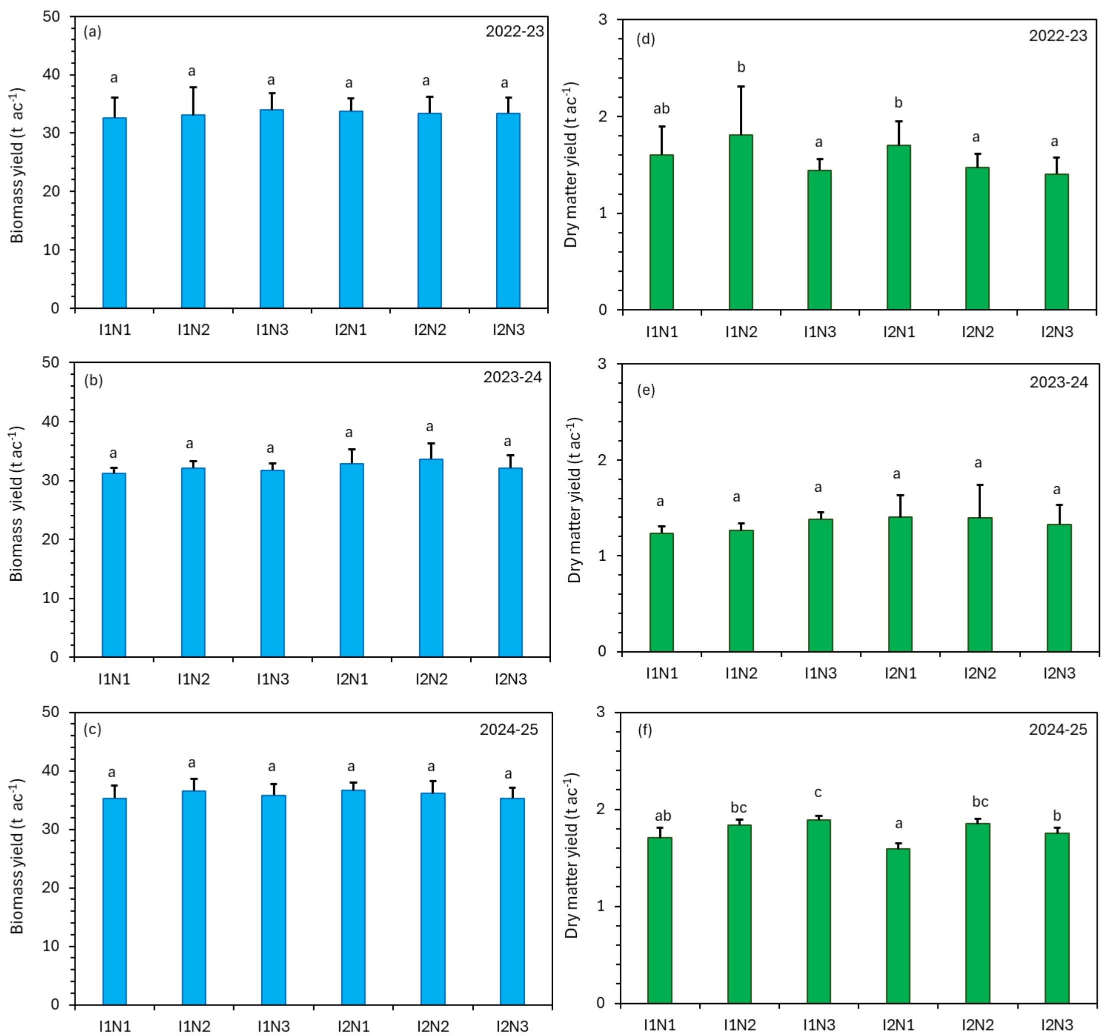

Figure 2. Mean fresh biomass and dry matter biomass yields across treatments over the study seasons. Means followed by different letters in the bars differ from each other by Tukey's HSD test at 0.05 significance level. Error bars represent standard deviations of treatment means.

No consistent statistical effects of irrigation and N applications were found on dry biomass yield across different trials and years (Figures 2d-f). For instance, insignificant impacts from irrigation treatment and N application rates were obtained on dry biomass yield in the 2023-24 trials (p values ≥ 0.054). However, the effects of both irrigation strategy and N application scenario were statistically significant in the 2024-25 trial (p values ≤ 0.022).

Effects of irrigation and nitrogen management on N uptake. The results showed that nitrogen application rates had a significant effect on N uptake at harvest across all three seasons ($p < 0.05$) (Table 1). Irrigation strategy also had a significant effect in the 2023–24 and 2024–25 seasons ($p < 0.05$), however, the interaction between nitrogen application rate and irrigation strategy was not significant across treatments over the seasons. The findings illustrated a relatively wide range of N accumulated in lettuce plants, varying from 97 lbs. ac^{-1}, treatment I1N1 in the 2023–24 season, to 139 lbs. ac^{-1}, treatment I1N3 in the 2024–25 season.

Table 1. Mean N uptake (lbs. ac^{-1}) across the treatments over the study seasons. Means with different letters in the same column are statistically different from each other by Tukey's HSD test at 0.05 significance level. A summary of p-values from ANOVA for effects of I, N, and I×N is presented.

Treatment	2022-23	2023-24	2024-25
I1N1	112a	97a	108a
I1N2	130b	110b	122b
I1N3	118a	122b	139c
I2N1	113a	110b	114a
I2N2	117a	119b	132c
I2N3	126b	133c	134c
	p values of significance test		
Irrigation (I)	0.712	0.0002	0.022
Nitrogen (N)	0.047	<0.0001	<0.0001
I × N	0.057	0.738	0.006

Regardless of the variations in N application rates, the results suggested that nitrate-N concentrations were maintained above the threshold of 20 ppm in the top 1 foot of soil during the cropping season, implying minimal risk of N deficiency within the season when N is applied within 80-120% of the N amount recommended by the CropManage decision support tool. Minimizing soil residual N in lettuce fields at harvest is crucial to limit nitrate losses due to summer leaching in the desert region.

Conclusions. Effective irrigation and nitrogen management are crucial for maximizing lettuce yield while minimizing environmental impact, particularly in response to increasing water quality regulations and water conservation demands in California's low desert. Drip irrigation has the potential to improve yield productivity in lettuce fields due to increase plant population and more effective use of water and nutrient resources. However, an integrated optimal N and water management in lettuce is essential to enhance resource-use efficiency, allowing for lower fertilizer application rates that support both profitability and environmental sustainability. Predominant soil types generally range from silty loam to silty clay loam in the desert lettuce production systems. These soils are suitable for implementing 80-in-wide beds with three driplines, suggesting that this configuration could be a promising technique for desert to improve yield productivity and operational efficiency. However, growers may express concerns regarding the suitability of this practice for fine sandy soil textures and find the 40-in-wide bed configuration as a more feasible practice.

Higher N rates than the rates proposed in this study are likely necessary in over-irrigated lettuce fields, particularly in fields with low residual nitrate content from the past season and predominantly sandy soil texture. This study provides more accurate estimates of N uptake, supporting the optimization of in-season split N fertilizer applications in drip-irrigated desert lettuce. In conclusion, the integration of the CropManage decision support tool and the SNQT with the findings of this study offers regional growers a practical framework for enhancing operational efficiency, maximizing economic returns, and complying with the requirements of regulatory programs.

Acknowledgement. Funding for this study was provided by the California Department of Food and Agriculture (CDFA) – Fertilizer Research and Education Program (FREP). The authors would like to thank Tayebeh Hosseini and several student interns from Imperial Valley College for their assistance with fieldwork-related tasks during the study. Appreciation is also extended to DREC staff for providing the necessary support and resources to conduct the trials.

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AUGUST WEATHER-INDUCED DISEASE-LIKE SYMPTOMS IN COTTON: BOLL ROT, LEAF SPOTS, AND BRONZING

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This August weather, with periods of excessive heat followed by high humidity and rain, has created conditions that favor several problems in cotton. After the period of excessive heat at the beginning of August, we observed some bronze wilt on the leaves. At the end of August, following the rainstorm and high humidity, we observed leaf spots and boll rots.

Boll rot - Cotton bolls were rotting, and in many cases, we saw white, gray, brown, or black fungal growth on their surface (Figure 1). The boll rot was most noticeable in the lower and middle parts of the plants, where bolls are closer to the soil and more shaded by the canopy. These areas tend to stay wetter longer after rain or irrigation, creating favorable conditions for rot. The condition in this case is not caused by a single organism but rather by many saprophytic (non-pathogenic) fungi and, in some cases, bacteria. Infected bolls may open early, fail to open, or drop off the plant. Wet weather, humid conditions, and dense plant canopies greatly increase the risk, and heavy insect damage also creates entry points for infection.

Figure 1: Cotton boll rots

The disease is very difficult to manage with fungicides, which usually do not provide effective control. Instead, management depends on cultural practices. Keeping the crop from getting too “rank” is key, since dense, leafy plants trap moisture around the bolls. Using nitrogen in balance and applying plant growth regulators when needed can help keep the canopy more open, allowing better air flow and sunlight, which makes conditions less favorable for boll rot. For future plantings, improving air flow in the canopy can help reduce boll rot. This can be achieved with wider row spacing or skip-row planting. Keeping fields free of weeds and controlling insect damage also helps reduce infection.

We are also observing **leaf spots** caused by opportunistic fungi such as *Alternaria*, *Cercospora*, or *Stemphylium* (Figure 2). These are being observed mainly in the upper canopy as brown or gray spots with purple to maroon margins. While these fungi are present, the real driver of this problem is usually nutrient stress inside the plant, particularly potassium deficiency, which weakens the tissue and allows these fungi to colonize. The issue can become more noticeable when early maturing varieties carry heavy fruit loads and nutrients are directed to boll production instead of the leaves. Fungicides are not very effective in this case. The best approach is to address the underlying nutrient deficiency and support balanced plant growth.

Figure 2. Cotton leaf spots

Finally, we saw bronze leaves following the very hot days at the beginning of August (Figure 3). Bronze discoloration and wilting of leaves in the upper canopy were observed during boll development. This condition, sometimes described as "bronze wilt," has been reported since the 1990s but is not caused by a pathogen. Instead, it is associated with environmental stress such as high heat and drought, followed by heavy irrigation, and possible nutrient imbalances. While the bronzing can look alarming, no crop protection products are needed because it is not caused by a disease. Damaged leaves will not recover, but if the environmental stresses ease, new leaves should develop normally, and no further bronzing will occur.

Figure 3. Cotton leaves exhibiting bronzing

In summary, management of these conditions should therefore focus on cultural practices, nutrition, and insect control, as fungicides and other crop protection products provide little benefit in these cases.

SURVEY IDENTIFIED ELEVATED BERMUDAGRASS STEM MAGGOT ADULT PRESENCE AND DAMAGE IN BERMUDAGRASS FIELDS IN THE IMPERIAL VALLEY

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Introduction. During the first week of August, while reviewing the yellow sticky traps for the area-wide pest monitoring program, I noticed that one of the sticky cards was covered with flies of the Bermudagrass stem maggot (BSM; *Atherigona reversura* Villeneuve). While it is not unusual to find a couple of BSM flies in the yellow sticky cards during this time of the year, this specific yellow sticky card had 498 adult BSM, equal to 71 BSM flies/day. This triggered an alarm, and I decided to survey the Imperial Valley to identify the BSM population levels in the Bermudagrass fields. Our survey identified significant BSM adult activity and damage symptoms in many of the surveyed fields across the Imperial Valley. Thus, this article aims to refresh growers, PCAs, and stakeholders by reviewing the biology of the pest, its damage symptoms, monitoring methods, and management options, followed by a discussion of recent survey findings. Keep in mind that much of the current information we have, including economic thresholds and pest management techniques, is based on research conducted in the Southeastern United States and may not fully align with our growing system in the low desert conditions.

Bermudagrass stem maggot origin. The Bermudagrass stem maggot is native to Southeast Asia and was first reported in the continental United States in 2009 in California (Holderbaum 2009). The pest subsequently spreads into many of the Southeastern states and is a significant concern for Bermudagrass production in these states. Infestation was confirmed in the Palo Verde Valley of Riverside County in 2018 (Rethwisch 2018) and subsequently in Imperial County in 2019.

Pest Description and Biology. The adult BSM fly is small (~ 3-3.5 mm in length) with a distinct orange-yellowish tone in the abdomen (Fig. 1A & B). The fly has a grey thorax when viewed from the top and four dark spots in the upper part of the abdomen towards the posterior end (Fig. 1B). Maggots feed inside the Bermudagrass stem and are yellowish white with a tapered mouth (Fig. 1D).

Female flies lay eggs on the leaves of plants. The eggs hatch within 2-3 days, and the maggots emerge, chewing a small hole near the tip of the pseudostem above the topmost node to tunnel into the pseudostem. Feeding inside the pseudostem causes the maceration of the vascular tissues, followed by the decay of the damaged part. The maggot feeds inside for seven to ten days and exits the pseudostem and drops to the soil for pupation. The pupation lasts seven to ten days. Adult flies live for up to 14-20 days under laboratory conditions (Baxter et al. 2024). Altogether, this pest can complete its life cycle in about three weeks, allowing for multiple overlapping generations to occur within a year. In the United States, they have been known to damage only the *Cynodon* spp., including Bermudagrass and stargrass (Baxter et al. 2024).

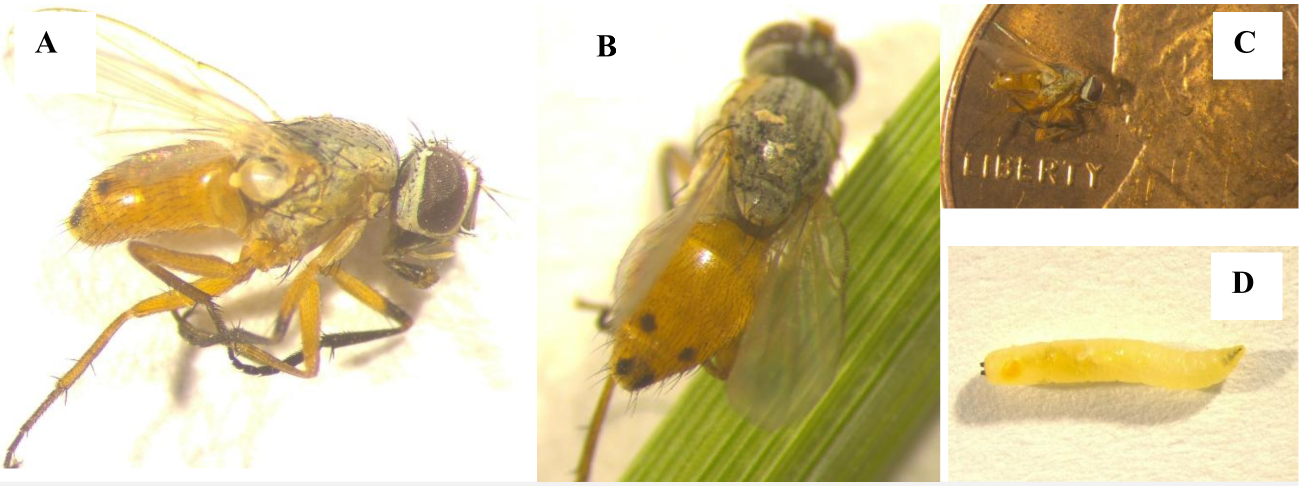

Fig. 1. A) Bermudagrass stem maggot adult: side view, B) BSM adult: dorsal view, notice the grey thorax and orangish-yellow colored abdomen with four dark spots in the posterior end, C) adult fly on a US penny for size comparison, and D) BSM larvae

Damage. The BSM-infested field shows characteristic "bronzing' resulting from the chlorosis of the top two or three leaves (Fig. 2A-C). For an unsuspecting scout, this damage might be mistaken for that of severe drought, frost, or even flea beetle damage when viewed from a distance. The maggot feeding on sap inside the pseudostem cuts the vascular tissue, blocking the water and nutrient flow above the feeding area, which leads to damage (Fig. 2C & D). Since the maggot feeding is restricted to above the topmost node where the new leaves emerge, only 2-3 newest leaves are affected by the feeding and show chlorosis. Chlorosis typically begins to appear one to three days after the initiation of damage (Hancock et al. 2014). The plants' tops, showing chlorosis if gently pulled, will easily get dislodged from the leaf sheath (Fig. 2E). The damage to the growing point prevents further development of the shoot, but the plant might produce sideshoots for compensation. If the infestation is left unmanaged, up to 80% of tillers in the fields can potentially be affected, leading to yield loss, and the side shoots produced by the plants also might be damaged by the subsequent BSM generation. In fields, damage may be more severe in field margins, irrigation ridges, and other areas where plants are often left unharvested.

Monitoring and Economic Threshold. Adult flies can be detected by taking sweep net samples from the field. Since flies spend most of their time low in the plant canopy, when collecting sweep net samples, ensure that the sweep net is driven into the canopy to reach the flies for efficient sampling. The flies are more active during the early morning hours; thus, sampling from morning hours until early noon is ideal

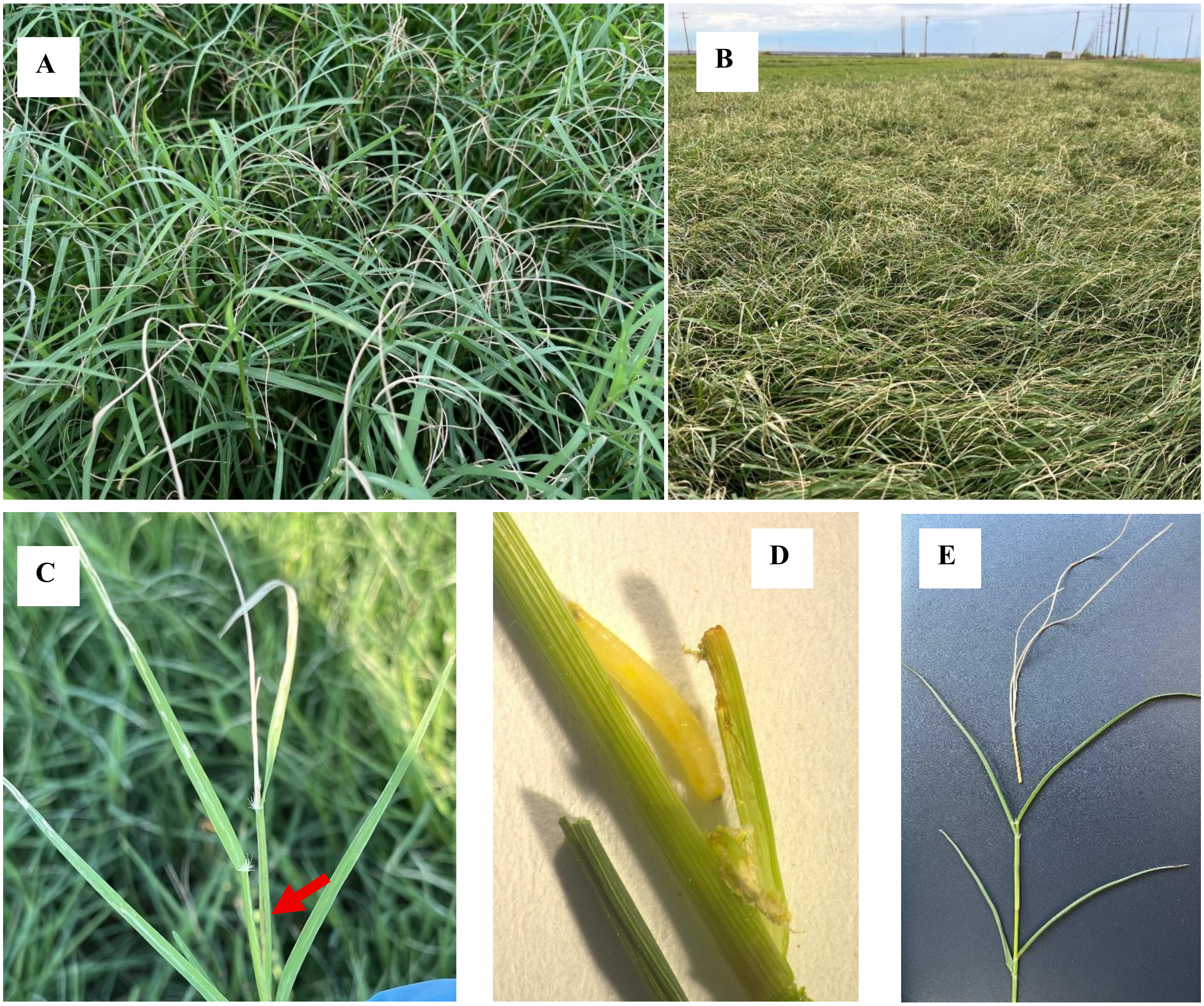

Fig. 2. A) Bermudagrass stem maggot damage symptoms in the field indicated by the plants with chlorotic tops, where chlorosis is restricted to the top one to three leaves. B) A severely BSM damaged field near Niland, CA C) Bermudagrass shoot with damage symptoms. The red arrow indicates the larval feeding site, D) BSM larvae exposed from their feeding site located inside the shoot, and E) The BSM-damaged plant tip can be easily pulled from the leaf sheath

for increasing their capture rate. Sample at least 2-3 locations within a field. While it is possible to detect flies directly in the sweep net, since they are relatively small (3-3.5 mm length), and active (one of the first insects that fly out of the sweep net if provided a chance), transferring the sweep net contents into a transparent ZipLock plastic bag for counting the flies is recommended. Counting the live flies through the plastic likely underestimates their number. Therefore, freezing the sample for 5-10 minutes and counting flies by examining the sample content using a handheld magnifying lens provides a more accurate estimate when precise counts are required. Followed by the sweep net sample collection, scout for the damage symptoms in the fields (Fig. 2A-C). The damage is often more prevalent in the less mowed parts of the fields, including the uncut patches around the field perimeters (Fig. 3), on irrigation ridges, or in certain portions of the field.

Additionally, yellow sticky traps can be deployed in the fields to detect adult activity. Since the flies tend to spend most of their time inside the plant canopy and rarely fly higher than 18 inches (Baxter et al. 2017), placing the sticky traps in the field 8 inches from the ground level (ideally) or just above the plant canopy level (for practical reasons) is recommended. The adult counts from the yellow sticky traps are less reliable for estimating the actual adult population in the field or the damage potential. However, the use of sticky traps can help detect adult activity in the field early in the season, acting as an early warning.

Fig. 3. An uncut residual area of the field with higher bermudagrass stem maggot damage symptoms than the rest of the field

Unfortunately, no economic threshold has been established for the BSM control in the Imperial Valley Bermudagrass production context. Researchers from the southeastern United States established a nominal economic threshold of 20 adults per 20 sweeps (i.e., one adult per sweep, where a sweep refers to a single swing of the net) or when 20-30 percent or more of the shoots show damage symptoms. (Baxter et al. 2024). These nominal thresholds were established for hay production in the Southeastern United States context and thus need to be validated in our production system. A more conservative threshold is likely necessary for our seed production system to prevent economic losses.

Management: In the Imperial Valley, BSM damage is more prevalent from late summer to fall. Scout the fields frequently for BSM at least from mid-June to late October. When the adult population or damage exceeds the economic threshold, strategically timed pyrethroid applications can reduce the adult BSM population and yield loss (Baxter et al. 2024). Two sets of pyrethroid applications are recommended in a harvesting cycle: the first set is applied 7-10 days after hay harvest, followed by a second application 7-10 days after the first. Since pyrethroids are not systemic insecticides, only adult BSM can be suppressed by their application. The first round of application, scheduled 7- 10 days after harvest, targets the adults that emerge from the pupae in the soil, as well as the adult flies that move into the field from neighboring fields. Any larvae developing inside the pseudostem, as well as pupae present in the soil, during the first round of application, will not be managed by pyrethroids. Thus, it is important to have a strategically timed second round of applications, 7-10 days after the initial application, targeting the adults that emerged from the larvae and pupae left unaffected during the first application (Baxter et al. 2024). Timing the insecticide application for early morning when the flies are most active. Strategies that improve insecticide reaching the lower canopy, where BSM adult flies spend most of their time, including lowering the boom height and increasing the water volume (a minimum of 12-15 gallons per acre), are recommended. With no efficacy data available for the BSM in Bermudagrass from the low-desert condition, the consistency and performance of pyrethroid treatments, which are known to break down under intense heat and solar radiation during the summer months, remain unknown.

Cultural control, including regular harvesting that removes developing larvae from the fields, is an IPM strategy to minimize the BSM population growth in the field. The variety is known to influence the severity of BSM damage and yield. The research from the state of Georgia indicates that the stargrass, *Cynodon nlemfuensis* Vanderyst, cultivars and their hybrids (stargrass, Tifton 68, Tifton 85, and Coastcross-II) had a lower percentage of their tillers damaged by the BSM than the fine-textured cultivars tested (Common, Coastal, Alicia) (Baxter et al. 2015).

BSM survey across the Imperial Valley: Following the detection of high BSM adult activity across the Imperial Valley through the yellow sticky traps deployed for the area-wide pest monitoring program in early August, a survey was conducted from August 13 to 27, 2025. Fields were selected randomly by travelling across the Imperial Valley. Both the BSM adult population and plant damage symptoms were quantified from 60 bermudagrass production fields across the Imperial Valley. From each field, BSM adults were sampled using sweep net at two separate sampling locations by two personnel, with 20 sweeps conducted per location. Additionally, from each sampling location within a field, the damaged pseudostem counts were taken from a 1-square-foot area.

To understand the relationship between the BSM adult counts in the sweep net sample and the number of shoots damaged by the BGM infestation, a simple linear regression was performed, and BSM adult counts were plotted against the number of shoots damaged by BSM using GraphPad Prism 6 software (GraphPad Software Inc., San Diego, CA).

Based on the physical appearance of the plant stand, color, and soil condition, the sampled fields were classified as either irrigated or non-irrigated fields. This was possible because irrigation is the primary source of water in these fields under low-desert conditions, where rainfall is scarce. Differences in BGM adult counts in these fields were then compared using the non-parametric Mann-Whitney test ($P = 0.05$).

Since sweep samples for quantifying BSM adults were collected from the two subsamples (sample location) within each field by two separate personnel, the adult counts estimated by two scouts were compared to determine if the sample estimate was influenced by the scout who sampled the fields. Sample means were compared using the two-tailed Wilcoxon matched-pairs rank test (P = 0.05). Additionally, the absolute difference in insect counts between the samples within each field was calculated, and a frequency distribution was charted.

Pest distribution. The survey detected significant BSM adults' presence (Fig. 4A) as well as damage symptoms (Fig. 4B) throughout the Imperial Valley Bermudagrass production area. Out of the 60 fields, the Bermudagrass stem maggot adult counts in these fields range from 0-91 flies/20 sweeps with an average of 10.9 ± 2.5 flies per 20 sweeps (mean ± SEM). BSM damage symptoms ranged from 0-271 damaged shoots/ sq. ft area with a mean value of 12.4 ± 4.8 damaged shoots/ sq. ft. From this data, it is evident that adult flies are active across the Imperial Valley and are present in relatively large populations in some fields, exceeding the nominal economic threshold set by researchers in the southeastern US. The population is likely to continue increasing in the valley over the coming months.

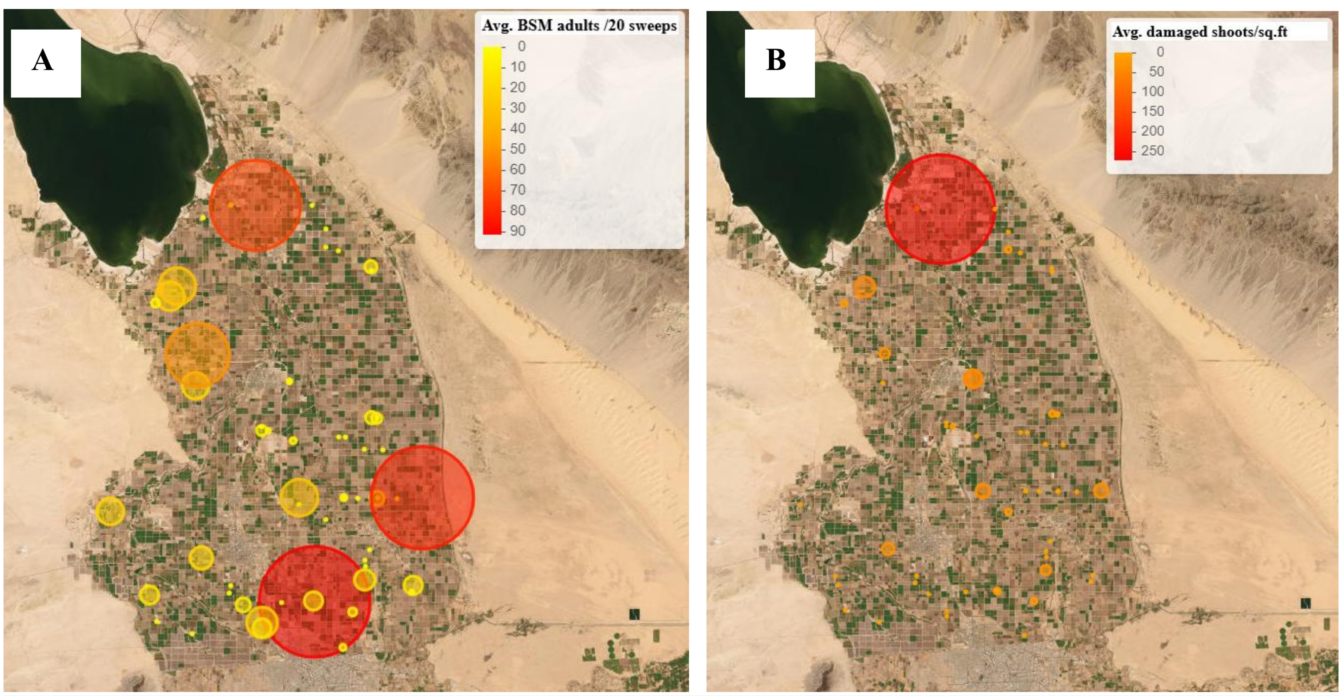

Fig. 4. A) Avg. BSM adults in Bermudagrass fields per 20 sweeps, and B) Average counts of BSM damaged shoots per one sq. ft area. A larger circle in the map indicates higher counts. The circles' diameters in the map representing the magnitude of the data are not equally scaled between the two figures.

Do scouts differ in their sampling efficacy? During the survey, each of the 60 fields was sampled by two different scouts. Comparing the overall mean BSM adult capture among the two scouts indicates no significant difference in the mean BSM adult capture between the scouts (Fig. 5A). This suggests that when using the sweep net with basic training, BSM adults can be scouted with minimal human sampling errors that influence the capture rate.

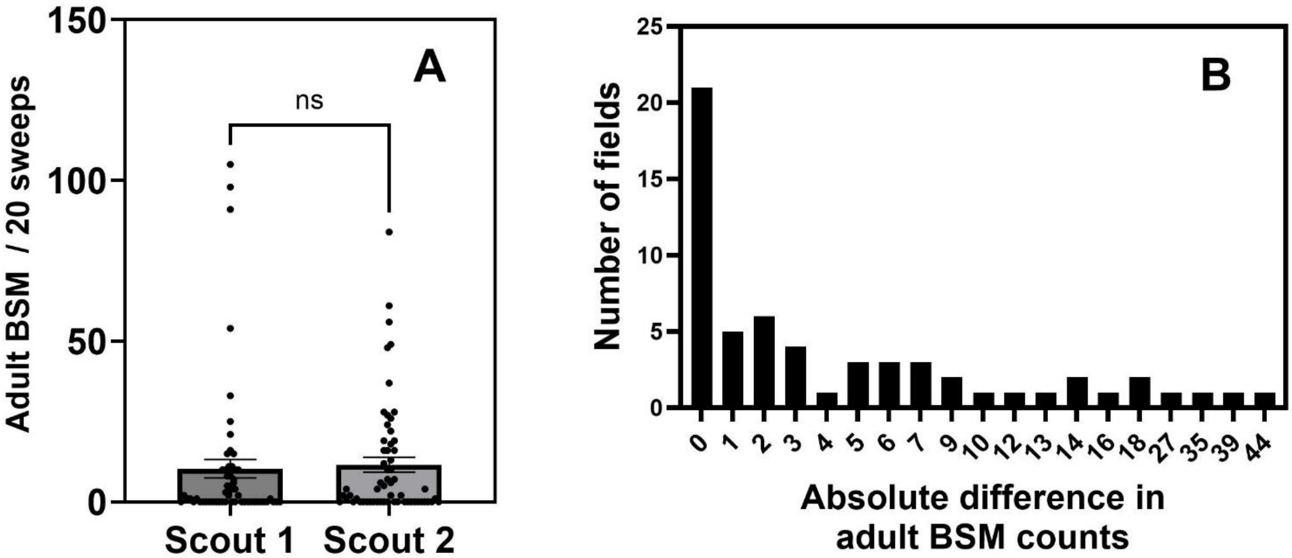

Fig. 5 A) Avg. BSM adults captured using sweep net sampling by two scouts; both sampled the same 60 fields across the Imperial Valley, but from two separate locations within a field, and B) Frequency distribution of absolute difference in adult BSM counts between the two sampling locations in various fields.

Does location within the field affect the adult BSM count in sweep net sampling? Absolute difference in adult BSM counts between two sampling locations within each field was calculated, and the frequency distribution of this difference in counts was plotted (Fig. 5B). Out of 60 fields sampled, 21 fields had no difference in the BSM counts among the sample locations. However, many of these fields were likely under the Deficit Irrigation Program, with poor plant growth, and recorded a zero adult capture. Fourteen fields had a difference of 5 BSM adults or more between the samples collected from the same field (range 5-44). This suggests that when taking the sweep net samples, the BGM adult counts can be influenced by the sampling location chosen within the fields. Therefore, ideally, multiple locations, a minimum of 2-3 locations within a field, should be sampled to reduce sampling error.

Do BGM adult counts in the sweep net sample predict the number of pseudostems with damage symptoms? While the number of adult BGM in the sweep net sample had a significant positive relationship with the number of BGM-damaged pseudostems observed in that field, the relationship is relatively weak (Fig. 6, R^2 =0.28). This is not surprising, as several factors can influence the observed BSM number in the field at any given time, affecting the timeline of damage symptoms' appearance. For example, a recent insecticide application to fields can result in a sudden decline in adult BGM counts due to adult mortality, but the fields retain the damage symptoms from the infestation, creating a mismatch between the BSM adult count and the extent of damage symptoms. On the contrary, a regrowth of a recently harvested field might have low damage symptoms visible (yet). But it may harbor a high adult BGM population in the field that emerged from the pupae of the previous generation. Additionally, field operations such as harvesting can facilitate the movement of BGM adults between fields. Thus, it is essential to continue monitoring the BGM adult population in the field, even if the field shows little to no damage symptoms.

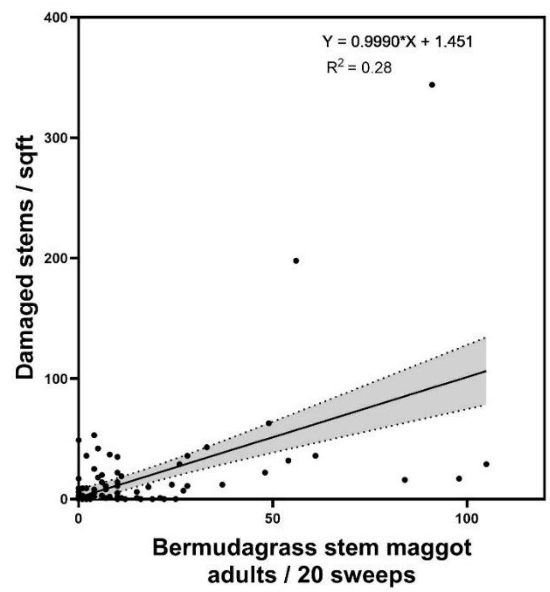

Fig. 6. Relationship between sweep net BSM adult count and the prevalence of damage symptoms

Does BGM population pressure differ between irrigated (actively growing) and restricted-irrigated fields? Out of the 60 fields sampled, 17 fields (28.3%) had sparse, grey patches of dry/semidry grass growing on dry, often cracked soil, indicating prolonged withholding of irrigation beyond the usual schedule. These fields could be under the Deficit Irrigation Program, a water conservation grant program implemented by the Imperial Irrigation District (IID 2025). Results from this study suggest that under Imperial Valley growing conditions, adult BGM was significantly more active in actively growing fields compared to fields under deferred irrigation or in the deficit irrigation program (Irrigated: 13.53 ± 3.9 and non-irrigated: 2.1 ± 5.4 BSM per 20 sweeps, Fig. 7A). Similarly, BGM damage symptoms were also more prevalent in the irrigated fields (Irrigated: 13.53 ± 3.9 and non-irrigated: 2.1 ± 5.4 damaged stems /one sq. ft, Fig. 7B). However, please note that the field classification to irrigated or non-irrigated was arbitrarily based on the physical appearance of the fields and plant growth characteristics associated with water stress rather than the actual irrigation data. In addition to irrigation, non-irrigated fields may differ from irrigated fields in terms of other management practices, including fertilizer application and crop protection measures.

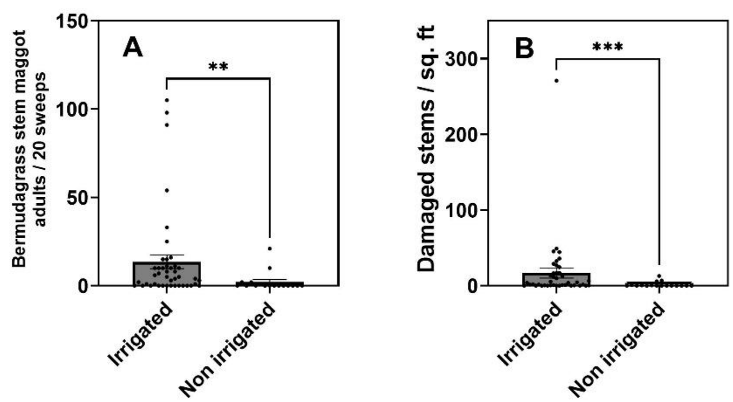

Fig. 7. Influence of field management status on the adult BSM population and damage symptoms in the Bermudagrass production fields.

Conclusion. The Bermudagrass stem maggot infestation is prevalent in the Imperial Valley. While only a small portion of the Bermudagrass fields is currently above the economic threshold, it is essential to continue monitoring the adult population in the Bermudagrass production fields over the next few months to make informed management decisions and prevent potential economic damage.

Acknowledgements. The author thanks Gustavo Gamboa Paredes for technical assistance and Frank Miranda and Steven Finnell for helpful suggestions.

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AREA-WIDE MONITORING OF KEY INSECT PESTS ACROSS THE IMPERIAL VALLEY: SEPTEMBER 2025 UPDATES

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This article is intended to provide growers, PCAs, and other stakeholders with information on the adult pest activity of whiteflies, aphid complex, western flower thrips, and flea beetles across the Imperial Valley. The data were collected using a yellow sticky trap network maintained by the UCCE Entomology program. The yellow sticky traps set up in each site consist of a 6 × 12 in (15.2 × 30.5 cm) sticky trap (Olson Products, Medina, OH), shaped into a cylinder, attached to a wooden stake using a binder clip, and positioned about 60 cm above the ground (Fig. 1A and 1B). The traps are distributed throughout the Imperial Valley in major agricultural areas (Fig. 1C). Insects that are attracted to the yellow colors get trapped on the sticky surfaces when they land on the surface during their flight. The traps are replaced weekly. The type and abundance of trapped insect pests are examined in the laboratory using a stereo microscope.

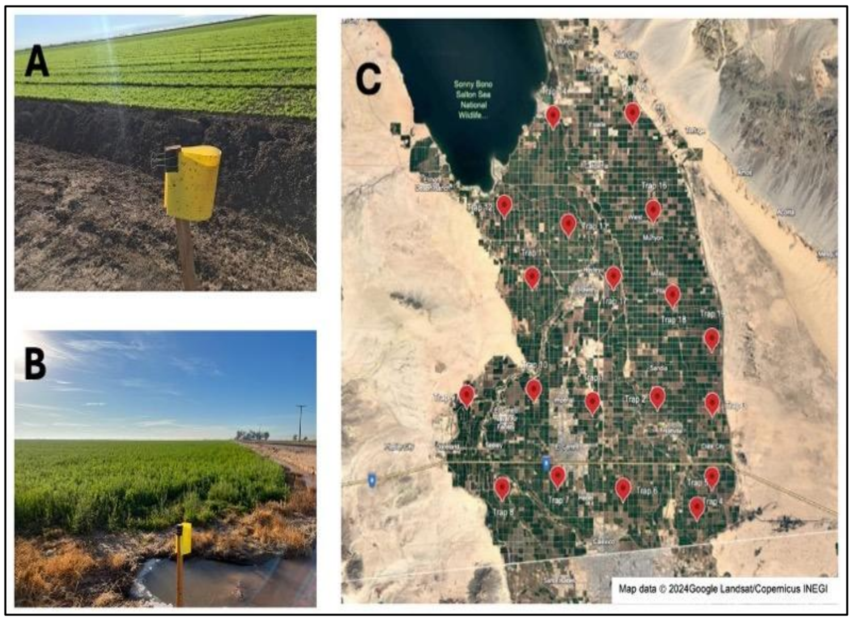

Figure 1 A & B. Yellow sticky traps in various fields, and C) Trap locations across the Imperial Valley

Insect count data from the sticky traps could help forecast the adult insect activity of targeted pests around crop fields. However, since several biological (crop type, crop age, presence of weed hosts, etc.) and physical factors (temperature, wind, precipitation, etc.), and farm operations (insecticide sprays, dust from the land preparation, crop harvest, etc.) can influence insect populations development in the field and trap capture efficiency, the insect numbers in sticky traps do not always strongly correlate to the actual infestation levels in the grower's fields. Despite this, the insect pest counts from the sticky traps are a valuable indicator of adult insects' prevalence across a landscape. Collecting data on trapped insects across multiple years may help establish a baseline of pest activity and potential crop infestations throughout the season. Such historical pest data can then be compared with current pest activity in the traps to identify population trends. The sticky traps can also be screened to detect invasive insect pests, such as Asian citrus psyllids, spotted lanternflies, and Mexican fruit flies.

Insect count updates until 2nd September 2025

The insect counts from the monitoring trap network are presented below (Figs. 2, 3, 4, and 5). Each dot in each of the graphs represents the average insect count from 19 traps placed across the Imperial Valley for that sampling week, with the value expressed as the number of insects per trap per day.

Whiteflies: The whitefly counts (Fig. 2) in the traps consisted mainly of sweetpotato whitefly (*Bemisia tabaci* MEAM1), but also a small fraction (< 5%) of bandedwinged whiteflies, *Trialeurodes abutilonia*, and other minor whitefly species. Although we observed a temporary decline in adult whitefly counts in the traps following the recent monsoon storm, the numbers are now beginning to increase again.

Aphids. The trap count data for aphids (Fig. 3) do not focus on any single species but represent the aphid complex in the Valley. The aphid population in the Imperial Valley was relatively active before mid-February but has since declined to near-zero alate aphid activity.

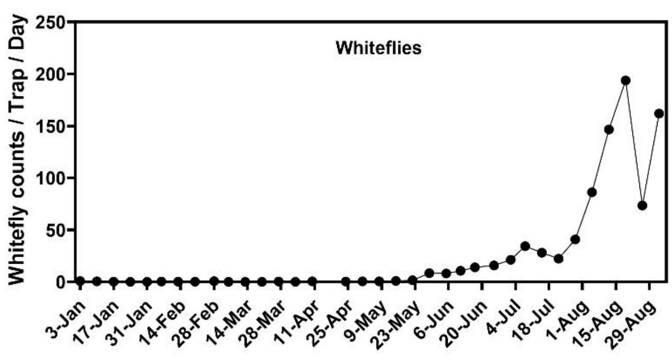

Figure 2. Whitefly counts from the traps

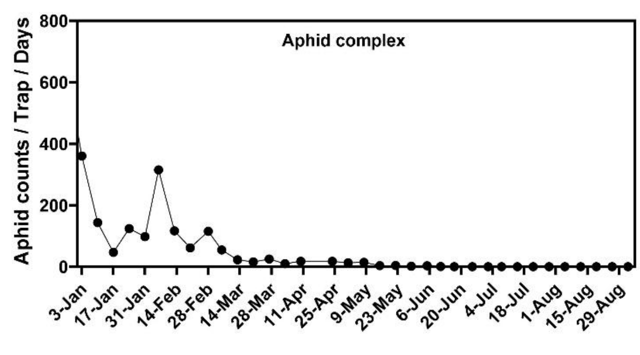

Figure 3. Aphids count from the traps

Flea beetles. The flea beetle counts on the traps (Fig. 4) comprised the pale-striped flea beetle, *Systena blanda*, the desert corn flea beetle, *Chaetocnema ectypa,* and other minor species. Currently, we are observing very high adult activity across the Imperial Valley.

Western flower thrips. Several thrip species were captured in the traps, but only western flower thrips, *Frankliniella occidentalis,* the major thrip species of concern for several crops of the Imperial Valley, were counted. Currently, we are observing very low adult activity across the Imperial Valley.

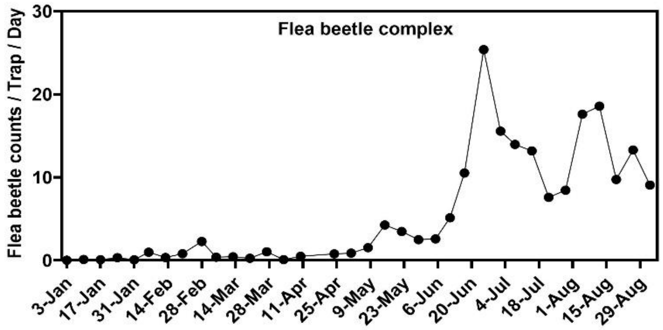

Figure 4. Flea beetle count from the traps

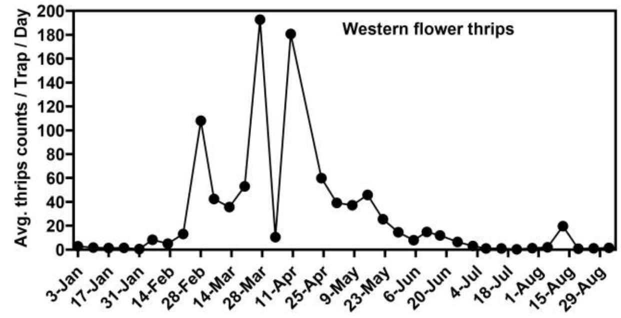

Figure 5. Western flower thrips count from the traps

Additional biweekly updates of trap capture data are available from the UCCE Imperial County Entomology webpage, which can be accessed at https://ucanr.edu/county-office/cooperative-extension-imperial-county/imperial-valley-areawide-pest-monitoring. If you are interested in additional data from this project or have questions or comments, please contact Arun Babu at (442) 265-7700 or arbabu@ucanr.edu.

Acknowledgements

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COTTON BEING REVISITED IN THE IMPERIAL VALLEY?

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Introduction. Cotton has been an important and one of the major field crops in California's low desert, particularly the Imperial Valley (IV), Palo Verde Valley, and Blythe (Riverside, CA). California produces the highest-quality, highest-yield cotton in the world, largely due to its climate and managed, efficient irrigation systems. Historically, cotton was introduced to the Imperial Valley around 1913. However, according to the Imperial Valley press (1907), some people had been growing cotton in the valley as early as 1906. Cotton has been king in terms of cash receipts for farmers over the decades. Both upland and Pima cotton varieties are planted in the Imperial Valley. Pima cotton has exceptional fiber quality, but it is of relatively small boll size and has reduced lint production. Pima cotton remains one of the most popular types planted in California, despite a decline in total acreage. Pima varieties remain the most popular among growers, accounting for nearly 146,000 acres statewide, compared to 25,645 acres of upland (Fitchette, 2020).

California cotton acreage is down significantly. California's total cotton acreage fell to well under 200,000 acres. Profitable cotton production in the IV has become increasingly challenging. Imperial Valley cotton acreage declined from 96,000 acres in 1979 to 1602 acres in 2023 (Figure 1) and was almost abandoned, except in the Palo Verde Valley. Accordingly, the IV is no longer considered the "cotton production belt".

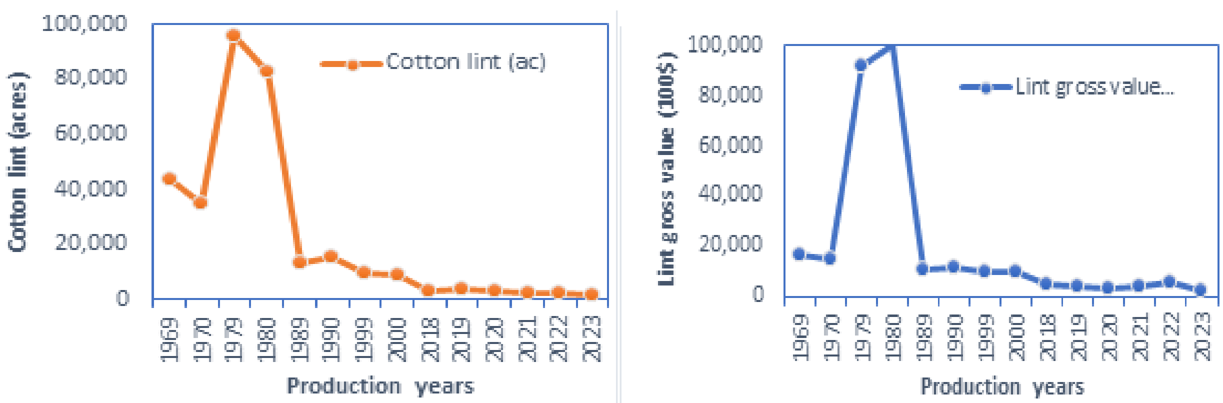

Fig. 1. Trends of cotton production acreage and value in the Imperial Valley (source: extracted from the Imperial County Agriculture and Livestock Report)

The decline of cotton production in Imperial County is attributed to several factors, among which are: (1) drought conditions that limited water availability and increased water and production costs, (2) increased pest infestations, particularly pink bollworm (eradicated from the US in 2018) and sweet potato whitefly, (3) urbanization and increased demand for water from urban centers, (4) low cotton prices and poor market conditions. These factors, along with others, collectively contributed to the challenges, contributing to declining interest and abandonment of cotton production in the IV. Kings County, with nearly 87,000 acres, and the San Joaquin Valley, with over 171,000 acres of cotton, are the only regions left with large cotton acreage since 2020, while the low deserts of Riverside and Imperial counties have just under 13,000 acres of Upland cotton during the same year (Fitchette, 2020).

There are different cotton production methods. Conventional or standard cotton production typically employs wide beds (38 or 40 inches) planted with a single line of seeds. Some cotton researchers suggested that a standard row cotton results in lower plant populations, requires a longer time to grow into a closed canopy, and yields lower. A narrow planting involves the use of narrower bed sizes (Reddy et al., 2009), which involves planting two lines over the same standard-size beds. A narrow row cotton planting has been tested for the IV by Bachie and Pacheco (2015). Cotton soil is typically pre-irrigated to achieve optimal moisture levels. Two hundred fifty pounds of nitrogen per acre is usually necessary to produce a good cotton crop. Nitrogen applications should be made before planting in the pre-irrigated beds, with an additional application as a side-dress before the first bloom. After the germination irrigation, the next irrigation is usually necessary about 1st square or around 60 days after the germination water. The irrigation frequency for the remainder of the season will depend on plant growth, boll load, and weather conditions. Cotton yield in the IV is usually higher when the crop is planted in early to mid-March. Yields start to decrease when cotton is planted after April 15th. A soil temperature of at least 62°F at a 6-inch depth is desirable for successful germination.

Among cotton pests, whiteflies and lygus are the most serious threats. Other damaging pests, such as the cotton leaf perforator, tobacco budworm, and cotton bollworm, have been reduced to low levels due to the use of selected varieties. Leafhoppers and spider mites require occasional treatment. The most common pathogens are *Pythium ultimum*, *Rhizoctonia solani*, and *Thielaviopsis basicola*. Cotton seedling diseases may be more severe where cotton follows sugar beets or alfalfa. Fungicide seed treatments should be used to control seedling diseases. Root knot nematode (*Meloidogyne* spp.) could also be a problem in cotton production. The extremely hot and dry environmental conditions in the IV pose severe challenges to cotton production, necessitating the development of heat-tolerant cotton varieties (Husman and White, 2024). Heat stress is known to significantly reduce cotton yields in the low desert. Changes in abiotic factors such as climatic conditions and drought stress have a significant impact on cotton performance and productivity. Among the needed improved breeding strategies are the development of heat- and drought-tolerant cotton

(Thompson et al., 2025). Cotton reproductive stages are more susceptible to heat stress than vegetative stages.

While cotton production acreages have declined and mostly been abandoned in Imperial County, except in the Palo Verde Valley, cotton production has recently resurfaced in the Imperial Valley, adapting to overcome major challenges. The recent increase in cotton acreage in the IV suggests a potential revival of the cotton industry in the once-renowned cotton production belt. While cotton acreage is on the rise, we were drawn to a unique situation and productivity-impacting conditions in one of the cotton fields. In this particular field, we observed widespread damage to the growing tips, particularly near the terminal, which appeared to be chewing damage (Fig. 2A & B). Most of the plants with stem damage often showed leaf

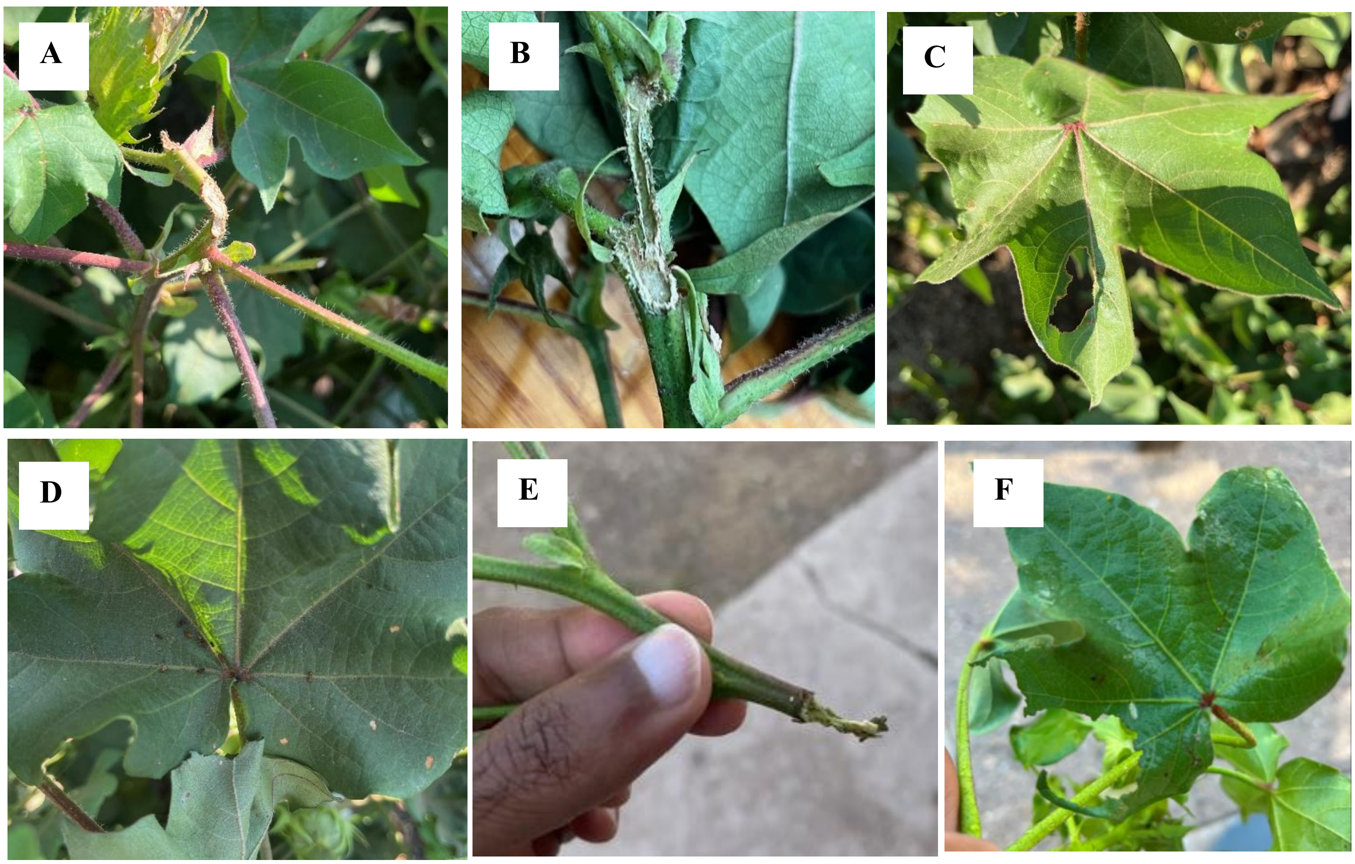

Fig. 2. A&B) Stem girdle damage often near the terminal, C) Leaf feeding damage, D) Black pellet shaped droppings, E &F) Stem and leaf damage resulted by the field crickets when confined on a cotton plant

feeding damage (Fig. 2C). Upon careful inspection, the upper surface of the leaves directly below the damaged stem and leaf often has black pellet-like droppings (Fig. 2D). A quick sweep net sampling suggests that the field has low infestation of sweetpotato whiteflies *Bemisia tabaci*, low levels of threecornered alfalfa hoppers *Spissistilus festinus*, and western tarnished plant bugs, *Lygus hesperus*, but none of them can cause damage described above. The field was clean without any substantial weed growth. Additionally, no signs of any other pest or rodent activity were noticed. Although it was hidden from plain sight, we detected the presence of field crickets by their loud chirping from the males. A few crickets were collected from the field by randomly turning the soil clods on the field edges. The cotton plant terminals, with 2-3 side shoots and leaves, that showed no damage symptoms, were collected and placed in a Ziplock bag. One to two field crickets were confined in this setup. Two days after the collection, plants confined with the crickets were inspected for damage symptoms. Leaf feeding damage (Fig. 2F), similar to the damage observed in the field (Fig. 2C), was noted in the cotton plants confined with the crickets. Additionally, we noticed fresh feeding and girdling damage on the base of the stem where we cut to detach the plants for the experiment. No other gouging or girdling was found on the intact plant stem. However, when we repeated the experiment, with no access to the base of the stem (with a fresh cut) to the crickets, we didn't see the girdling and stem gouging symptoms. Thus, the damage, especially the leaf damage we observed in the field, appears to be caused by crickets. While we cannot confirm that stem girdling or gouging damage is definitely caused by crickets, further field inspections suggest that some of the stem feeding/girdling-like damage may have originated around abscission scar left on the plant stem when a reproductive structure detached from the plant, indicating that this damage can be caused by field crickets feeding on the abscission wound, possibly due to the lack of alternative food sources nearby. The damage appears serious and has the potential to reduce cotton yields. The variety of cotton planted in this area is DP 2317 B3TXF, featuring Bollgard 3 ThryvOn® with XtendFlex®. Although three EPA-registered insecticides were applied in the field (Imperial County Ag Commission, 2025), and with no record of recent herbicide application in or around the fields, we are confident that these applications do not contribute to the symptoms we observed.

While we continue to search for a diagnosis and potential remedy for future crops, we would be delighted to hear from anyone who has faced a similar situation.

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UNDERSTANDING THE IMPACTS OF NEMATICIDE TREATMENTS ON RHIZOSPHERE MICROBIOME AND NUTRIENT CYCLING IN MELON

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Introduction

Root-knot nematodes *(Meloidogyne* spp.*)* remain one of the main nematode parasites of cucurbits in California. Management of root-knot nematodes primarily depends on the use of high-risk nematicides such as oxamyl (Vydate), metam sodium (Vapam), and 1,3-dichloropropene or 1,3-D (Telone II) (Becker and Westerdahl, 2016). All of these are EPA Restricted-Use Pesticides or the latter two are California Restricted Materials, which means only certified applicators are allowed to use. Non-fumigants, including Nimitz (fluensulfone), Velum (fluopyram), and Salibro (fluazaindolzine) are also used for nematode management in cucurbits. Understanding the impacts these nematicides have on rhizosphere microbiome (bacterial, fungal, and nematode communities) is important to provide a holistic view of the target nematode pest and potential impacts these products may have on the rhizosphere microbiome. Microbial activities in the soil break down pesticides, perform nutrient cycling, extend the root system, and provide other soil ecosystem services. In this study, we examined the impacts of organic and synthetic nematicides on the microbiome and how it regulates nutrient cycling in the rhizosphere of cantaloupe melon.

Materials and Methods

A field trial was conducted in the spring of 2025 at the Coachella Valley Agricultural Research Station (33°31'15.0"N 116°09'04.8"W) to examine the impacts of organic and conventional nematicides on rhizosphere microbiome and nutrient cycling on melon. Nematicide treatments, active ingredients, target pests, application rates, and sources are listed in Table 1. An untreated water control treatment was included, and the experiment was arranged in a randomized complete block design with four replications (Fig. 1). Each experimental plot was 45 ft × 3 ft. Melon was directly seeded using a handheld planter in a single seed line on 36-inch raised beds and drip irrigated. Nematicides were applied a month after planting using a handheld pressure sprayer, directly applied on the plots and irrigated to wash into the root zone. The experiment was terminated after three months. At the time of termination, 18 soil cores were collected from the top 8 inches per plot, composited in a gallon Ziplock, and aliquots of 20 cm^3, 100 cm^3, and 250 cm^3 were subsampled for metabarcoding environmental DNA (eDNA) targeting bacteria and fungi, total nematode extraction including root-knot nematodes, and comprehensive nutrient analysis, respectively. Severity of root-knot nematode-induced galling on melon roots were assessed based on 0-10 scale, where

0 = healthy root and 10=heavily galled root system (Bridge and Page, 1980). Soil samples were sent to a commercial laboratory for metabarcoding eDNA targeting bacterial 16S rRNA gene and fungal ITS region of rRNA gene. Nematodes were extracted by the Baermann Funnel method, and individual nematodes were morphologically identified to genus. Soil samples were sent to a commercial laboratory for comprehensive nutrient analysis, including primary and secondary nutrients, micronutrients, soil organic matter, soil pH, and salinity, among others. Data were analyzed using SAS version 9.4 (SAS Institute Inc., Cary, NC). Means were separated using the Waller–Duncan *k*-ratio (*k*=100) *t*-test, and only true means were presented.

Figure 1. Cantaloupe melon trial 8 weeks after planting at the Coachella Valley Agricultural Research Station.

Table 1. Nematicide treatments, active ingredients, target pests, application rates, and sources.

Nematicides	Active ingredient	Target	Application rate	Manufacturer
Vydate	Oxamyl	Nematode	1 gal/ac	Corteva
Velum	Fluopyram	Nematode/fungi	6.8 fl oz/ac	Bayer
Salibro	Fluazaindolzine	Nematode	31 fl oz/ac	Corteva
Majestene	*Burkholderia* spp.	Nematode	1 gal/ac	ProFarm
Control	Water	-	-	-

Results and Discussion

Based on the eDNA analysis, at least 116 species of bacteria and 57 species of fungi were detected in the rhizosphere of melon. The nematicide treatments impacted the abundance of bacteria and fungi in these orders: Majestene < Salibro < Vydate < Velum < Control and Velum < Majestene < Control < Salibro < Vydate, respectively. Although the response of bacterial and fungal abundance to nematicides was not significant, marginal differences appeared to explain important trends among the nematicide treatments (Fig. 2-3). It is worth noting that the differences in the abundance of bacteria and fungi in the rhizosphere of melon attributed more to beneficial nematode activity than the direct impact of nematicide treatments.

Table 2. Nitrate nitrogen, phosphorus, potassium, soil organic matter, soil pH, and soil salinity at the end of melon crop.

Nematicides	N (lb/ac-ft)	P (lb/ac-ft)	K (lb/ac-ft)	SOM (%)	pH (units)	Salinity (dS/m)
Vydate	35.61	33.00	222.08	0.71	7.93	2.04
Velum	40.58	34.00	232.64	0.68	7.98	2.34
Salibro	43.70	37.00	237.72	0.78	7.88	2.22
Majestene	43.00	37.00	229.90	0.71	7.93	2.40
Untreated control	36.23	36.00	220.91	0.72	7.93	1.99

N=nitrate nitrogen, P=phosphorus, K=exchangeable potassium, SOM=percent soil organic matter, pH=soil pH. Means (n=4) are not different from each other, according to the Waller–Duncan k-ratio (k =100) t-test.

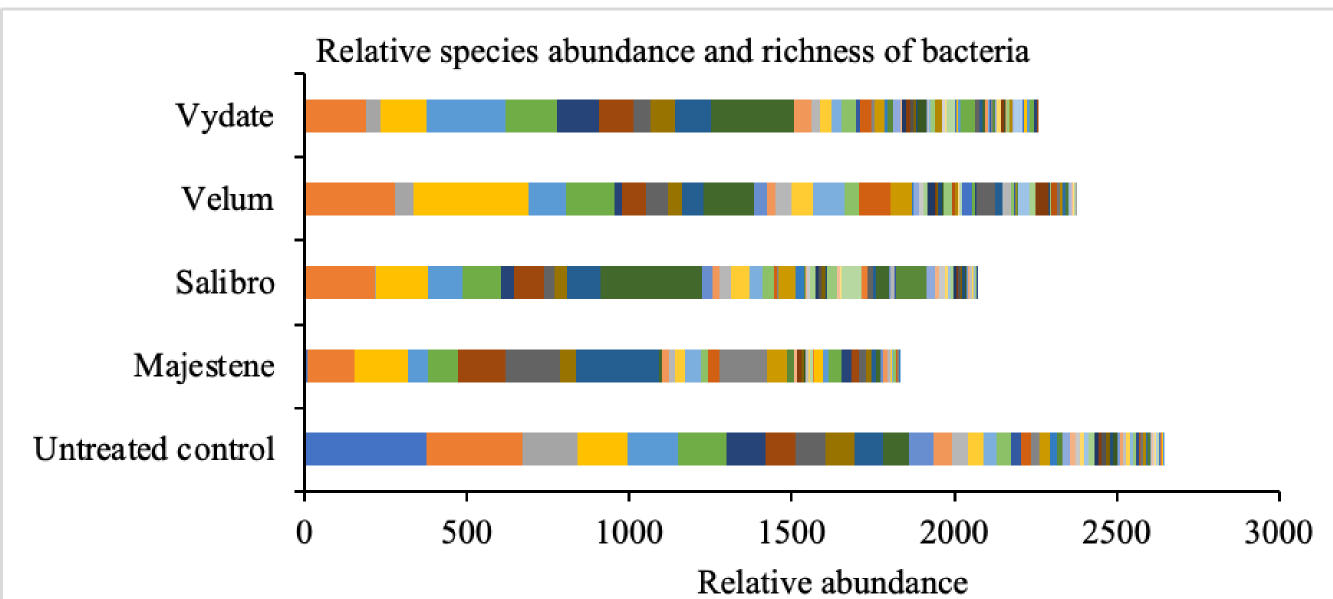

Figure 2. Relative abundance of bacterial species (bars) in different nematicide treatments. Each color represents 116 unique species (species list not shown). Bars represent means (n=4), and the means are not different, according to the Waller–Duncan k-ratio (k=100) t-test.

Free-living or beneficial nematodes (bacterivores, fungivores, and omnivores) were significantly suppressed by Velum compared to untreated control (P<0.05; Fig. 4) while Majestene, Salibro, and Vydate did not. This observation is in line with previous findings that Velum indiscriminately controlled both target root-knot nematodes and non-target beneficial nematodes while Salibro only targeted root-knot nematodes (Waisen, 2023). The abundance of bacteria was numerically low in Majestene and Salibro treatments attributing to high bacterial feeding nematode activity (Fig. 2). This means more bacterivorous nematodes are feeding on bacteria and reducing its abundance in the soil. In terms of fungal activity, Vydate recorded numerically the highest abundance of fungi. This observation is expected because fungal feeding nematode count was low in Vydate treated plots to feed on fungi in the soil. Velum treated soil, however, recorded low fungal abundance even with lower fungal feeding nematodes indicating that Velum may have suppressed the abundance of fungi. This observation is not surprising because Velum is a known fungicide and nematicide and expected to impact both fungi and nematode. We also determined if nematicide treatments impact nutrient cycling in treated soil. One would expect high microbial activity to increase nutrient cycling in the soil. Majestene and Salibro treated soils had marginally higher nitrate-nitrogen and phosphorus levels attributing to high bacterial and fungal feeding nematode activities contributing to nutrient recycling (Table 2).

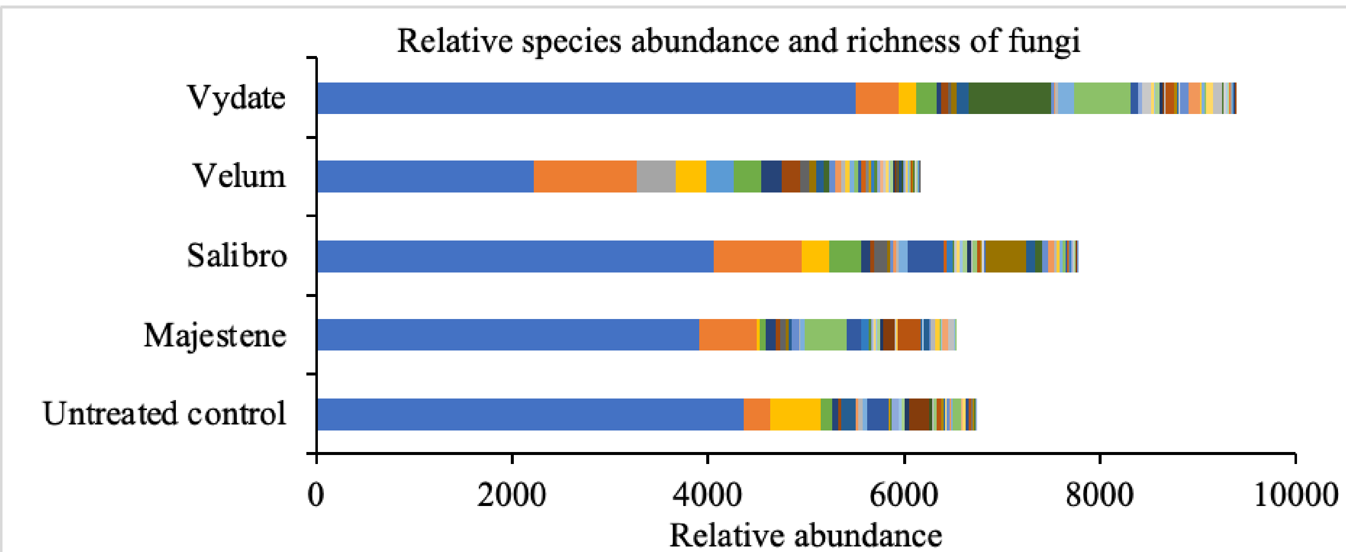

Figure 3. Relative abundance of fungal species (bars) in different nematicide treatments. Each color represents 57 unique species (species list not shown). Bars represent means (n=4), and the means are not different, according to the Waller–Duncan k-ratio (k=100) t-test.

Among the nematicides tested, = Velum significantly suppressed the root-knot nematode count in the soil compared to untreated control (Fig. 4). However, root-gall index or the severity of galling on melon roots was not reduced by Velum suggesting that Velum was only able to control the nematodes in the soil but unable to kill those that entered the roots while Salibro only numerically reduced the severity of root galling (Fig. 5). These observations aligned with our recent findings (Waisen, 2025).

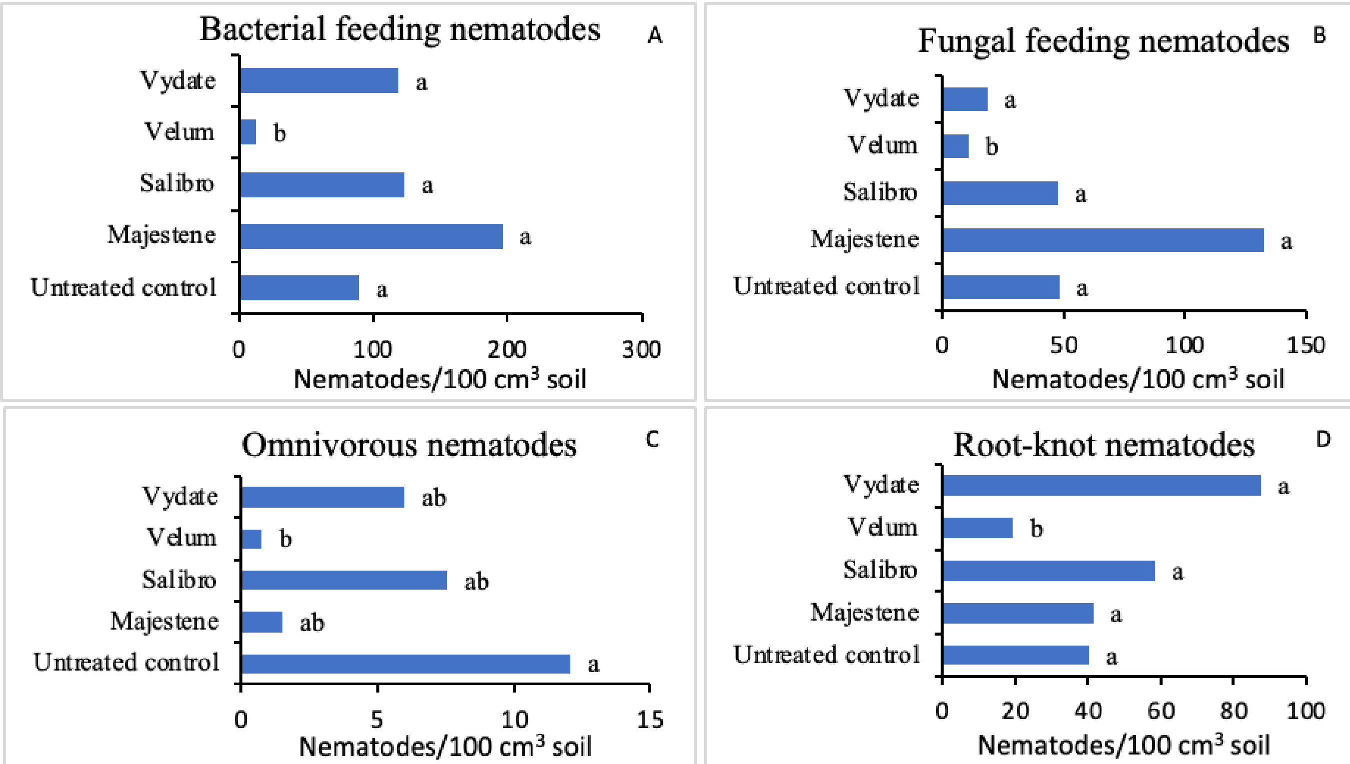

Figure 4. A) Bacterial feeding nematodes, B) fungal feeding nematodes, C) omnivorous nematodes, and D) root-knot nematodes. Bars and numbers represent means (n=4), and the means followed by the same letter(s) are not different, according to the Waller–Duncan k-ratio (k=100) t-test.

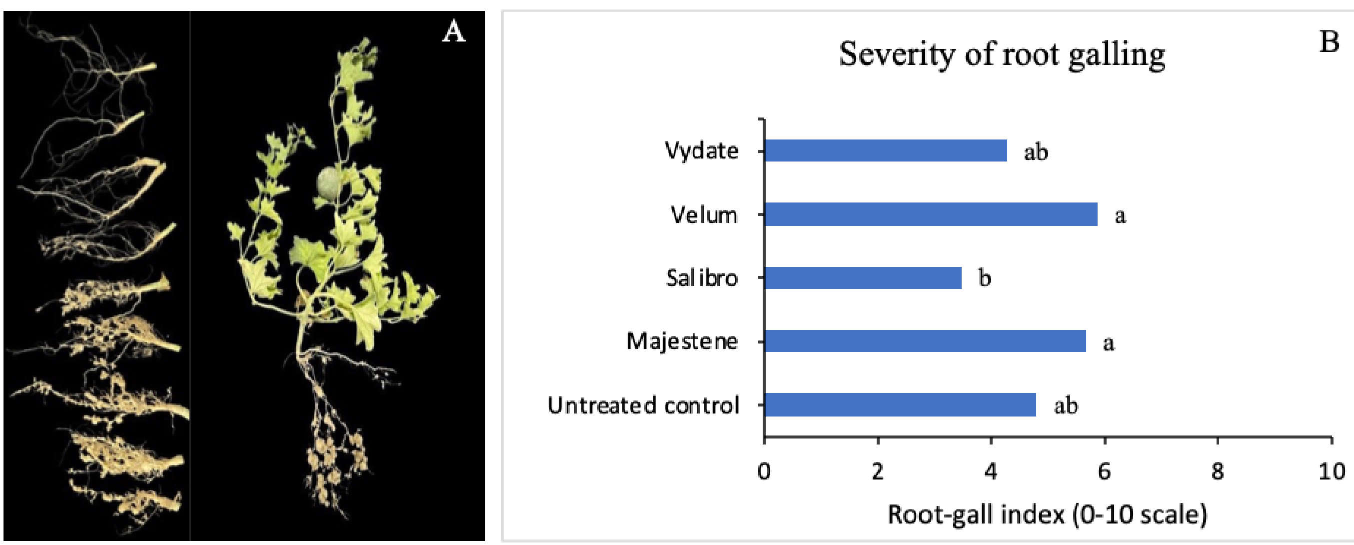

Figure 5. A) Severity of root-knot nematode induced galls on melons and B) bars represent means (n=4) and the means followed by the same letter(s) are not different, according to the Waller–Duncan k-ratio (k=100) t-test.

Conclusion

This study investigated the potential impacts of organic (Majestene) and synthetic (Salibro, Velum, and Vydate) nematicides on rhizosphere microbiome and corresponding nutrient cycling in cantaloupe melon. Velum not only suppressed root-knot nematodes but also bacterivorous, fungivorous, and omnivorous nematodes, which are free-living beneficial nematodes important for providing soil ecosystem services, including nutrient cycling. While successfully controlling root-knot nematodes in the soil, it is evident that Velum can compromise microbial activity and nutrient cycling in the soil. In addition, we also found that Velum, as a known fungicide, appeared to reduce fungal abundance in the soil. Bacterial and fungal communities in the soil appeared to be sensitive to beneficial nematode activity (bacterial and fungal feeding nematodes) than nematicide treatments. Synthetic nematicide Vydate reduced fungal feeding nematodes resulting in higher fungal activity while organic nematicide Majestene had high counts of beneficial nematodes which reduced the abundance of bacteria and fungi in the soil by directly feeding on them as food sources. As a result of high beneficial nematode activity in Majestene treatment, nitrogen and phosphorus levels in the soil were higher. Salibro treated soil also had relatively high nitrogen and phosphorus attributing to high fungal activity. In summary, organic nematicide Majestene did not appear to compromise soil microbiome and nutrient cycling. Any change observed in bacterial and fungal communities was due to change in beneficial nematodes feeding on the bacteria and fungi Conversely, Velum negatively impacted soil microbiome as evidenced in the suppression of beneficial nematodes.

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THIS ARTICLE IS INTENDED TO PROVIDE GROWERS, PCAS, IMPERIAL VALLEY CIMIS REPORT AND UC WATER MANAGEMENT RESOURCES

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The reference evapotranspiration (ETo) 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 ETo by a crop coefficient (Kc) 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 ETo 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/.

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