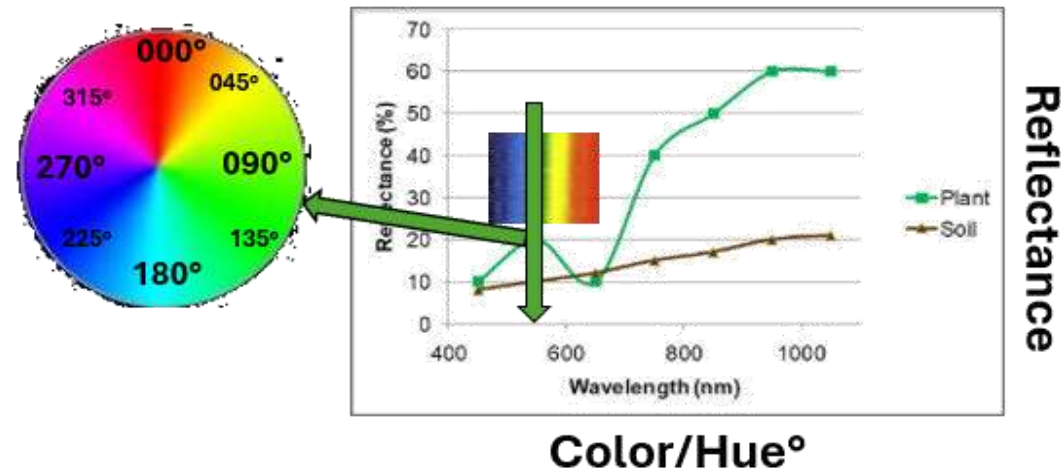


# Visual Image Data and Its Use in Assessing Turf Quality

Karcher and Richardson (2003) demonstrated that analyzing digital visual images (400–700 nm) reliably measures color reflectance (hue°) from vegetated surfaces. A digital camera will measure the turf's hue°, and if an area is designated the standard deviation (variability) of the color is measured.



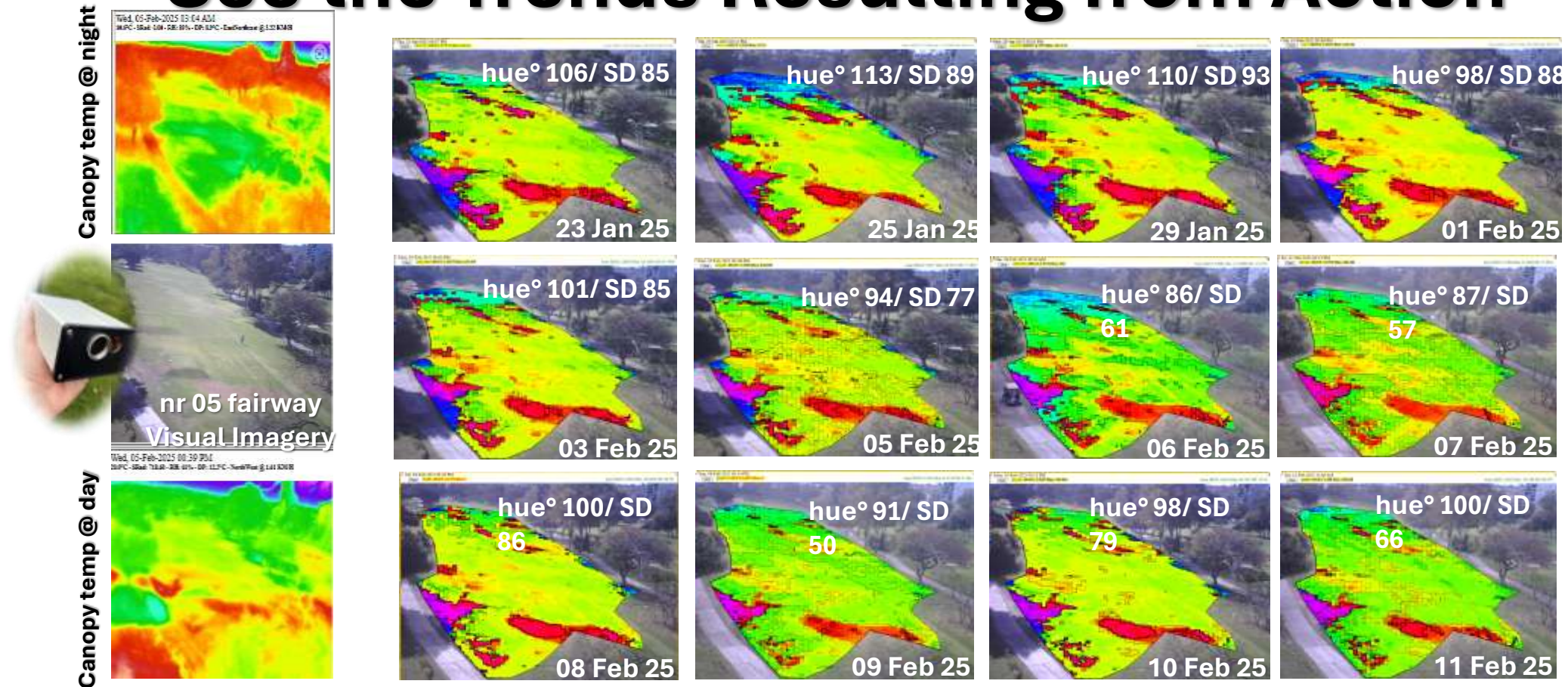
Most healthy and growing cool season and warm season turfgrass measure hue° between 80° - 120°, depending on the cultivar. Typical hue° standard deviations of well maintained golf course greens are near 3 and fairways and sport fields are near 8.

When the average hue° shifts towards yellow, an undesirable change in health and fertility is seen often suggesting a need for nitrogen. When an increase in standard deviation of the hue° is seen the playing surface is becoming more variable. Examining the persistent trend of the hue° and its uniformity can be used to understand the health and quality of the turf and measure the result of cultivation practices.

**Jim Etro**

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# See the Trends Resulting from Action



The image displays a sequence of thermographic images taken from January 23 to February 11. These images use colors to represent the condition of the vegetation on the fairway:

- **Red and Purple Areas:** These colors indicate regions on the fairway where there is no significant vegetation improvement. It's likely that these areas are either bare ground or have dead plant material. The suggestion here is that these spots should be seeded soon. Seeding them before the temperature rises will help ensure that grass grows instead of weeds, which tend to sprout in warmer conditions.
- **Other Colors (Green, Yellow, etc.):** These likely represent healthier areas with living plants or areas that are improving over time.

The purpose of these maps is to visually track and manage the health and treatment of the turf, ensuring optimal maintenance and intervention strategies are applied. By seeding the red and purple areas soon, the goal is to improve these patches and integrate them with the healthier sections of the fairway.

# The next pages slice the fairway into pieces for a better understanding of the value of applying electrolysis to the irrigation water

## Graphs:

- There are three graphs, each for a different zone of the fairway (Zone A and Zone B and the perpetually Ugly zone).
- The graphs track the trends in Hue° and the uniformity of the depicted zones over several weeks.
  - **Blue Line:** Represents the average hue over time. A hue closer to 85 implies a greener and healthier look.
  - **Orange Line:** Shows the standard deviation of the hue, indicating how uniform the color is across the area. A lower value means more uniformity.
  - **Dotted Lines:** These are linear trend lines that help to visualize if the overall trend is improving or declining over time.

## Key Observations:

- In Zones A and B, the average hue° value shows fluctuation but it trends towards improvement. The grass is getting greener.
- In Zones A and B, the standard deviation decreases, suggesting that the uniformity of the grass is becoming more consistent.
- The 'Ugly' zone is far from uniformity. The green areas where there is live grass is improving but most of the area is unchanged.

## Summary:

- The data suggests that treating the irrigation water with electro-mechanical methods is having a positive impact on the grass of the fairway in terms of both color and uniformity. This might be due to better water quality, leading to healthier and more evenly distributed plant growth.

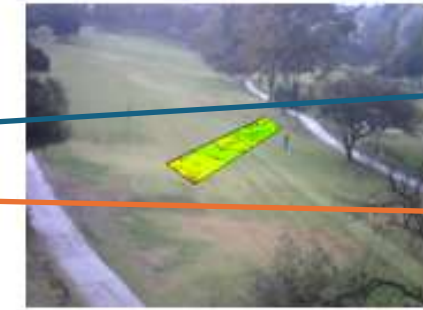
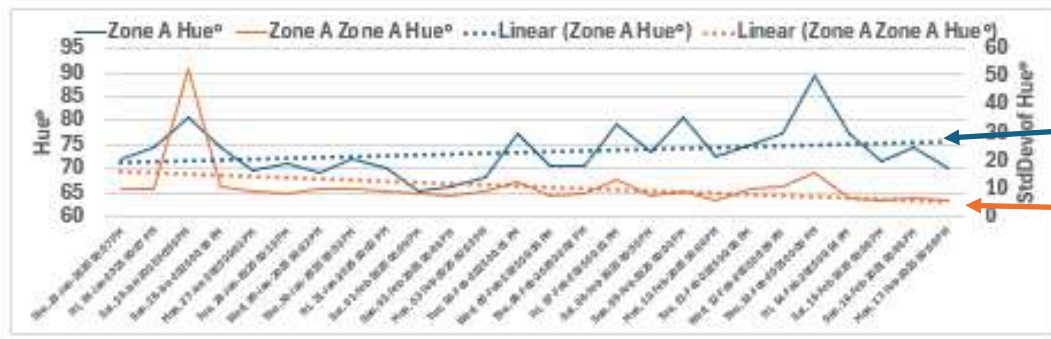
**This approach helps to visually and statistically track the benefits of the electrified irrigation water treatment (electrolysis).**

# Measuring the Trends Resulting from Treating Irrigation Water with Electrolysis

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE		
1																																	

## Zone A

Zone A Hue°	72	75	81	74	70	71	69	72	70	65	66	68	77	71	70	79	74	81	72	75	78	89	77	71	74	70
Zone A Hue° StDev	9.7	10	53	11	9.5	8.7	10	9.8	9.1	8.3	7.8	8.8	13	7.2	8.5	13	7.7	9	5.8	9.9	11	16	6.4	5.5	6.7	5.5

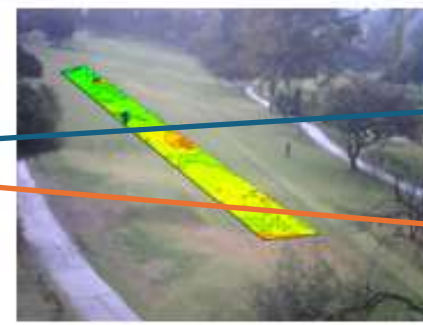
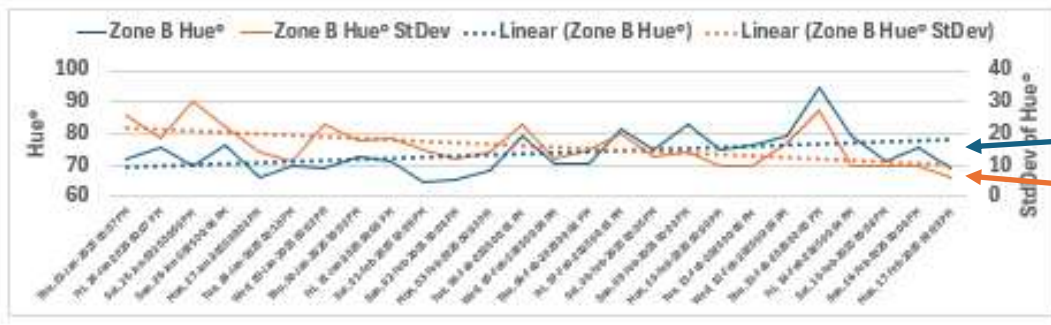


Improving Hue°

Improving Uniformity

## Zone B

Zone B Hue°	72	76	70	76	66	69	69	73	71	64	66	68	80	71	71	81	75	83	75	76	79	94	79	71	76	69
Zone B Hue° StDev	26	19	30	22	14	12	23	18	18	15	12	14	23	12	15	20	13	14	9.8	10	17	27	9.6	9.9	9.7	6.3

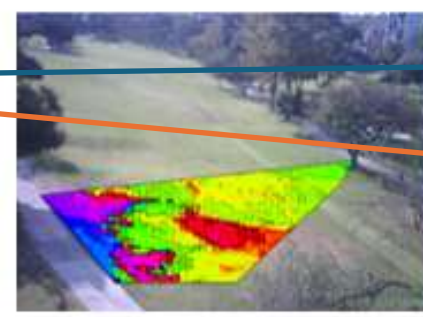
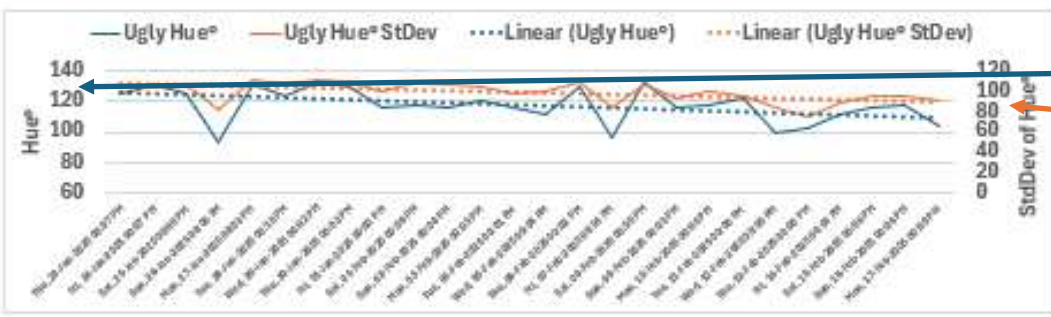


Improving Hue°

Improving Uniformity

## Ugly

Ugly Hue°	125	131	125	94	130	124	133	129	116	117	116	120	115	111	129	96	132	116	118	121	99	102	111	116	118	103
Ugly Hue° StDev	105	105	106	81	111	106	110	108	100	107	106	105	97	99	108	83	106	93	99	96	83	75	87	96	94	90

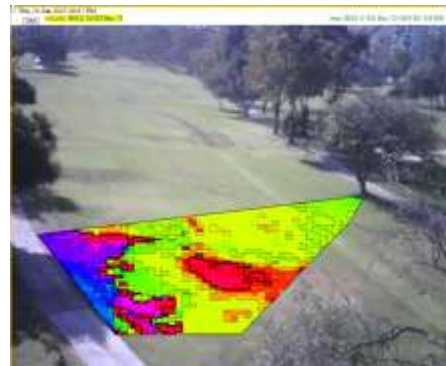


Hue° bad

Uniformity bad

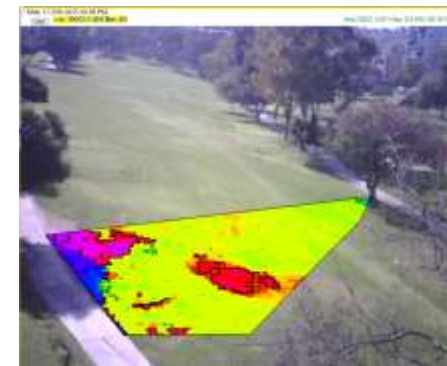
23 Jan 2025

Thu, 23-Jan-2025 00:07 PM  
23.3°C - SRad: 625.00 - RH: 8% - DP: -12.8°C - NorthEast @ 20.92 KM/H



17 Feb 2025

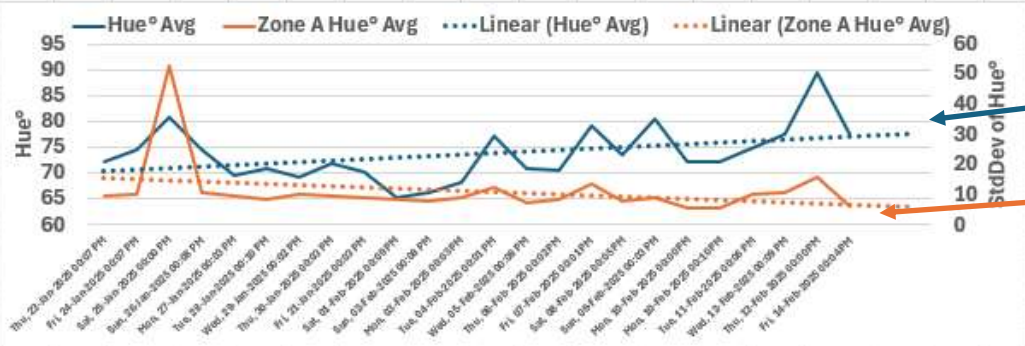
Mon, 17-Feb-2025 00:09 PM  
20.0°C - RH: 51% - DP: 9.4°C - SouthWest @ 9.66 KM/H



# Measuring the Trends Resulting from Treating Irrigation Water with Electrolysis

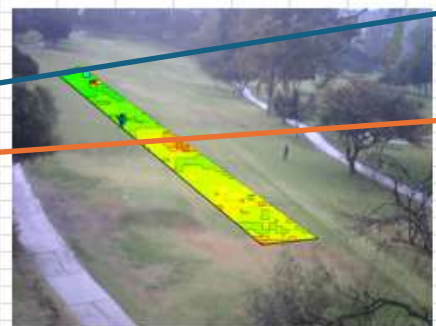
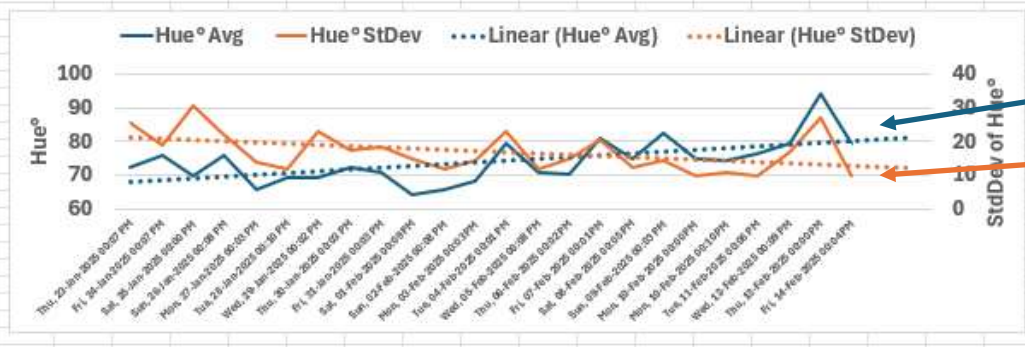
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD						
1																																				
2																																				
3																																				
4																																				

Zone A																																			
Hue° Avg	72.2	74.5	80.9	74.4	69.6	71	69.3	71.9	70.4	65.4	66.2	68.2	77.1	70.7	70.4	79.2	73.5	80.6	72.3	72.2	74.8	77.6	89.4	77.4											
Hue° StDe	9.69	10.1	52.9	10.8	9.55	8.7	10.3	9.77	9.11	8.31	7.76	8.76	12.6	7.16	8.54	13.4	7.75	9.05	5.75	5.85	9.87	10.8	15.6	6.42											



Improving Hue°  
Improving Uniformity

Zone B																																			
Hue° Avg	72.2	75.9	69.7	76.1	65.8	69.5	69.2	72.5	70.9	64.4	65.7	68.3	79.6	70.8	70.5	81.1	74.7	82.6	74.9	74.5	76.4	79.2	94.4	79.4											
Hue° StDe	25.7	18.7	30.5	22.1	14	11.6	23	17.6	18.4	15.1	11.9	14.3	23.2	11.9	14.7	20.3	12.5	14.5	9.78	10.9	9.98	16.8	27	9.61											



Improving Hue°  
Improving Uniformity