Technical Report | December 11, 2024 | Public Release

Water Resiliency Corn Hybrid Performance Trials

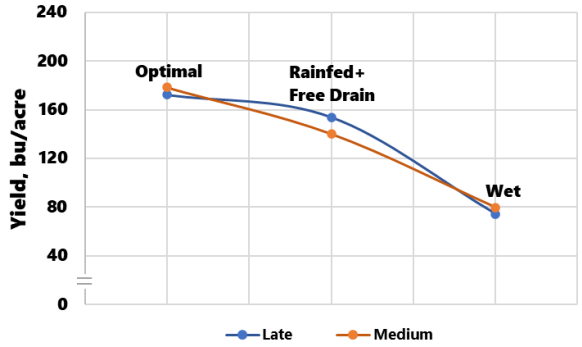
Summary

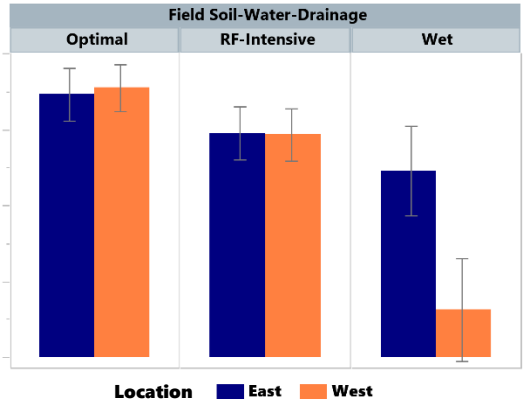
- We detected yield differences in late (≥116 day) and medium (110-115 day) season relative maturity group hybrids under Rainfed, Optimal, and Wet field soil-water-drainage regimes. In-season Wet stress reduced yield significantly compared to Rainfed. The impact of severe drought in June was partly offset by rainfall events beginning the first week of July.
- Monitoring root zone soil water status coupled with timely irrigation and drainage improved aggregate grain yield by 28.2 bu/acre compared to Rainfed exposure.
- Yield response to in-season wet stress is determined by the timing and number of stress days.
- High yield and yield stability year to year can be optimized by managing in-season root zone water balance.

2024 Corn Resilience Trial Summary
Relative Maturity Group Mean Aggregate Performance

Soil-Water Regime	Relative Maturity Group (Days)	n	Yield[‡], bu/acre	CV
Optimal	Medium (112-115)	48	178.4	5.6
	Late (≥116)	48	172.2	12.1
	Mean		175.3	
Rainfed	Late (≥116)	48	153.9	11.4
	Medium (112-115)	48	140.2	10.1
	Mean		147.1	
Wet	Medium (112-115)	48	79.7	69.9
	Late (≥116)	48	74.4	75.5
	Mean		77.0	

[‡]Means with the same color band are not different at the LSD α=0.05 test level.





Above: Mean yield response to water stress for Late (≥116 day), and Medium (110-115 day) season corn hybrids in 2024. **Right**: Mean yield response ± standard deviation by plot location within Soil-Water-Drainage treatment block (see Pg. 6 field map for spatial extent). We observed no significant difference in grain yield by location under Optimal and RF-Free Drainage, but plot location strongly influenced yield in the Wet block. This inflated the coefficient of variation (CV) relative to Optimal and RF-Free Drainage. The location-dependent WET variances, however, were indifferent ($\alpha = 0.05$) according to the O'brien and Levene tests, indicating that yield differences among hybrids were driven mainly by an unequal number of stress days observed in the East and West locations, not genetics.

Introduction

The water resiliency performance trials were established to:

- Evaluate elite, commercially available corn hybrids to water stress conditions during critical development stages.
- Provide an objective guide for extension agents, producers, and advisors in selecting hybrids appropriate for their field situations.

The trials, conducted at the Total Ag Water Management (TAWM) Site located at the Tidewater Research Station in Plymouth, NC, artificially impose water stress during the growing season under a uniform soil type and observed natural precipitation. Twenty-four hybrid entries from seven agribusiness partners were trialed in 2024. The hybrids were randomized and replicated four times in a two-level experimental design on a Portsmouth fine sandy loam soil. The target planting density was 34,000 plants/acre on 30-inch row spacing. The trial plots were planted on May 3 and harvested on the 25th and 26th of September. Yield data were analyzed as a mixed-effects model with unequal variance and compound symmetry covariance structure in SAS 9.4 Proc Glimmix. Mean separation was performed via least significant difference (LSD, $\alpha = 0.05$); the two top-yielding ranges are displayed.

Hybrids were evaluated under three soil-water treatment regimes. The soil-water regimes were defined as:

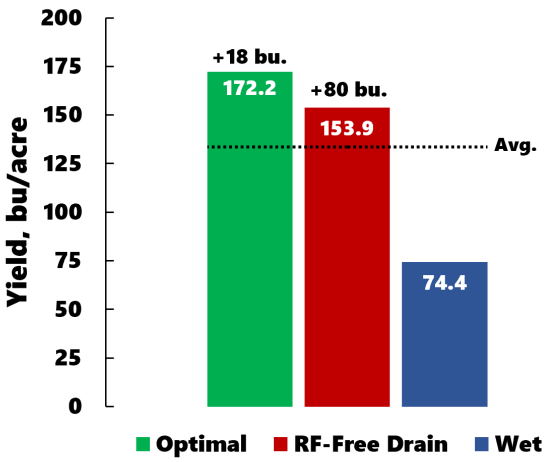
- Rainfed-Free Drain: intended to create drier than normal conditions typical of well-drained sites in NC. Drain tile spacing is 37.5' which is highly intensive for a Portsmouth fine sandy loam soil and intended to provide a much higher drainage intensity than needed for efficient crop production on this soil type. Soil water matric potential is governed entirely by natural rainfall with tile drains discharging at full capacity throughout the growing season.
- Optimal: intended to create ideal conditions representative of economically efficient water management systems. Soil water matric potential is continuously monitored 8" and 20" deep in the root zone with subsurface drip irrigation being utilized to apply water during dryer than normal periods.
- Wet: Intended to create wet stress conditions. Tile drainage spacing was 37.5' and was controlled to both reduce and/or stop drainage to artificially impose wet stress. This is coupled with subsurface drip irrigation to further impose wet stress. The drainage outlet was not allowed to free flow unless the groundwater was between 0' and 1.0' below the surface. Irrigation water was pumped into the drainage system if the water table fell below 1.0' along with daily subsurface drip irrigation to enhance wet stress conditions at critical growth stages. This treatment would represent river bottoms, tidal controlled drainage areas, and small depressional areas.

Key Performance Statistics for RM ≥ 116 Day Hybrids, Tidewater Research Station 2024

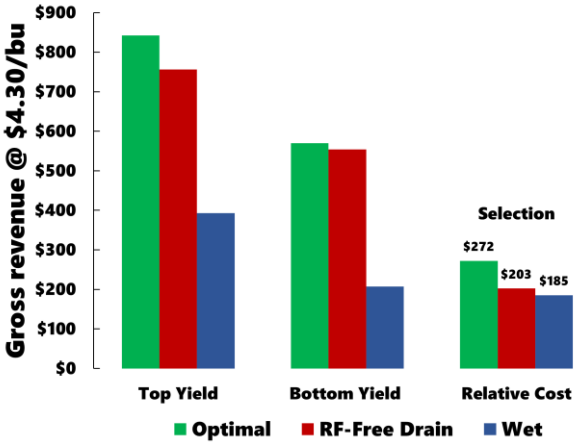
2024 Late Maturity Corn Hybrid Resilience Trial Information

Soil-Water Regime	Source	Entry	RM, Days	n	Yield‡, bu/acre	CV
Optimal	Gateway	GT3919TRE	119	4	195.8	5.3
	Meherrin	RV1839TC1250	118	4	190.3	7.7
	Bayer	DKC68-35VT2P	118	4	188.4	4.4
	Pioneer	P17677YHR	117	4	184.6	10.7
	DynaGro	DG58VC65	118	4	179.8	6.5
	Bayer	DKC117-8VT2P	116	4	177.7	8.6
	Meherrin	RV1627TC1250	116	4	175.9	3.9
	Bayer	DKC68-95SS	118	4	172.1	2.1
	Syngenta	NK1677-3110	116	4	168.8	3.8
	Bayer	DKC66-06TRE	116	4	153.5	6.9
	Pioneer	P1870YHR	118	4	146.5	3.3
	Syngenta	NK1694GT	116	4	132.5	5.2
		Mean			172.2	
		LSD, 0.05			16.3	
Rainfed	Gateway	GT3919TRE	119	4	175.9	7.0
	Meherrin	RV1839TC1250	118	4	168.4	5.7
	Meherrin	RV1627TC1250	116	4	165.4	6.5
	Pioneer	P17677YHR	117	4	163.8	11.5
	Bayer	DKC68-35VT2P	118	4	162.9	4.7
	Bayer	DKC117-8VT2P	116	4	150.8	11.9
	Bayer	DKC66-06TRE	116	4	150.3	6.4
	Pioneer	P1870YHR	118	4	147.9	7.7
	Syngenta	NK1677-3110	116	4	147.3	12.3
	DynaGro	DG58VC65	118	4	144.7	12.1
	Bayer	DKC68-95SS	118	4	141.4	2.9
	Syngenta	NK1694GT	116	4	128.8	7.0
		Mean			153.9	
		LSD, 0.05			19.9	
Wet	Syngenta	NK1694GT	116	4	91.3	68.3
	Bayer	DKC68-95SS	118	4	88.3	37.2
	Bayer	DKC117-8VT2P	116	4	82.9	77.4
	DynaGro	DG58VC65	118	4	82.0	66.4
	Pioneer	P17677YHR	117	4	81.8	100.8
	Pioneer	P1870YHR	118	4	80.8	71.7
	Syngenta	NK1677-3110	116	4	76.6	84.8
	Bayer	DKC66-06TRE	116	4	74.5	92.9
	Bayer	DKC68-35VT2P	118	4	65.7	119.0
	Meherrin	RV1839TC1250	118	4	64.4	113.8
	Meherrin	RV1627TC1250	116	4	56.9	79.1
	Gateway	GT3919TRE	119	4	48.2	99.3
		Mean			74.4	
		LSD, 0.05			38.8	
Overall	Pioneer	P17677YHR	117	12	143.4	44.9
	Meherrin	RV1839TC1250	118	12	141.0	49.4
	Gateway	GT3919TRE	119	12	140.0	52.5
	Bayer	DKC68-35VT2P	118	12	139.0	50.0
	Bayer	DKC117-8VT2P	116	12	137.1	39.5
	DynaGro	DG58VC65	118	12	135.5	38.5
	Bayer	DKC68-95SS	118	12	133.9	30.7
	Meherrin	RV1627TC1250	116	12	132.7	46.1
	Syngenta	NK1677-3110	116	12	130.9	41.1
	Bayer	DKC66-06TRE	116	12	126.1	42.6
	Pioneer	P1870YHR	118	12	125.1	35.9
	Syngenta	NK1694GT	116	12	117.5	32.5
		Mean			133.5	
		LSD, 0.05			15.2	

‡Means with the same color band are not different at the LSD α=0.05 test level.
Entries highlighted in blue are non-insect protected refuge comparisons.



Optimal root zone moisture achieved by real-time soil water monitoring and timely irrigation returned 18 bu/acre (+11.7%) and 80 bu/acre (+107%) more grain than RF-Free Drain and Wet treatments, respectively.



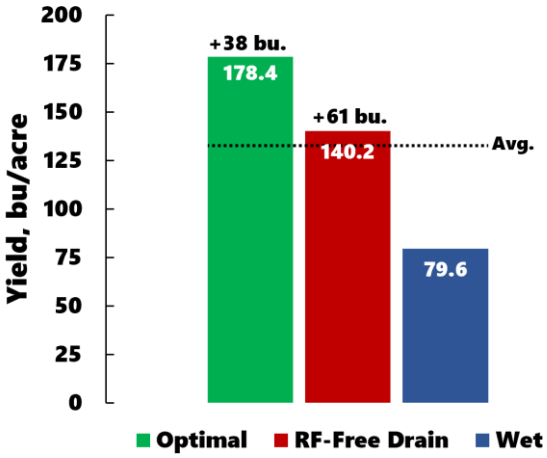
Gross revenue and relative cost comparison of late maturity (≥116 day) hybrid selection under three soil water treatment exposures, based on 2024 Tidewater trial data. Top Yield is the gross revenue generated by the highest average yielding hybrid in each management category; Bottom Yield is the gross revenue generated by the lowest average yielding hybrid. Relative cost is Top Avg. – Bottom Avg. for each category representing the cost of hybrid selection in different environments.

Key Performance Statistics for RM 110-115 Day Hybrids, Tidewater Research Station 2024

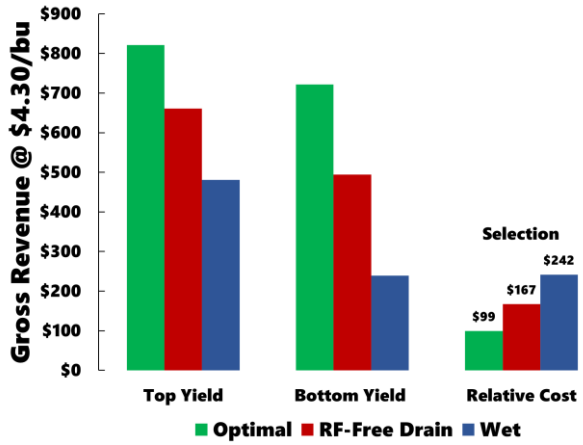
2024 Medium Maturity Corn Hybrid Resilience Trial Information

Soil-Water Regime	Source	Entry	RM, Days	n	Yield†, bu/acre	CV
Optimal	Gateway	GT1214RR2	114	4	191.0	1.5
	Bayer	DKC63-56RR2	113	4	188.4	1.9
	Pioneer	P13841PWUE	113	4	184.7	6.3
	Meherrin	RV1577RR1250	115	4	180.1	2.0
	AgVenture	AV4713PCE	113	4	179.5	5.0
	Pioneer	P13777PWUE	113	4	179.4	3.8
	Pioneer	P14830VYHR	114	4	176.8	5.6
	Pioneer	P1587LR	115	4	175.9	1.5
	Syngenta	NK1228AA	112	4	174.9	7.3
	Syngenta	NK1386VZ	113	4	174.2	3.3
	Bayer	DKC65-93RR2	115	4	168.2	3.4
	Syngenta	NK1307DV	113	4	167.9	7.9
		Mean			178.4	
		LSD, 0.05			10.8	
Rainfed	Pioneer	P13841PWUE	113	4	153.7	4.8
	Syngenta	NK1307DV	113	4	151.2	5.9
	AgVenture	AV4713PCE	113	4	148.4	3.1
	Pioneer	P14830VYHR	114	4	145.5	6.2
	Syngenta	NK1386VZ	113	4	143.3	6.5
	Bayer	DKC63-56RR2	113	4	142.1	10.8
	Pioneer	P1587LR	115	4	141.0	3.8
	Pioneer	P13777PWUE	113	4	140.6	6.0
	Meherrin	RV1577RR1250	115	4	139.3	13.3
	Gateway	GT1214RR2	114	4	136.6	8.5
	Syngenta	NK1228AA	112	4	126.3	10.4
	Bayer	DKC65-93RR2	115	4	114.9	10.3
		Mean			140.2	
		LSD, 0.05			16.3	
Wet	Pioneer	P1587LR	115	4	111.8	66.5
	Syngenta	NK1386VZ	113	4	110.4	54.6
	Pioneer	P14830VYHR	114	4	98.2	66.8
	Pioneer	P13777PWUE	113	4	84.1	75.4
	Syngenta	NK1228AA	112	4	82.3	51.5
	Gateway	GT1214RR2	114	4	79.5	76.4
	Syngenta	NK1307DV	113	4	74.9	79.3
	Bayer	DKC65-93RR2	115	4	69.6	86.2
	Bayer	DKC63-56RR2	113	4	66.9	104.6
	Pioneer	P13841PWUE	113	4	64.1	75.4
	AgVenture	AV4713PCE	113	4	58.5	116.4
	Meherrin	RV1577RR1250	115	4	55.6	67.4
		Mean			79.7	
		LSD, 0.05			42.4	
Overall	Pioneer	P1587LR	115	12	142.9	33.3
	Syngenta	NK1386VZ	113	12	142.6	29.5
	Pioneer	P14830VYHR	114	12	140.2	34.7
	Gateway	GT1214RR2	114	12	135.7	42.4
	Pioneer	P13777PWUE	113	12	134.7	39.3
	Pioneer	P13841PWUE	113	12	134.2	44.4
	Bayer	DKC63-56RR2	113	12	132.4	48.5
	Syngenta	NK1307DV	113	12	131.3	40.4
	AgVenture	AV4713PCE	113	12	128.8	50.1
	Syngenta	NK1228AA	112	12	127.8	36.2
	Meherrin	RV1577RR1250	115	12	125.0	46.7
	Bayer	DKC65-93RR2	115	12	117.6	45.0
		Mean			132.8	
		LSD, 0.05			15.2	

†Means with the same color band are not different at the LSD α=0.05 test level.
Entries highlighted in blue are non-insect-protected refuge comparisons.



Optimal root zone moisture achieved by real-time soil water monitoring and timely irrigation returned 38 bu/acre (+27.1%) and 61 bu/acre (+76.2%) more grain than RF-Free Drain and Wet treatments, respectively.



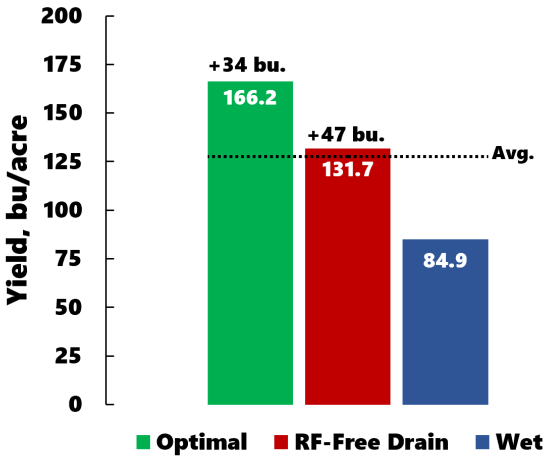
Gross revenue and relative cost comparison of medium maturity (110-115 day) hybrid selection under three soil water treatment exposures, based on 2024 Tidewater trial data. Top Yield is the gross revenue generated by the highest average yielding hybrid in each management category; Bottom Yield is the gross revenue generated by the lowest average yielding hybrid. Relative cost is Top Yield – Bottom Yield for each category representing the cost of hybrid selection in different environments.

Key Performance Statistics for Non-Insect Protected Hybrids, Tidewater Research Station 2024

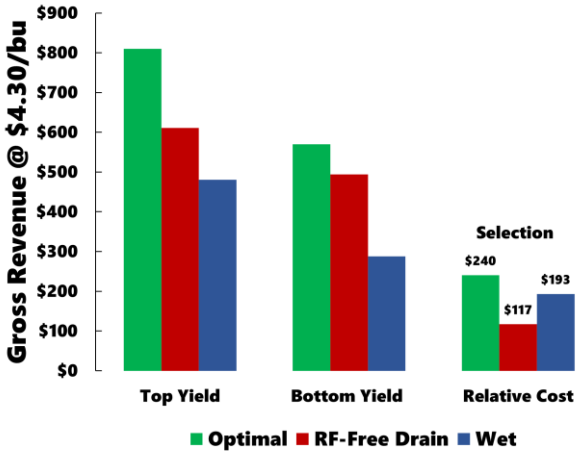
2024 Non-Insect-Protected Corn Hybrids Trial Information

Soil-Water Regime	*Source*	*Entry*	*RM, Days*	*n*	*Yield†, bu/acre*	*CV*
Optimal	Bayer	DKC63-56RR2	113	4	188.4	1.9
	Pioneer	P1587LR	115	4	175.9	1.5
	Bayer	DKC65-93RR2	115	4	168.2	3.4
	Syngenta	NK1694GT	116	4	132.5	5.2
		Mean			166.2	
		LSD, 0.05			7.6	
Rainfed	Bayer	DKC63-56RR2	113	4	142.1	10.8
	Pioneer	P1587LR	115	4	141.0	3.8
	Syngenta	NK1694GT	116	4	128.8	2.9
	Bayer	DKC65-93RR2	115	4	114.9	10.3
		Mean			131.7	
		LSD, 0.05			16.2	
Wet	Pioneer	P1587LR	115	4	111.8	66.5
	Syngenta	NK1694GT	116	4	91.3	68.3
	Bayer	DKC65-93RR2	115	4	69.6	86.2
	Bayer	DKC63-56RR2	113	4	66.9	104.6
		Mean			84.9	
		LSD, 0.05			59.4	
Overall	Pioneer	P1587LR	115	12	142.9	33.3
	Bayer	DKC63-56RR2	113	12	132.4	48.5
	Bayer	DKC65-93RR2	115	12	117.6	45.0
	Syngenta	NK1694GT	116	12	117.5	32.5
		Mean			127.6	
		LSD, 0.05			20.2	

†Means with the same color band are not different at the LSD α=0.05 test level.

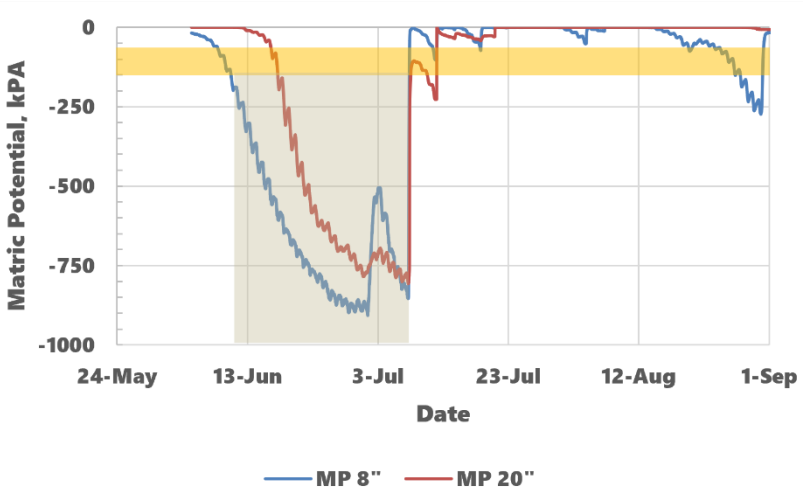


Optimal root zone moisture achieved by real-time soil water monitoring and timely irrigation returned 34 bu/acre (+25.7%) and 47 bu/acre (+55.3%) more grain than RF-Free Drain and Wet treatments, respectively.

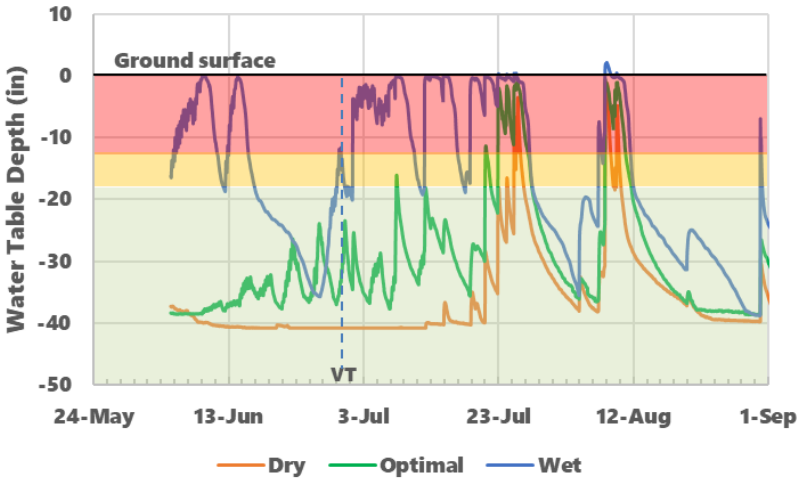


Gross revenue and relative cost comparison of non-insect-protected hybrid selection under three soil water treatment exposures, based on 2024 Tidewater trial data. Top Yield is the gross revenue generated by the highest average yielding hybrid in each management category; Bottom Yield is the gross revenue generated by the lowest average yielding hybrid. Relative cost is Top Yield – Bottom Yield for each category representing the cost of hybrid selection in different environments.

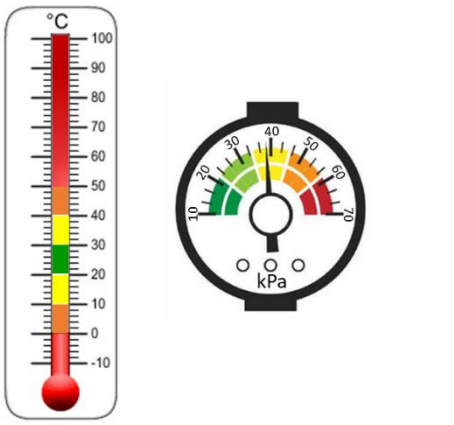
Interpretive Guide and Indicators



Dry stress levels in corn were determined by monitoring in-season matric potential in real time 8" and 20" deep in the root zone. Matric potential is a measure of the energy needed by plants to extract water in a porous medium like soil. Lower matric potential (more negative) causes plants to work harder to provide the water necessary for nutrient uptake, thermoregulation, and carbon assimilation. The yellow horizontal band in the chart above delineates the -55 kPa to -100 kPa range where -55 kPa is the threshold for "minor" water stress 8" deep and -100 kPa the threshold for "major" stress 8" deep and -55 kPa 20" deep in the root zone in a Portsmouth fine sandy loam soil. The light brown vertical band delineates a period of acute soil water deficit observed in June through early July. Episodes of "minor" stress may occur during irrigation events depending on the rate of water redistribution in the soil.

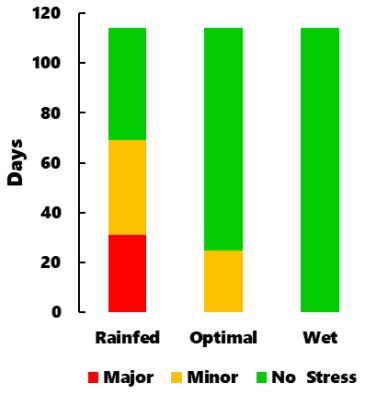


Ground water table depth traces showing depth of the water table beneath corn in RAINFED, OPTIMAL, and WET treatments. Zones are color coded according to the depth and relative crop stress level: Red=highest crop stress, <12" deep; Yellow=medium crop stress, 12-18" deep; and Green=no crop stress, >18" deep. Line above the ground surface on August 8 is ponded water.

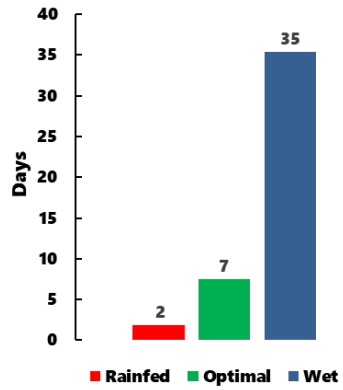


Above, thermometer measuring heat content with fill color indicating human comfort ranges. Right: dial gauge measuring soil water matric potential in kilopascals (kPa) with fill color indicating plant comfort ranges. Green=optimal Red= danger zone.

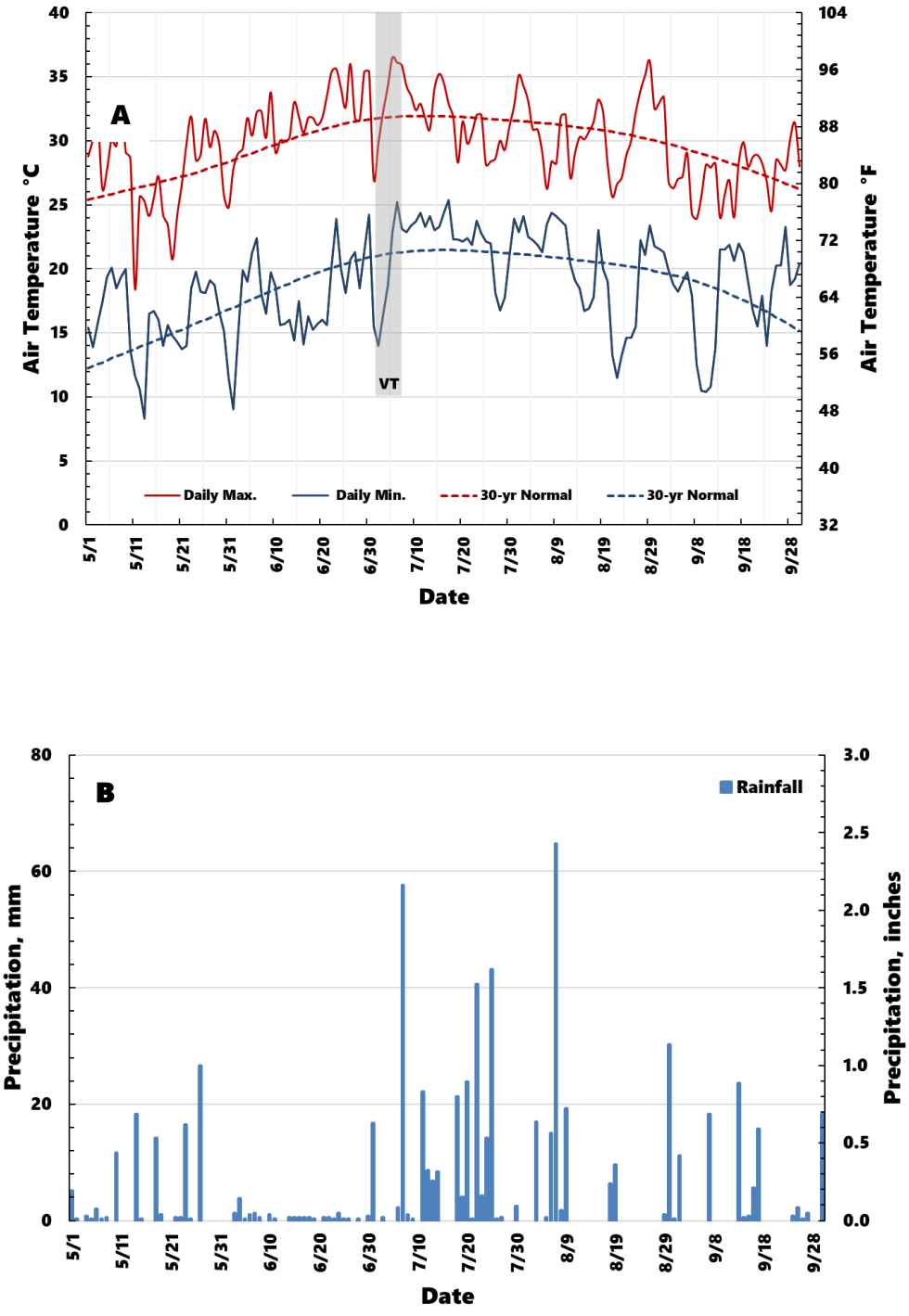
2024 Corn dry stress V6 through black layer, top 20" of root zone



2024 Corn wet stress V6 through black layer, top 12" of root zone



Weather Information for the Tidewater Research Station May-September 2024



May 1 to September 30, 2024. Panel **A:** Daily maximum and minimum temperatures, and 30-yr Normals. Grey rectangle is the observed VT interval for drainage treatments and hybrids. Panel **B:** Daily precipitation.

Acknowledgements

Corn Growers Association of North Carolina Program Support

We thank Professor Ron Heiniger, Extension Corn Specialist, for his assistance in planting operations, and for the use of post-harvest crop drying facilities.

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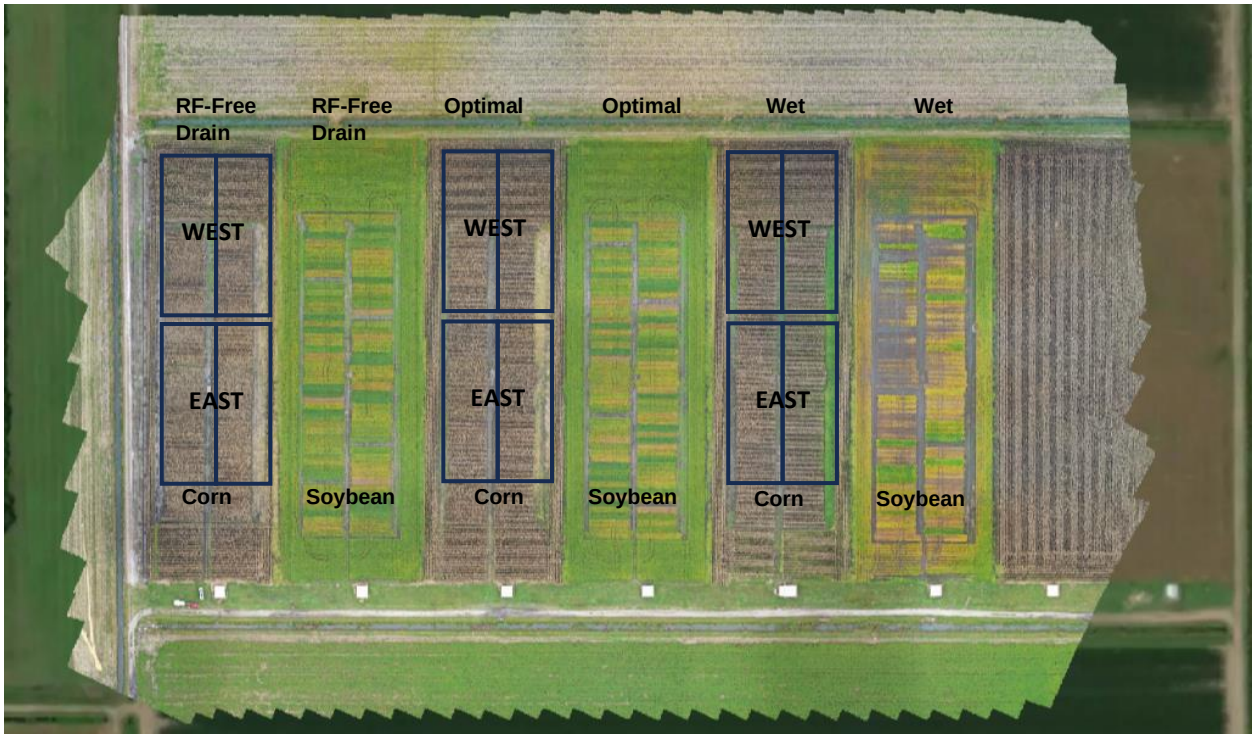

Aerial view of corn and soybean plots and spatial extent of West and East Ranges at the Total Agricultural Water Management site, Plymouth, NC. Treatment blocks are rotated annually following major producers in the region. *Image: J. Ward*