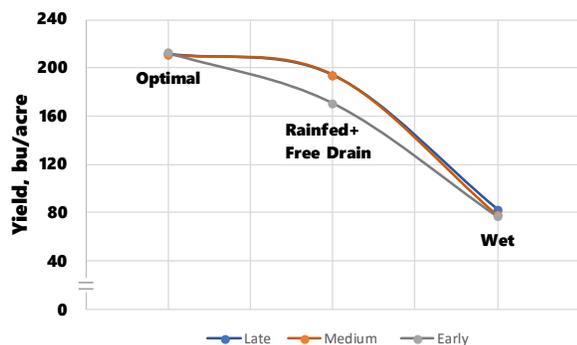


Summary

- We detected yield differences in late (≥ 116 day) and medium (110-115 day) season relative maturity group hybrids under Rainfed and Optimal soil-water regimes. In-season Wet stress reduced yield but significant differences were only detected in late season hybrids. Early (≤ 109 day) season hybrids were indifferent.
- Monitoring root zone soil water status coupled with timely irrigation and drainage improved aggregate grain yield by 25.3 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.



Yield response to water stress by Late (≥ 116 day), Medium (110-115 day), and Early (≤ 109 day) season corn hybrids in 2023.

2023 Corn Resilience Trial Summary
Relative Maturity Group and Aggregate Performance

Soil-Water Regime	Relative Maturity Group (Days)	n	Yield [†] , bu/acre	CV
Optimal	Early (≤ 109)	8	212.5	5.4
	Late (≥ 116)	36	211.5	6.6
	Medium (110-115)	28	211.1	4.9
	Mean		211.7	
Rainfed	Medium (110-115)	28	194.4	6.7
	Late (≥ 116)	36	194.0	8.1
	Early (≤ 109)	8	170.8	4.9
	Mean		186.4	
Wet	Late (≥ 116)	36	82.7	25.8
	Medium (110-115)	28	78.1	14.9
	Early (≤ 109)	8	77.0	21.5
	Mean		79.3	

[†]Means with the same color band are not different at the LSD $\alpha=0.05$ test level.

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.

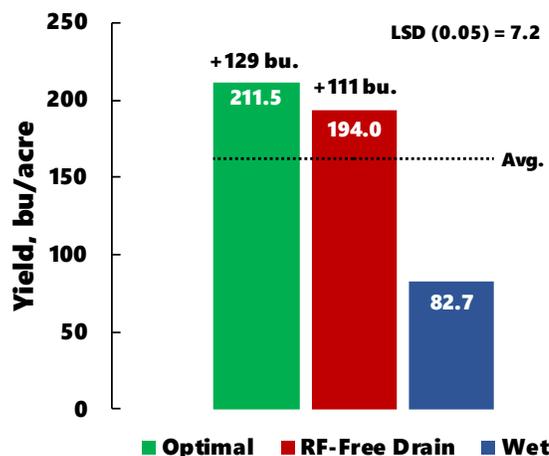
The trials, conducted at the Total Ag Water Management (TAWM) Site located at the Tidewater Research Station in Plymouth, NC, artificially impose water stress during the growing season under a uniform soil type, fertility program, and observed natural precipitation. Eighteen hybrid entries from seven agribusiness partners were trialed in 2023. 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 8 and harvested October 3. Yield data were analyzed as a mixed-effects model 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:

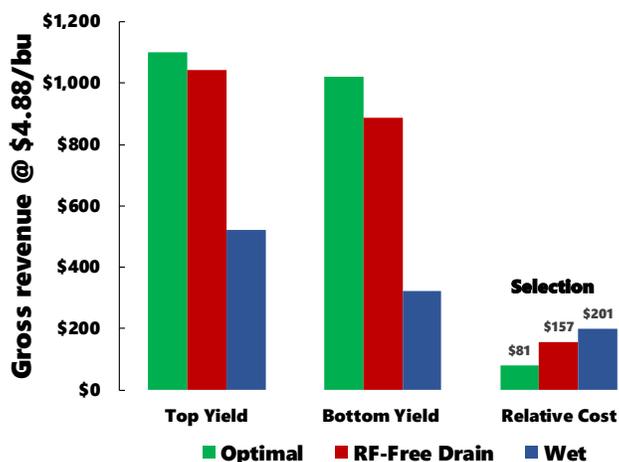
- Rainfed-Free Drain:** intended to create drier than normal conditions typical of well-drained sites in NC. Drain tile spacing is 37.5' which is highly intensive for a Portsmouth fine sandy loam soil and intended to provide a much higher drainage intensity than needed for efficient crop production on 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 efficient water management systems. Intensive drainage 37.5' and drip irrigation is used systemically to control soil water. Soil water matric potential is continuously monitored 8" and 20" deep in the root zone to determine when 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 continually pumped into the drainage system if the water table fell below 1.0' along with daily subsurface drip irrigation to enhance wet stress conditions. 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 2023

Late Maturity Corn Hybrid Resilience Trial Information						
Soil-Water Regime	Company	Entry	RM, Days	n	Yield [†] , bu/acre	CV
Optimal	Dyna-Gro	DG58VC65	118	4	225.7	5.7
	Bayer	DK68-35VT2P	118	4	223.8	4.4
	Bayer	DK68-95SS	118	4	219.2	3.8
	Syngenta	NK1677-3110	116	4	215.3	2.2
	Pioneer	P1608YHR	116	4	211.4	4.5
	Bayer	DK68-69VT2P	118	4	211.2	2.8
	Pioneer	P1870YHR	118	4	209.1	1.9
	Bayer	DK67-70RR2	117	4	204.7	1.7
	Revere	RV1627TRE	116	4	182.9	4.1
		<i>Mean</i>				211.5
	<i>LSD, 0.05</i>				10.5	
Rainfed	Dyna-Gro	DG58VC65	118	4	213.6	5.9
	Pioneer	P1870YHR	118	4	208.6	6.1
	Bayer	DK68-95SS	118	4	200.4	6.2
	Bayer	DK68-35VT2P	118	4	200.0	6.2
	Syngenta	NK1677-3110	116	4	198.6	4.9
	Bayer	DK68-69VT2P	118	4	189.4	4.4
	Pioneer	P1608YHR	116	4	181.5	4.2
	Revere	RV1627TRE	116	4	178.3	3.4
	Bayer	DK67-70RR2	117	4	175.3	4.5
		<i>Mean</i>				194.0
	<i>LSD, 0.05</i>				14.0	
Wet	Bayer	DK68-35VT2P	118	4	107.2	10.8
	Bayer	DK67-70RR2	117	4	105.9	13.9
	Dyna-Gro	DG58VC65	118	4	91.2	5.5
	Bayer	DK68-95SS	118	4	90.6	10.5
	Revere	RV1627TRE	116	4	90.1	9.2
	Bayer	DK68-69VT2P	118	4	83.1	6.6
	Pioneer	P1608YHR	116	4	66.0	19.0
	Syngenta	NK1677-3110	116	4	58.4	17.6
	Pioneer	P1870YHR	118	4	51.8	31.9
		<i>Mean</i>				82.7
	<i>LSD, 0.05</i>				15.5	
Overall	Bayer	DK68-35VT2P	118	12	177.0	30.2
	Dyna-Gro	DG58VC65	118	12	176.8	36.3
	Bayer	DK68-95SS	118	12	170.1	35.3
	Bayer	DK67-70RR2	117	12	162.0	27.3
	Bayer	DK68-69VT2P	118	12	161.2	36.4
	Syngenta	NK1677-3110	116	12	157.4	46.9
	Pioneer	P1870YHR	118	12	156.5	49.9
	Pioneer	P1608YHR	116	12	153.0	43.2
	Revere	RV1627TRE	116	12	150.5	30.0
		<i>Mean</i>				162.7
	<i>LSD, 0.05</i>				7.5	



Optimal root zone moisture achieved by real-time soil water monitoring and timely drainage and irrigation returned 18 bu/acre (+9.3%) and 129 bu/acre (+155%) more grain than RF-Free Drain and Wet treatments, respectively. LSD=Least significant difference, 7.2 bu/acre.



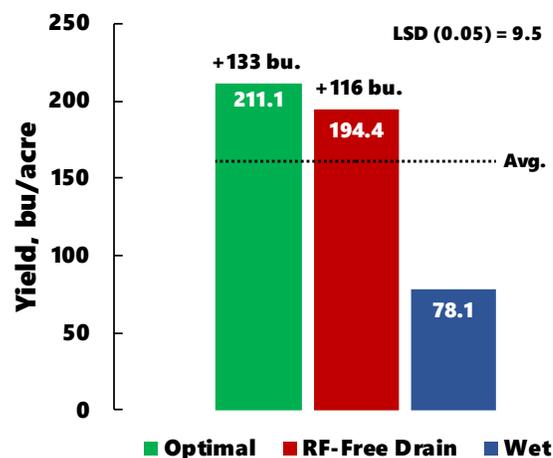
Gross revenue and relative cost comparison of late maturity (≥116 day) hybrid selection under three soil water treatment exposures, based on 2023 Tidewater trial data. Top Yield is the gross revenue generated by the highest average yielding hybrid in each management category; Bottom Yield is the gross 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.

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

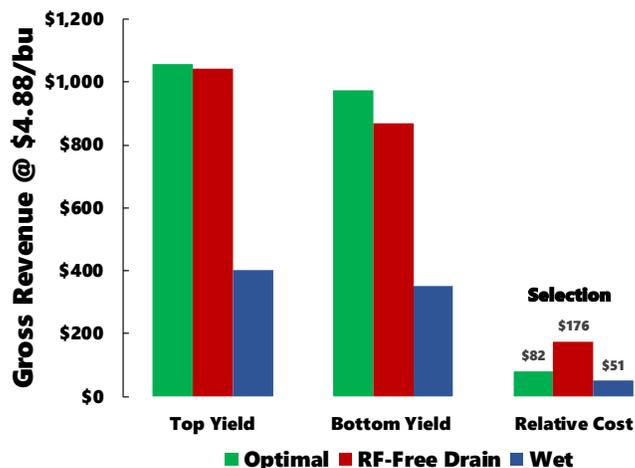
Key Performance Statistics for RM 110-115 Day Hybrids, Tidewater Research Station 2023

Medium Maturity Corn Hybrid Resilience Trial Information						
Soil-Water Regime	Company	Entry	RM, Days	n	Yield [‡] , bu/acre	CV
Optimal	Gateway	GT2715VT2	115	4	216.6	4.5
	Pioneer	P1289YHR	112	4	216.3	3.3
	Pioneer	P1222YHR	112	4	215.9	4.9
	AgVenture	AV3514AML	114	4	212.9	5.8
	AgVenture	AV6010AM	110	4	211.6	4.5
	Syngenta	NK1523-V	115	4	204.4	4.5
	Pioneer	P1511YHR	115	4	199.8	3.4
		<i>Mean</i>				211.1
	<i>LSD, 0.05</i>				14.7	
Rainfed	Pioneer	P1289YHR	112		213.9	4.8
	Pioneer	P1222YHR	112		199.4	2.6
	AgVenture	AV3514AML	114		196.5	4.1
	AgVenture	AV6010AM	110		194.7	3.8
	Gateway	GT2715VT2	115		189.7	6.7
	Pioneer	P1511YHR	115		188.5	5.1
	Syngenta	NK1523-V	115		177.8	4.0
		<i>Mean</i>				194.4
	<i>LSD, 0.05</i>				11.9	
Wet	Gateway	GT2715VT2	115		82.6	21.4
	AgVenture	AV6010AM	110		82.2	16.4
	Pioneer	P1289YHR	112		81.2	11.2
	Syngenta	NK1523-V	115		77.2	4.9
	Pioneer	P1222YHR	112		76.0	18.7
	Pioneer	P1511YHR	115		75.5	19.1
	AgVenture	AV3514AML	114		72.2	13.3
		<i>Mean</i>				78.1
	<i>LSD, 0.05</i>				14.4	
Overall	Pioneer	P1289YHR	112		170.5	39.0
	Pioneer	P1222YHR	112		163.8	40.3
	Gateway	GT2715VT2	115		163.0	37.9
	AgVenture	AV6010AM	110		162.8	37.3
	AgVenture	AV3514AML	114		160.5	41.3
	Pioneer	P1511YHR	115		154.6	38.4
	Syngenta	NK1523-V	115		153.1	37.6
		<i>Mean</i>				160.6
	<i>LSD, 0.05</i>				7.6	

[‡]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 drainage and irrigation returned 17 bu/acre (+8.7%) and 133 bu/acre (+170%) more grain than RF-Free Drain and Wet treatments, respectively. LSD=Least significant difference, 9.5 bu/acre.

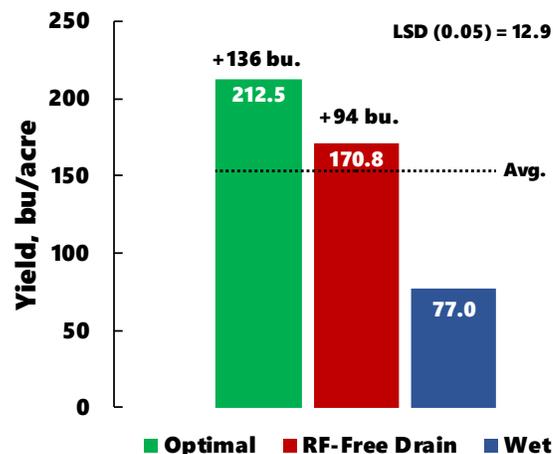


Gross revenue and relative cost comparison of medium maturity (110-115 day) hybrid selection under three soil water treatment exposures, based on 2023 Tidewater trial data. Top Yield is the gross revenue generated by the highest average yielding hybrid in each management category; Bottom Yield is the 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.

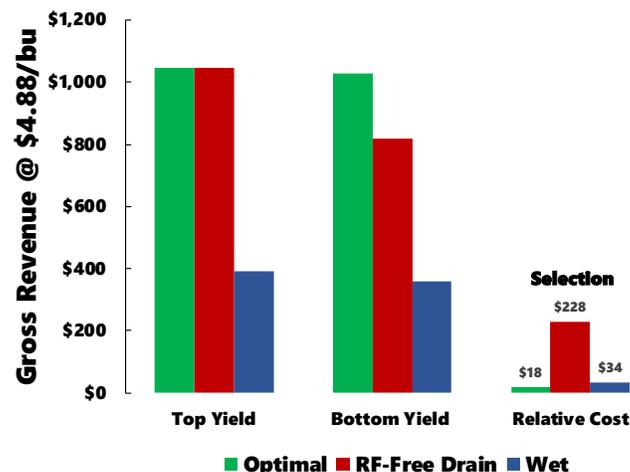
Key Performance Statistics for ≤109 Day Hybrids, Tidewater Research Station 2023

2023 Early Maturity Corn Hybrid Resilience Trial Information						
Soil-Water Regime	Company	Entry	RM, Days	n	Yield [†] , bu/acre	CV
Optimal	Revere	RV0918VT2P	109	4	214.3	6.6
	Pioneer	P0953YHR	109	4	210.7	
	<i>Mean</i>				212.5	
					<i>LSD, 0.05</i>	37.5
Rainfed	Pioneer	P0953YHR	109	4	173.9	5.2
	Revere	RV0918VT2P	109	4	167.7	
	<i>Mean</i>				170.8	
					<i>LSD, 0.05</i>	11.0
Wet	Revere	RV0918VT2P	109	4	80.4	21.5
	Pioneer	P0953YHR	109	4	73.5	
	<i>Mean</i>				77.0	
					<i>LSD, 0.05</i>	25.1
Overall	Revere	RV0918VT2P	109	12	154.2	38.4
	Pioneer	P0953YHR	109	12	152.7	
	<i>Mean</i>				153.4	
					<i>LSD, 0.05</i>	42.1

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



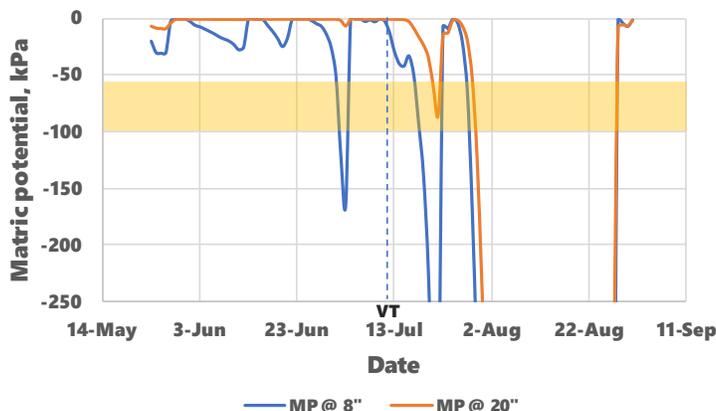
Maintaining optimal root zone moisture in two early maturity (≤109 day) hybrids returned 42 bu/acre (+24.6%) and 133 bu/acre (+176%) more grain than RF-Free Drain and Wet treatments, respectively. LSD=Least significant difference, 12.9 bu/acre.



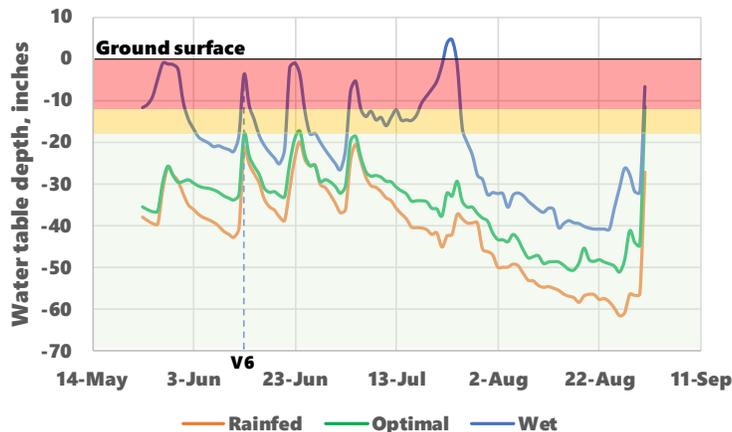
Gross revenue and relative cost comparison of early maturity (≤109 day) hybrid selection under three soil water treatment exposures, based on 2023 Tidewater trial data. Top Yield is the gross revenue generated by the highest average yielding hybrid in each management category; Bottom Yield is the gross 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

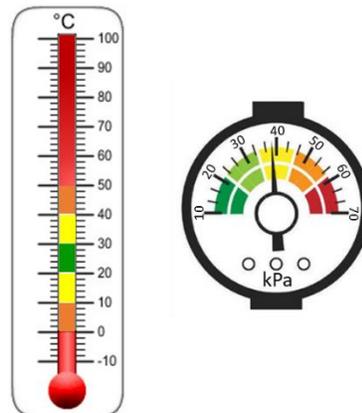
Observed 2023 Teros 21 sensor readings beneath Rainfed corn



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. Episodes of "minor" stress may occur during irrigation events depending on the rate of water redistribution in the soil.

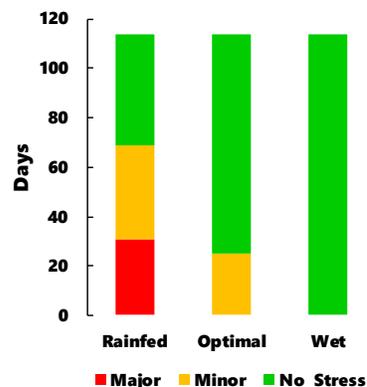


Ground water table depth traces showing depth of the water table beneath corn in RAINFED, OPTIMAL, and WET treatments. Zones are color coded according to the depth and relative crop stress level: Red=highest crop stress, <12" deep; Yellow=medium crop stress, 12-18" deep; and Green=no crop stress, >18" deep. Line above the ground surface on July 23 is ponded water.

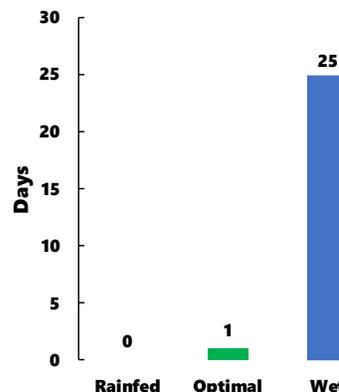


Above, thermometer measuring heat content with fill color indicating human comfort ranges. Right: dial gauge measuring soil water matric potential in kilopascals (kPa) with fill color indicating plant comfort ranges. Green=optimal Red= danger zone.

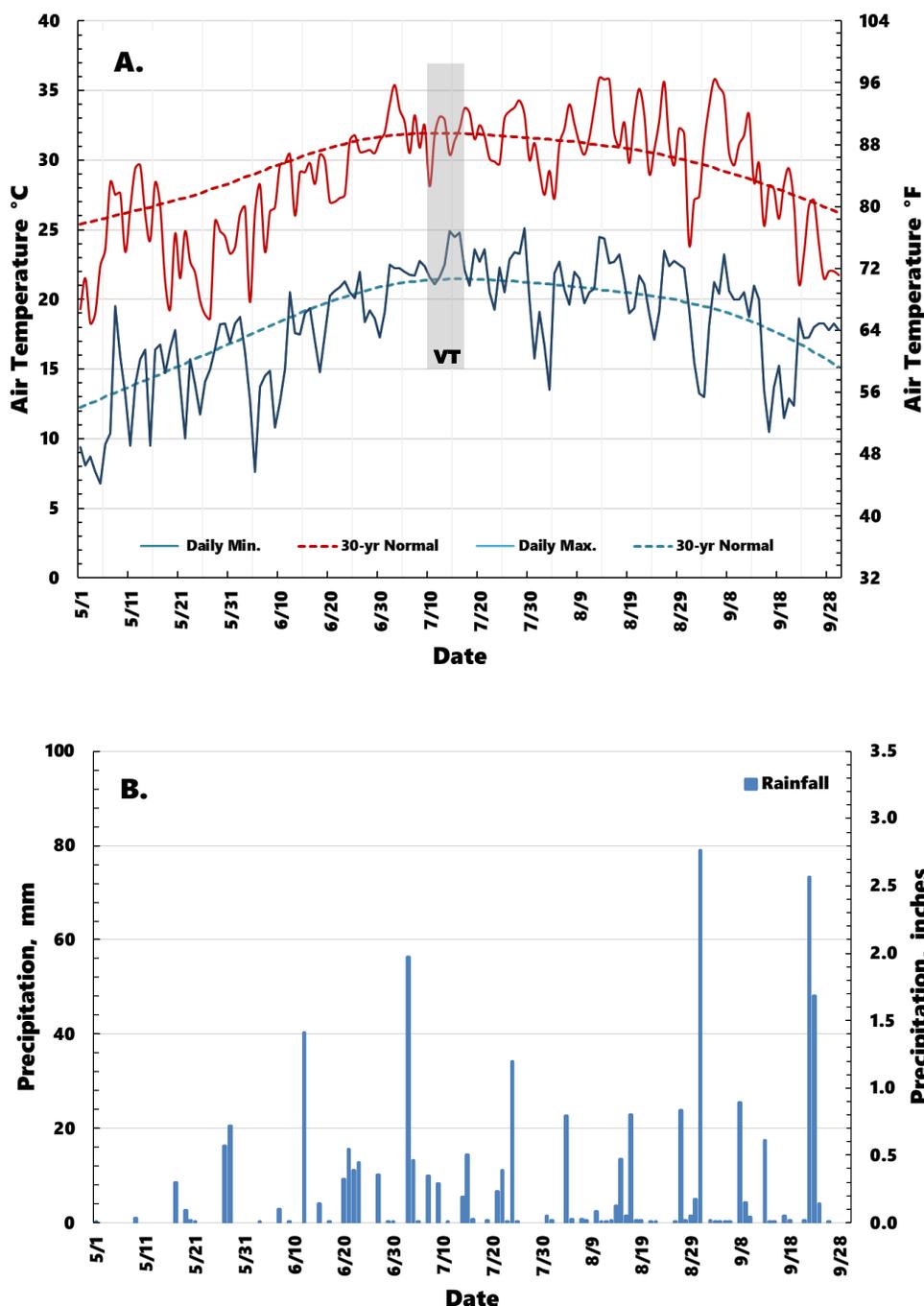
2023 Corn dry stress V6 through black layer, top 20" of root zone



2023 Corn wet stress V6 through black layer, top 12" of root zone



Weather Information for the Tidewater Research Station May-September 2023



May 1 to September 30, 2023. Panel **A.**: Daily maximum and minimum temperatures, and 30-yr Normals. Grey rectangle is VT-R1 interval across drainage treatments and hybrids. Panel **B.**: Daily precipitation.

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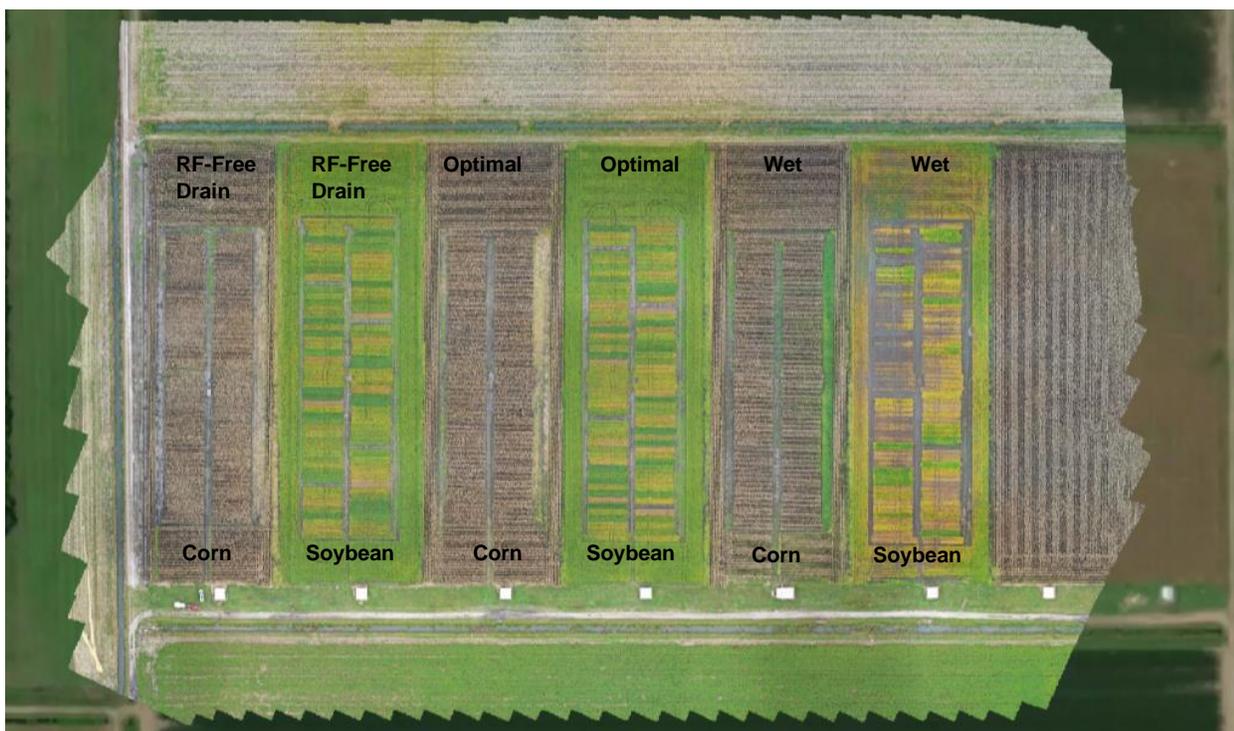


Figure 2. Aerial view of corn and soybean plots in mid-September 2023 at the Total Agricultural Water Management site, Plymouth, NC. Treatment blocks are rotated annually following major producers in the region. *Image: J. Ward*