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Water Resiliency Soybean Variety Performance Trials

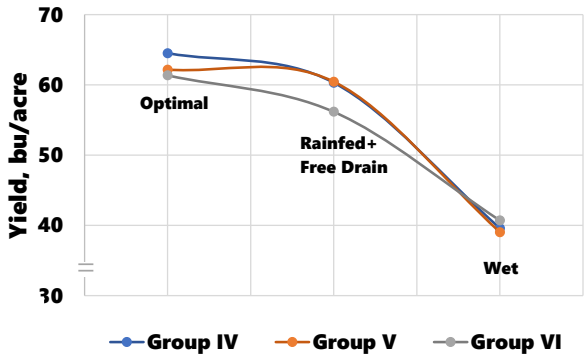
Summary

- Soybean yield varied with relative maturity (RM) group under Optimal and Rainfed + Free Drain (dryland) soil-water regimes. No differences were observed under wet conditions.
- Overall, Group IV varieties outperformed Group VI varieties accounting for the difference in varietal entries. Group V varietal performance was not different from Group IV and VI.
- Dryland exposure suppressed Group VI grain yield, a response we also observed in 2022.
- Significant yield decreases occurred in all maturity groups due to poor drainage conditions compared to other treatments.

2023 Soybean Resilience Trial Information
Performance by Maturity Group

Relative Maturity Group (MG)	*n*	*Yield*, bu/acre*	*CV*
IV	120	54.8	23.8
V	72	54.6	25.1
VI	60	52.7	22.7

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



Soybean response to three treatment exposures in 2023. Solid dots are the average yield for Group IV, V, and VI varieties (n=21).

Introduction

The goals of these performance trials were to:

- Evaluate elite, commercially available soybean varieties to water stress exposure during the yield critical R2 to R5 development stages.
- Provide an objective guide for extension agents, producers, and advisors in selecting varieties 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-one varieties from nine agribusiness partners were trialed in 2023. The varieties were randomized and replicated four times in a two-level experimental design on a Portsmouth fine sandy loam soil. The target planting density was 120,000 seeds/acre on 30-inch row spacing. The trials were planted on May 11 and harvested from September 27 to November 9. Aggregate yield (Maturity Group) data were analyzed as a mixed-effects model with unequal variance for Soil-Water Regime and compound symmetry covariance structure in SAS 9.4 Proc Glimmix. Mean yield for Maturity Group, and varietal entry within Maturity Group and Soil-Water Regime were separated via least significant difference (LSD, $\alpha = 0.05$); the two top yielding ranges are displayed.

Varieties were evaluated under three soil-water treatments, 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 was governed entirely by natural rainfall and tile drains discharging at full capacity throughout the growing season.
- Optimal: intended to create ideal conditions representative of efficient water management systems. The tile spacing was set to 37.5' to prevent saturated soil conditions. Soil water matric potential was continuously monitored 8" and 20" deep in the root zone. Subsurface drip irrigation was utilized to apply water during dryer than normal periods.
- Wet: This treatment was intended to create a water saturated root zone. Tile drainage spacing was 37.5' and controlled to both reduce and/or stop drainage to artificially impose wet stress. This was coupled with subsurface tile and 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 subsurface drip irrigation to enhance wet stress conditions. This treatment would represent river bottoms, and tidal controlled drainage areas during most growing seasons. It would be similar to poorly drained and very poorly drained fields with little surface or subsurface drainage capacity.

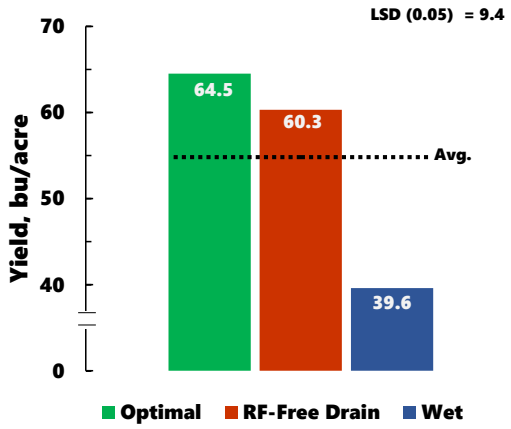
Water Resiliency Soybean Variety Performance Trials

Key Performance Statistics for **Group IV** Varieties, Tidewater Research Station 2023

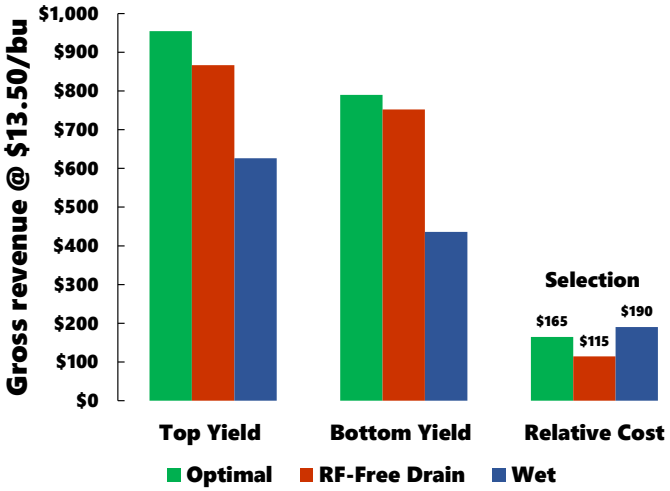
2023 Group IV Soybean Resilience Trial Information

Soil-Water Regime	Company	Entry	RM Group	n	Yield* bu/acre	CV
Optimal	Gateway	GT431RXS	4.3	4	70.7	2.2
	Gateway	GT473XFS	4.7	4	67.9	1.6
	Pioneer	P42A84E	4.2	4	67.1	5.7
	Syngenta	NK48-H3XFS	4.8	4	67.0	6.1
	Pioneer	P45A81E	4.5	4	65.6	12.8
	Pioneer	P45T88E	4.5	4	63.9	3.3
	Gateway	GT457XFS	4.5	4	61.8	6.5
	Bayer	AG48XF2	4.8	4	61.5	3.2
	Syngenta	NK45-P9XF	4.5	4	61.0	3.7
	So. Harvest	SH4622E3	4.6	4	58.5	2.9
		Mean			64.5	
		LSD, 0.05			5.5	
RF-Free Drain	Pioneer	P45A81E	4.5	4	64.2	9.9
	Pioneer	P42A84E	4.2	4	63.1	6.2
	Gateway	GT431RXS	4.3	4	63.1	4.8
	Gateway	GT473XFS	4.7	4	62.4	4.4
	Gateway	GT457XFS	4.5	4	60.8	8.4
	Bayer	AG48XF2	4.8	4	59.7	7.4
	Syngenta	NK48-H3XFS	4.8	4	59.5	4.2
	Pioneer	P45T88E	4.5	4	57.9	5.8
	Syngenta	NK45-P9XF	4.5	4	56.7	5.2
	So. Harvest	SH4622E3	4.6	4	55.7	5.7
		Mean			60.3	
		LSD, 0.05			5.6	
Wet	Gateway	GT431RXS	4.3	4	46.4	30.2
	Gateway	GT457XFS	4.5	4	45.3	18.2
	Pioneer	P42A84E	4.2	4	44.4	28.5
	Gateway	GT473XFS	4.7	4	41.7	27.3
	Syngenta	NK48-H3XFS	4.8	4	39.8	18.8
	Bayer	AG48XF2	4.8	4	39.4	22.4
	Pioneer	P45A81E	4.5	4	36.6	28.4
	Syngenta	NK45-P9XF	4.5	4	36.2	14.5
	So. Harvest	SH4622E3	4.6	4	33.8	23.1
	Pioneer	P45T88E	4.5	4	32.3	24.7
		Mean			39.6	
		LSD, 0.05			6.0	
Overall	Gateway	GT431RXS	4.3	12	60.1	21.5
	Pioneer	P42A84E	4.2	12	58.2	21.5
	Gateway	GT473XFS	4.7	12	57.3	23.6
	Gateway	GT457XFS	4.5	12	56.0	16.9
	Pioneer	P45A81E	4.5	12	55.5	29.9
	Syngenta	NK48-H3XFS	4.8	12	55.4	23.4
	Bayer	AG48XF2	4.8	12	53.5	22.1
	Pioneer	P45T88E	4.5	12	51.4	30.1
	Syngenta	NK45-P9XF	4.5	12	51.3	23.5
	So. Harvest	SH4622E3	4.6	12	49.3	26.2
		Mean			54.8	
		LSD, 0.05			3.2	

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



Group IV soybean variety response to Optimal, RF-Free Drain (Dryland), and Wet treatment exposure.



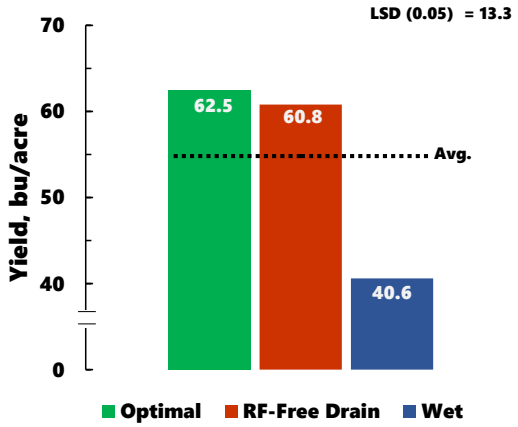
Gross revenue and relative cost comparison of Group IV variety selection under three soil water treatment exposures, based on the 2023 Tidewater trials. Top Avg. $ is the gross revenue generated by the highest average yielding variety in each management category; Bottom Avg. $ is the gross revenue generated by the lowest average yielding variety. Relative cost is Top Avg. – Bottom Avg. for each category representing the cost of variety selection in different environments.

Key Performance Statistics for **Group V** Varieties, Tidewater Research Station 2023 con't.

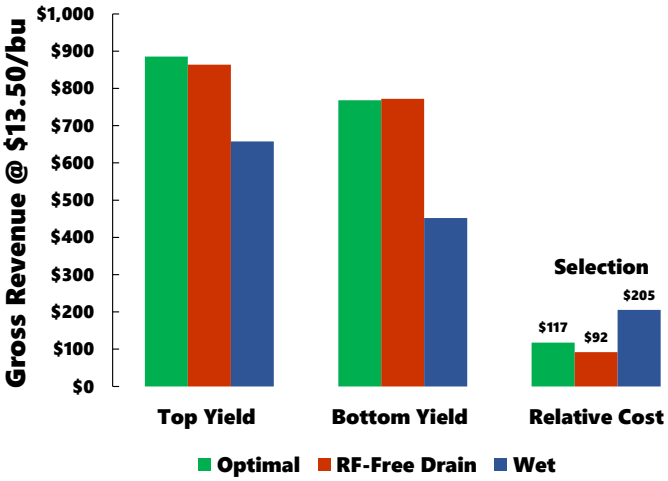
2023 Group V Soybean Resilience Trial Information

Soil-Water Regime	*Company*	*Entry*	*MG Group*	*n*	*Yield* bu/acre*	*CV*
Optimal	Pioneer	P52A14SE	5.2	4	65.6	5.4
	MorSoy	MS5640XF	5.6	4	63.8	3.4
	Syngenta	NK52-V1XF	5.2	4	63.5	3.4
	Pioneer	P56A71E	5.6	4	62.7	3.6
	Don Mario	DM55F62S	5.5	4	56.9	5.4
		Average			62.5	
		LSD, 0.05			3.9	
RF-Free Drain	Pioneer	P52A14SE	5.2	4	64.0	8.7
	MorSoy	MS5640XF	5.6	4	63.1	8.6
	Pioneer	P56A71E	5.6	4	62.2	4.3
	Don Mario	DM55F62S	5.5	4	57.3	2.2
	Syngenta	NK52-V1XF	5.2	4	57.2	8.2
		Average			60.8	
		LSD, 0.05			6.2	
Wet	Pioneer	P52A14SE	5.2	4	48.7	22.2
	Pioneer	P56A71E	5.6	4	42.9	34.6
	MorSoy	MS5640XF	5.6	4	39.2	44.7
	Syngenta	NK52-V1XF	5.2	4	38.8	44.5
	Don Mario	DM55F62S	5.5	4	33.5	38.2
		Average			40.6	
		LSD, 0.05			7.7	
Overall	Pioneer	P52A14SE	5.2	12	59.4	17.4
	Pioneer	P56A71E	5.6	12	55.9	22.3
	MorSoy	MS5640XF	5.6	12	55.4	27.7
	Syngenta	NK52-V1XF	5.2	12	53.1	27.2
	Don Mario	DM55F62S	5.5	12	49.2	27.5
		Average			54.6	
		LSD, 0.05			3.3	

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



Group V soybean variety response to Optimal, RF-Dree Drain (Dryland), and Wet treatment exposure.



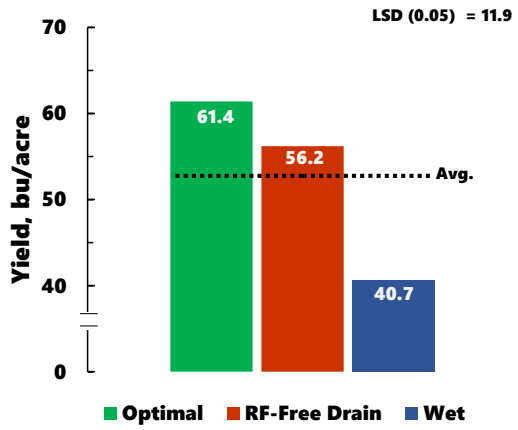
Gross revenue and relative cost comparison of Group V variety selection under three soil water treatment exposures, based on the 2023 Tidewater trials. Top Yield is the gross revenue generated by the highest average yielding variety in each management category; Bottom Yield is the gross revenue generated by the lowest average yielding variety. Relative cost is Top Yield – Bottom Yield for each category representing the cost of variety selection in different environments.

Key Performance Statistics for **Group VI** Varieties, Tidewater Research Station 2023 con't.

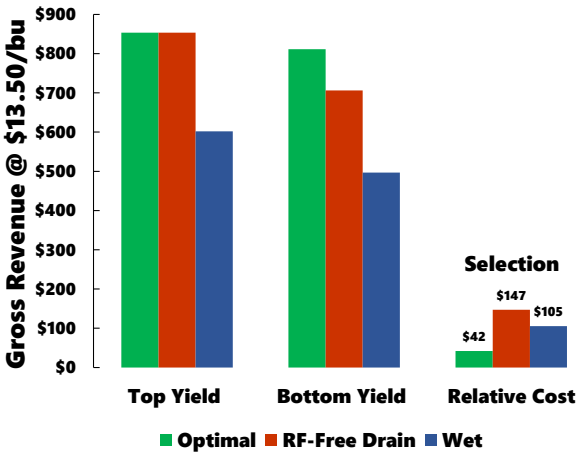
2023 Group VI Soybean Resilience Trial Information

Soil-Water Regime	*Company*	*Entry*	*MG Group*	*n*	*Yield* bu/acre*	*CV*
Optimal	Pioneer	P68A41BE	6.8	4	63.2	7.4
	AgVenture	AV68Y8BE	6.8	4	62.0	5.6
	Pioneer	P63A93E	6.3	4	60.8	8.7
	USG	USG7633XF	6.3	4	60.7	3.2
	Syngenta	NK67-P1XF	6.7	4	60.1	6.7
		Average			61.4	
		LSD, 0.05			4.5	
RF-Free Drain	USG	USG7633XF	6.3	4	61.4	13.3
	Pioneer	P63A93E	6.3	4	57.9	8.7
	Pioneer	P68A41BE	6.8	4	54.9	12
	Syngenta	NK67-P1XF	6.7	4	54.4	5.2
	AgVenture	AV68Y8BE	6.8	4	52.3	7.9
		Average			56.2	
		LSD, 0.05			7.2	
Wet	Pioneer	P63A93E	6.3	4	44.6	30.6
	Pioneer	P68A41BE	6.8	4	43.5	30.2
	Syngenta	NK67-P1XF	6.7	4	41.6	42.7
	AgVenture	AV68Y8BE	6.8	4	37.1	22.7
	USG	USG7633XF	6.3	4	36.8	19.2
		Average			40.7	
		LSD, 0.05			10.3	
Overall	Pioneer	P63A93E	6.3	12	54.4	19.9
	Pioneer	P68A41BE	6.8	12	53.9	21.8
	USG	USG7633XF	6.3	12	53.0	24.7
	Syngenta	NK67-P1XF	6.7	12	52.0	25.5
	AgVenture	AV68Y8BE	6.8	12	50.4	24.7
		Average			52.7	
		LSD, 0.05			4.1	

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



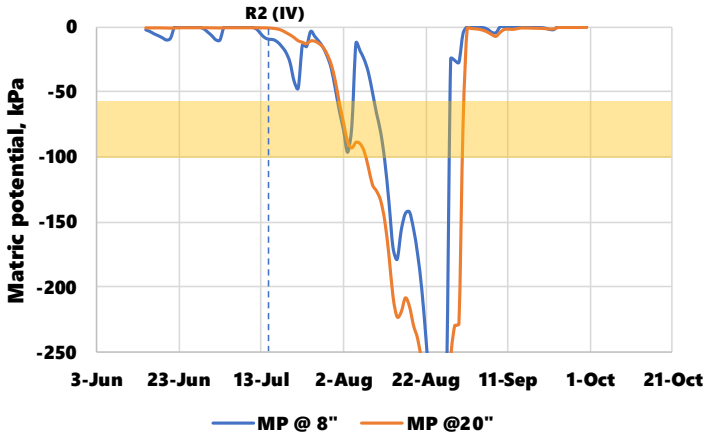
Group VI soybean variety response to Optimal, RF-Dree Drain (Dryland), and Wet treatment exposure.



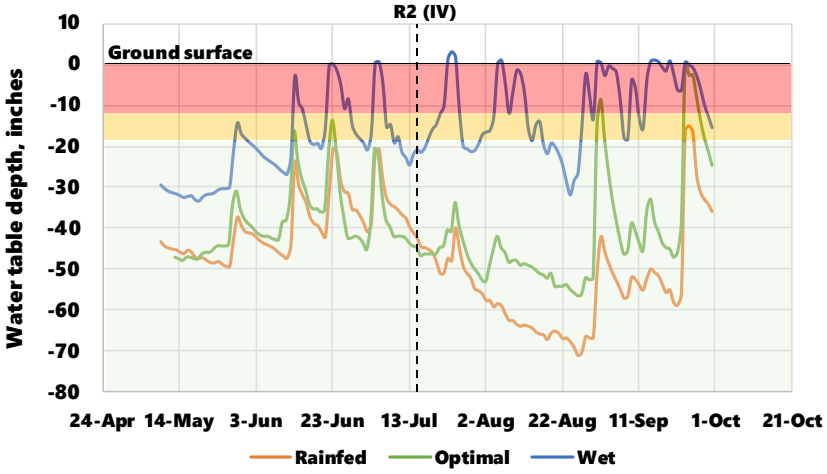
Gross revenue and relative cost comparison of Group VI variety selection under three soil water treatment exposures, based on the 2023 Tidewater trials. Top Yield is the gross revenue generated by the highest average yielding variety in each management category; Bottom Yield is the gross revenue generated by the lowest average yielding variety. Relative cost is Top Yield – Bottom Yield for each category representing the cost of variety selection in different environments.

Interpretive Guide and Indicators

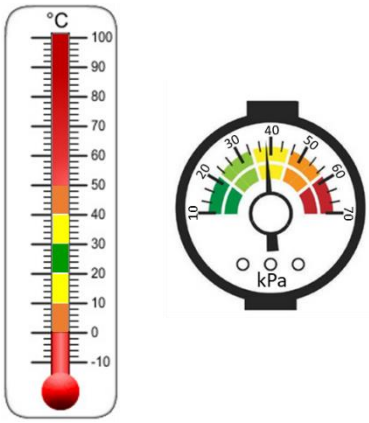
Observed 2023 Teros 21 sensor readings beneath rainfed soybeans.



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.

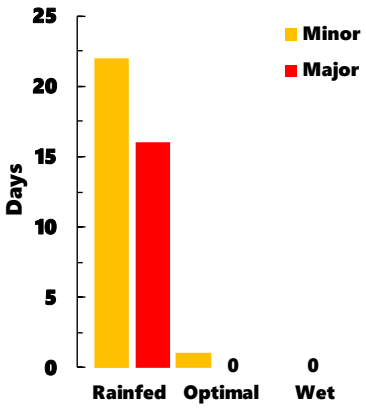


Ground water table depth trace showing depth of the water table beneath soybean in three treatment exposures. Presence of a water table indicates a lack of oxygen essential for healthy root metabolism. Soils in tidal zone areas like the North Carolina Blacklands are naturally poorly drained and depend entirely on water table management via efficient drainage for agricultural productivity. Depth to water table is a critical stress indicator. Zones are color coded according to the depth and relative crop stress level: Red=high crop stress, <12" deep; Yellow=medium crop stress, 12-18" deep; and Green=no crop stress, >18" deep. A "wet stress day" is defined as a 24-hr. period of saturated crop root zone with water table <12" beneath ground surface. Traces running above 0 ft. indicate surface ponded water.

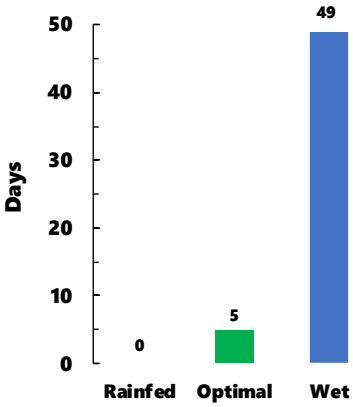


Above, thermometer measuring heat content with fill color indicating human comfort ranges. Right: dial gauge measuring soil water matric potential in kilopascals (kPa) with fill color indicating plant comfort ranges. Green=optimal Red= danger zone.

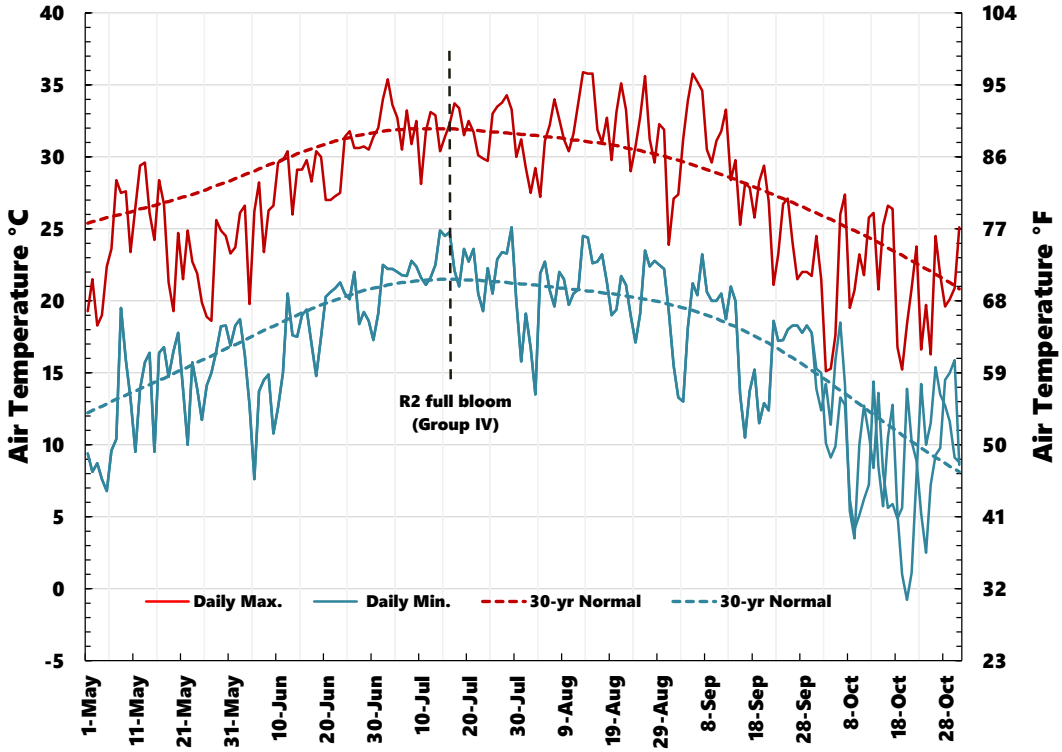
2023 soybean dry stress V3 through R6+, top 20" of root zone

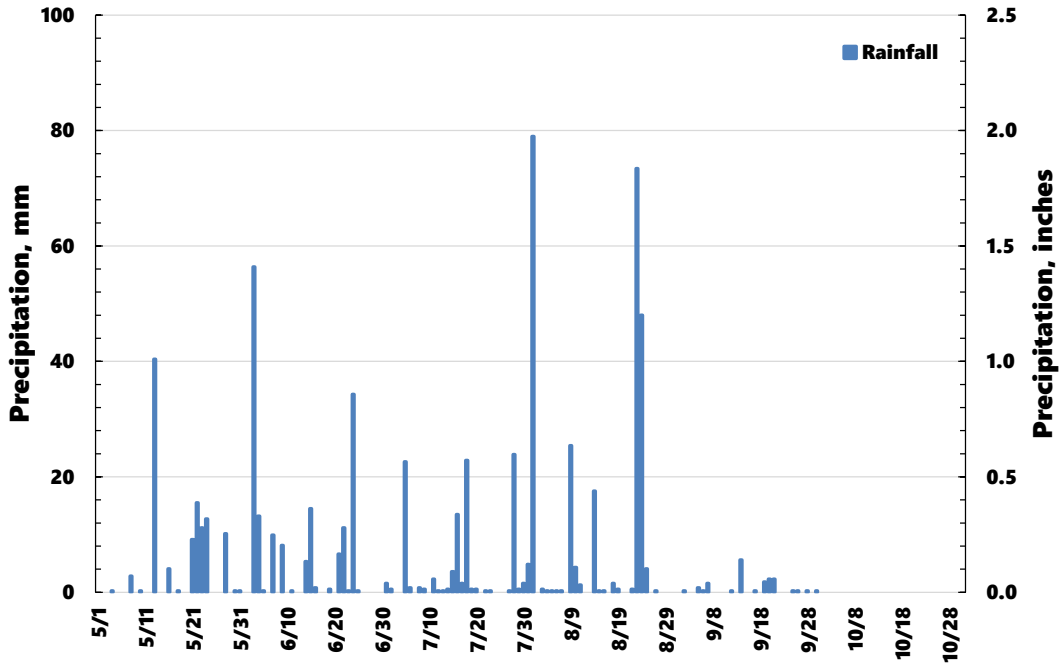


2023 soybean wet stress V3 through R6+, top 12" of root zone



Weather Information for the Tidewater Research Station May-October 2023





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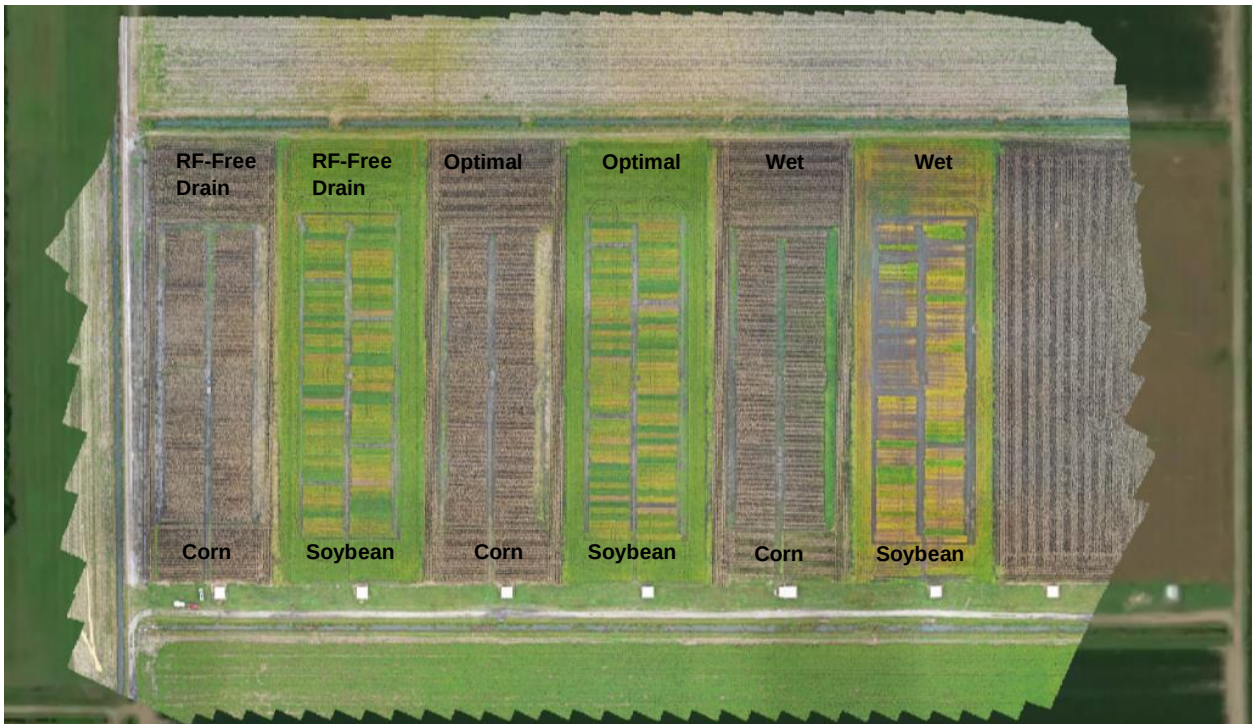

Aerial view of corn and soybean plots in mid-September 2023 at the Total Agricultural Water Management Site, Plymouth, NC. Treatment blocks are rotated annually in accordance with producers in the region. *Image: J. Ward*