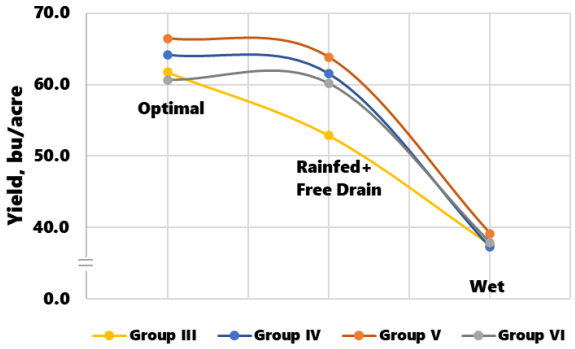
Technical Report | December 11, 2024 | Public Release

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. Irrigation benefit in 2024 was limited due to rainfall conditions after the end of June and limited dry stress during reproduction periods. No differences were observed under wet conditions.
- Overall, Group V varieties outperformed Group III, IV and VI varieties accounting for the difference in varietal entries. Group IV and V varietal performance were not significantly different.
- Dryland exposure suppressed Group VI grain yield, a response we observed in 2022 and 2023.
- Group III varieties significantly trailed Group IV, V, and VI under Rainfed + Free Drain (dryland) conditions.



Soybean response to three treatment exposures in 2024. Solid dots are the average yield for Group III, IV, V, and VI varieties (n=18).

2024 Soybean Resilience Trial Information
Performance by Maturity Group

Relative Maturity Group (MG)	*n*	*Yield, bu/acre*	*CV*
V	60	56.5	23.8
IV	72	54.3	25.2
VI	60	52.9	22.3
III	24	50.7	23.7

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

2024 Soybean Resilience Trial Information
Performance by Soil-Water-Drainage Exposure

Soil Water	*n*	*Yield*, bu/acre*	*CV*
Optimal	72	63.6	8.9
RF-Intensive	72	60.8	8.9
Wet	72	38.0	18.5

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

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. Eighteen varieties from seven agribusiness partners were trialed in 2024. 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 30 and harvested on October 21 and 22. Aggregate yield (Maturity Group) data were analyzed as a mixed-effects model with unequal variance for Soil-Water-Drainage 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-Drainage 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:

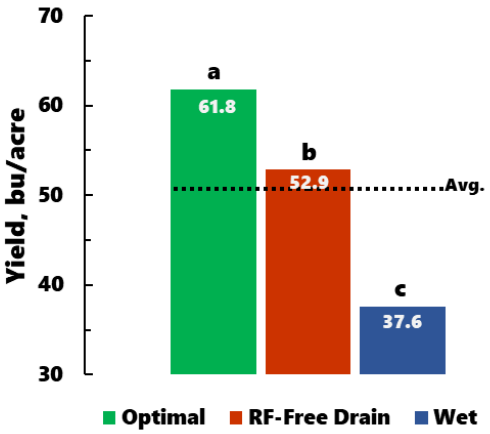
- Rainfed-Free Drain: intended to create drier than normal conditions typical of well-drained sites in NC. Drain tile spacing is 37.5' which is highly intensive for a Portsmouth fine sandy loam soil and intended to provide a much higher drainage intensity than needed for efficient crop production on 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 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.

Key Performance Statistics for **Group III** Varieties, Tidewater Research Station 2024

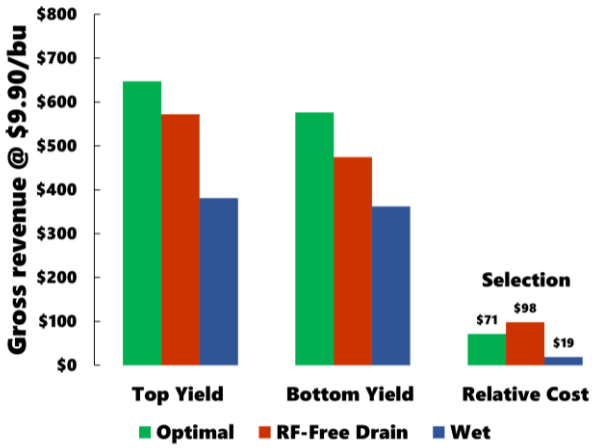
2024 Group III Soybean Resilience Trial Information

Soil-Water Regime	*Company*	*Entry*	*MG Group*	*n*	*Yield* bu/acre*	*CV*
Optimal	Bayer	AG39XF3	3.9	4	65.4	5.4
	Pioneer	P37Z06E	3.7	4	58.2	19.3
		Average			61.8	
		LSD, 0.05			23.3	
RF-Free Drain	Bayer	AG39XF3	3.9	4	57.8	2.7
	Pioneer	P37Z06E	3.7	4	47.9	5.3
		Average			52.9	
		LSD, 0.05			3.1	
Wet	Pioneer	P37Z06E	3.7	4	38.5	15.8
	Bayer	AG39XF3	3.9	4	36.6	12.7
		Average			37.6	
		LSD, 0.05			15.8	
Overall	AG39XF3	Bayer	3.9	12	53.3	24.6
	P37Z06E	Pioneer	3.7	12	48.2	22.4
		Average			50.7	
		LSD, 0.05			7.4	

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



Group III soybean variety response to Optimal, RF-Free Drain (Dryland), and Wet treatment exposure. Means with the same lower-case letter are not different at the LSD α = 0.05 test level.



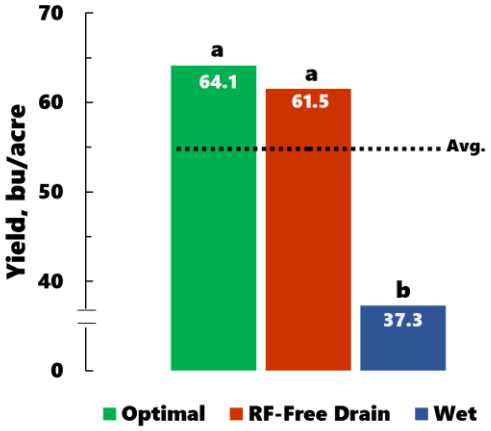
Gross revenue and relative cost comparison of Group III variety selection under three soil water treatment exposures, based on the 2024 Tidewater trials. Top Yield is the gross revenue generated by the highest average yielding variety in each management category; Bottom Yield is the gross revenue generated 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 IV** Varieties, Tidewater Research Station 2024

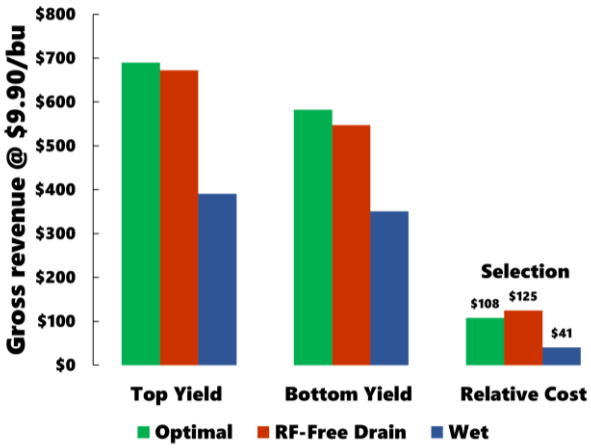
2024 Group IV Soybean Resilience Trial Information

Soil-Water Regime	*Company*	*Entry*	*RM Group*	*n*	*Yield* bu/acre*	*CV*
Optimal	Pioneer	P45A81E	4.5	4	69.7	4.6
	Pioneer	P43Z44SE	4.3	4	68.4	7.6
	Gateway	GT487XFS	4.8	4	68.2	3.6
	Bayer	AG43XF2	4.3	4	59.9	7.7
	So. Harvest	SH4622E3	4.6	4	59.8	6.2
	Bayer	AG40XF5	4.0	4	58.8	9.9
		Mean			64.1	
		LSD, 0.05			5.8	
RF-Free Drain	Pioneer	P43Z44SE	4.3	4	67.9	8.5
	Pioneer	P45A81E	4.5	4	64.8	6.2
	Gateway	GT487XFS	4.8	4	64.4	7.8
	So. Harvest	SH4622E3	4.6	4	60.8	9.8
	Bayer	AG40XF5	4.0	4	55.9	1.8
	Bayer	AG43XF2	4.3	4	55.3	2.1
		Mean			67.9	
		LSD, 0.05			4.5	
Wet	Bayer	AG43XF2	4.3	4	39.5	20.5
	Gateway	GT487XFS	4.8	4	38.6	11.4
	Pioneer	P45A81E	4.5	4	38.3	21.7
	Bayer	AG40XF5	4.0	4	36.4	20.1
	Pioneer	P43Z44SE	4.3	4	35.5	15.7
	So. Harvest	SH4622E3	4.6	4	35.4	18.2
		Mean			37.3	
		LSD, 0.05			12.2	
Overall	Pioneer	P45A81E	4.5	12	57.6	26.8
	Pioneer	P43Z44SE	4.3	12	57.3	29.3
	Gateway	GT487XFS	4.8	12	57.1	24.8
	So. Harvest	SH4622E3	4.6	12	52.0	25.6
	Bayer	AG43XF2	4.3	12	51.5	20.6
	Bayer	AG40XF5	4.0	12	50.4	23.5
		Mean			54.3	
		LSD, 0.05			4.6	

*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. Means with the same lower-case letter are not different at the LSD α = 0.05 test level.



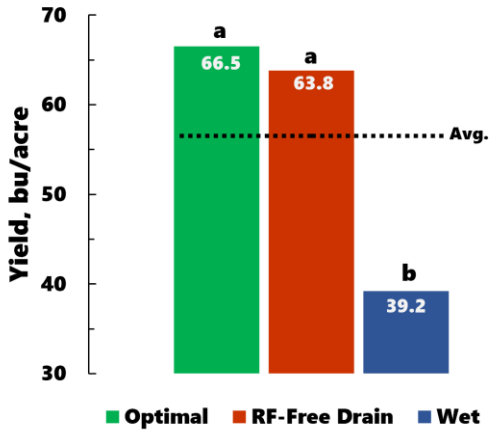
Gross revenue and relative cost comparison of Group IV variety selection under three soil water treatment exposures, based on the 2024 Tidewater trials. Top Yield is the gross revenue generated by the highest average yielding variety in each management category; Bottom Yield is the gross revenue generated 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 V** Varieties, Tidewater Research Station 2024

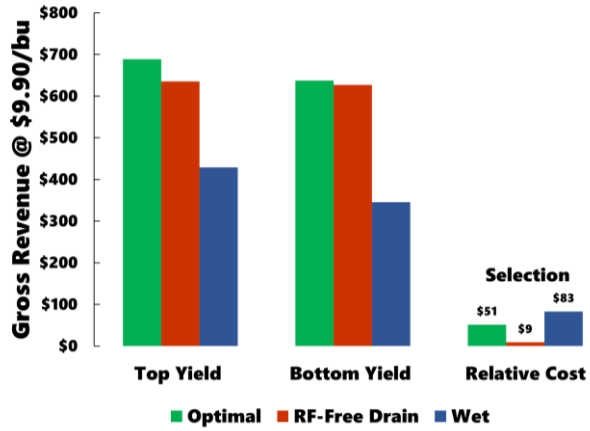
2024 Group V Soybean Resilience Trial Information

Soil-Water Regime	*Company*	*Entry*	*MG Group*	*n*	*Yield* bu/acre*	*CV*
Optimal	Syngenta	NK54J9XF	5.4	4	69.6	7.2
	So. Harvest	SH5124E3	5.1	4	67.4	2.7
	Revere	5735XFS	5.7	4	65.6	3.0
	Pioneer	P52A14SE	5.2	4	65.3	6.1
	Pioneer	P56A71E	5.6	4	64.4	3.2
		Average			66.5	
		LSD, 0.05			3.9	
RF-Free Drain	Syngenta	NK54J9XF	5.4	4	64.2	3.3
	So. Harvest	SH5124E3	5.1	4	64.0	5.2
	Revere	5735XFS	5.7	4	63.9	1.3
	Pioneer	P52A14SE	5.2	4	63.8	2.4
	Pioneer	P56A71E	5.6	4	63.3	5.4
		Average			63.8	
		LSD, 0.05			3.4	
Wet	Pioneer	P56A71E	5.6	4	43.3	21.3
	Pioneer	P52A14SE	5.2	4	41.3	24.6
	Revere	5735XFS	5.7	4	41.2	14.8
	Syngenta	NK54J9XF	5.4	4	35.2	29.1
	So. Harvest	SH5124E3	5.1	4	34.9	12.7
		Average			39.2	
		LSD, 0.05			14.0	
Overall	Pioneer	P56A71E	5.6	12	57.0	20.0
	Revere	5735XFS	5.7	12	56.9	21.3
	Pioneer	P52A14SE	5.2	12	56.8	22.5
	Syngenta	NK54J9XF	5.4	12	56.4	30.0
	So. Harvest	SH5124E3	5.1	12	55.4	28.1
		Average			56.5	
		LSD, 0.05			4.9	

*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. Means with the same lower-case letter are not different at the LSD α = 0.05 test level.



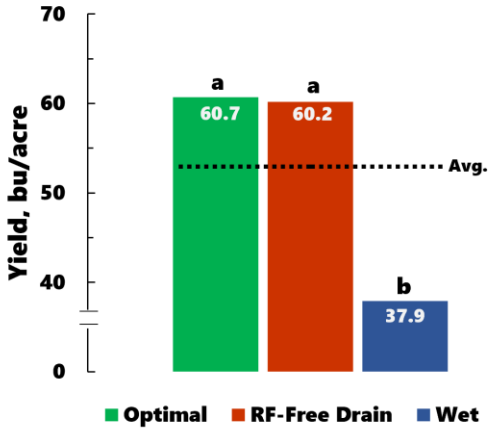
Gross revenue and relative cost comparison of Group V variety selection under three soil water treatment exposures, based on the 2024 Tidewater trials. Top Yield is the gross revenue generated by the highest average yielding variety in each management category; Bottom Yield is the gross revenue generated 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 2024

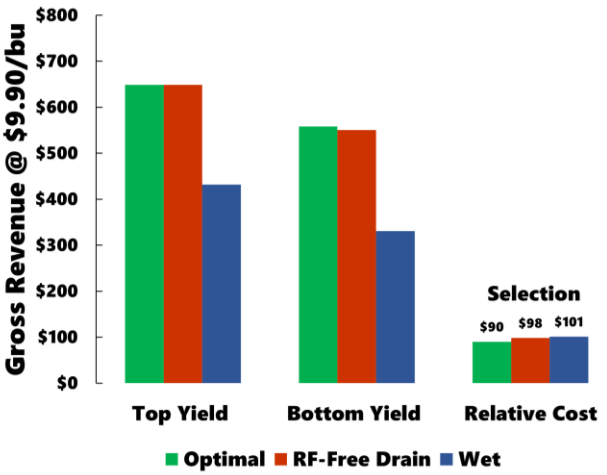
2024 Group VI Soybean Resilience Trial Information

Soil-Water Regime	*Company*	*Entry*	*MG Group*	*n*	*Yield* bu/acre*	*CV*
Optimal	Pioneer	P64Z52E	6.4	4	65.5	2.1
	Syngenta	NK67P1XF	6.7	4	62.9	2.6
	Pioneer	P63A93E	6.3	4	59.7	3.0
	AgVenture	AV64B2E	6.4	4	58.9	4.9
	Pioneer	P68A41BE	6.8	4	56.4	5.7
		Average			60.7	
		LSD, 0.05			2.7	
RF-Free Drain	Pioneer	P64Z52E	6.4	4	63.0	3.4
	Syngenta	NK67P1XF	6.7	4	62.8	5.8
	Pioneer	P63A93E	6.3	4	61.6	1.0
	Pioneer	P68A41BE	6.8	4	58.0	8.1
	AgVenture	AV64B2E	6.4	4	55.6	9.4
		Average			60.2	
		LSD, 0.05			5.7	
Wet	AgVenture	AV64B2E	6.4	4	43.6	2.8
	Pioneer	P64Z52E	6.4	4	38.9	12.3
	Syngenta	NK67P1XF	6.7	4	37.5	10.4
	Pioneer	P68A41BE	6.8	4	36.1	24.7
	Pioneer	P63A93E	6.3	4	33.4	23.0
		Average			39.7	
		LSD, 0.05			9.2	
Overall	Pioneer	P64Z52E	6.4	12	55.8	23.0
	Syngenta	NK67P1XF	6.7	12	54.4	23.5
	AgVenture	AV64B2E	6.4	12	52.7	14.3
	Pioneer	P63A93E	6.3	12	51.6	27.3
	Pioneer	P68A41BE	6.8	12	50.2	23.5
		Average			52.9	
		LSD, 0.05			3.5	

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



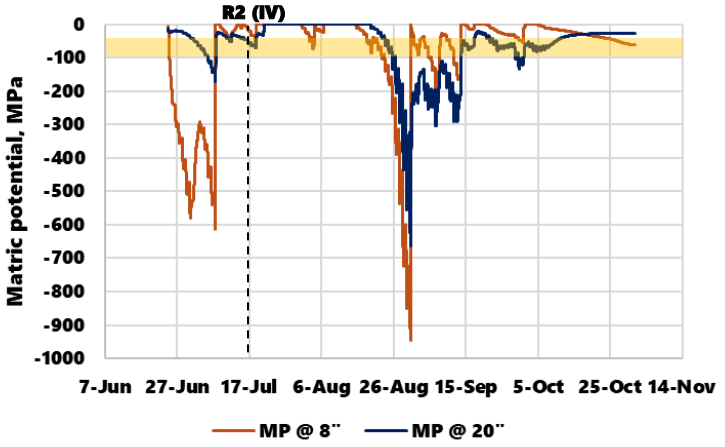
Group VI soybean variety response to Optimal, RF-Dree Drain (Dryland), and Wet treatment exposure. Means with the same lower-case letter are not different at the LSD α = 0.05 test level.



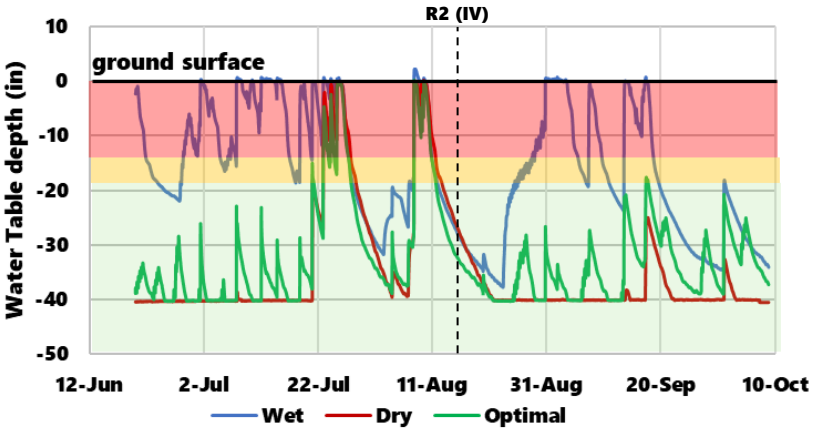
Gross revenue and relative cost comparison of Group VI variety selection under three soil water treatment exposures, based on the 2024 Tidewater trials. Top Yield is the gross revenue generated by the highest average yielding variety in each management category; Bottom Yield is the gross revenue generated 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

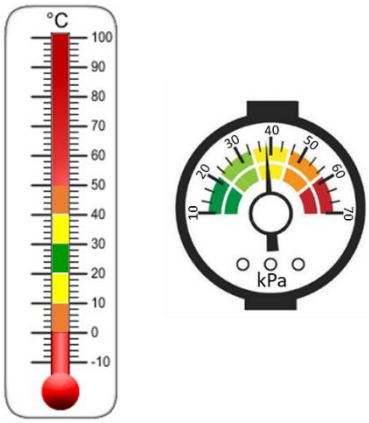
Observed 2024 Teros 21 sensor readings beneath rainfed soybeans.



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.

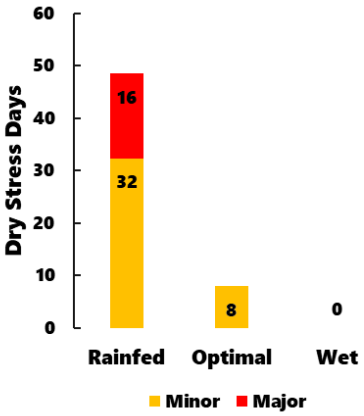


Ground water table depth trace showing depth of the water table beneath soybean in three treatment exposures. Presence of a water table indicates a lack of oxygen essential for healthy root metabolism. Soils in tidal zone areas like the North Carolina Blacklands are naturally poorly drained and depend 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.

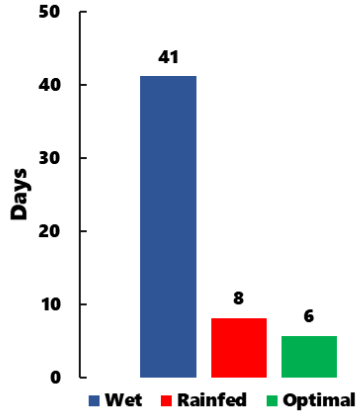


Above, thermometer measuring heat content with fill color indicating human comfort ranges. Right: dial gauge measuring soil water matric potential in kilopascals (kPa) with fill color indicating plant comfort ranges. Green=optimal Red= danger zone.

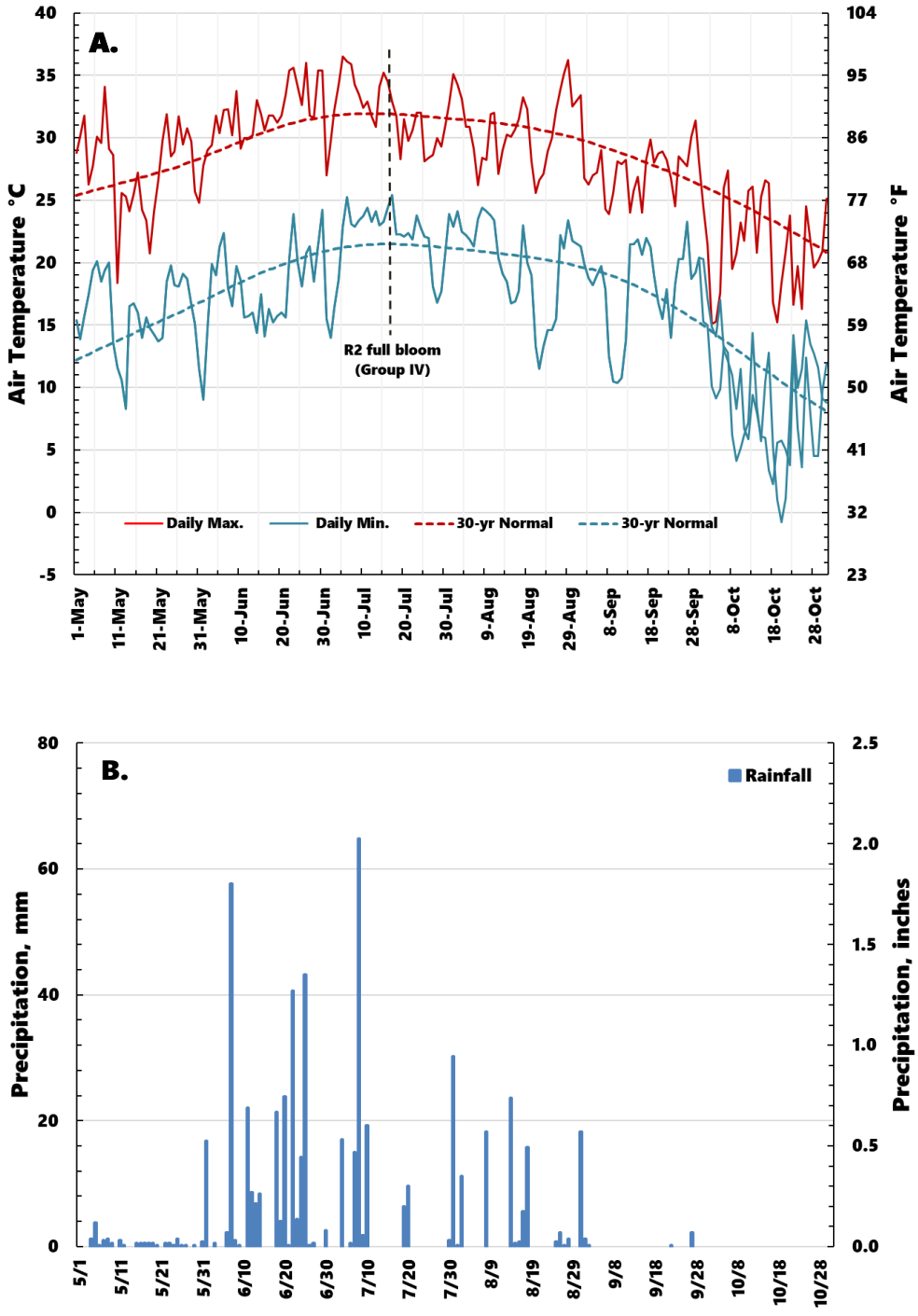
2024 soybean dry stress V3 through R6+, top 20" of root zone



2024 soybean wet stress V3 through



Weather Information for the Tidewater Research Station May-October 2024



May 1 to September 30, 2024. 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.

Acknowledgements

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