

## REGISTRATION

## Cultivar

# Registration of ‘S17-2243C’: A non-genetically modified maturity group IV soybean cultivar with high yield and elevated oil concentration

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## Abstract

‘S17-2243C’ (Reg. no. CV-557, PI 700003) is a semi-determinate, maturity group IV (relative maturity 4.9), non-genetically modified (non-GM) soybean [*Glycine max* (L.) Merr.] cultivar developed and released by the University of Missouri-Fisher Delta Research, Extension, and Education Center. S17-2243C was developed to meet the growing demands for new non-GM soybean cultivars with high yield and elevated seed oil content. S17-2243C is resistant to stem canker and charcoal rot and has tolerance to salinity conditions. Seed of S17-2243C has averaged 232 g kg<sup>-1</sup> of

**Abbreviations:** AYT, advanced yield trial; COOP, cooperative yield trial; CRT, charcoal rot; MG, maturity group; MU-FDREEC, University of Missouri – Fisher Delta Research, Extension, and Education Center; non-GM, non-genetically modified; PYT, preliminary yield trial; RM, relative maturity; SC, stem canker; SCN, soybean cyst nematode; SDS, sudden death syndrome; SRKN, southern root-knot nematode; SVT, state variety test; UT, USDA Uniform Soybean Test, Southern States.

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oil concentration on a dry weight basis, which was significantly higher than all check cultivars in the 2020 USDA Uniform Soybean Tests, Southern States. S17-2243C was tested against high-yielding private and public soybean cultivars from 2018 to 2021 in 80 locations across 12 states, including Alabama, Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, Ohio, South Carolina, Tennessee, and Virginia. With high yield potential, broad adaptability, early maturity, elevated seed oil content, and non-GM traits, S17-2243C is an excellent cultivar choice for soybean growers adopting alternative growing systems and benefiting from premium prices offered for non-GM soybean products.

## 1 | INTRODUCTION

Soybean [*Glycine max* (L.) Merr.] is one of the most economically important oilseed crops worldwide. Recently, there has been a growing demand for soybean oil due to its versatility as an ingredient in food, chemical products, and biofuel segments (Gebremariam & Marchetti, 2018; Vieira & Chen, 2021). In 2020, U.S. soybean oil production and consumption were approximately 11 and 10 million t, respectively. However, soybean oil consumption rate (146%) has grown faster than the production rate (131%) in the past decade (USDA, 2021). In recent years, biodiesel production from soybean oil has significantly increased from 1,297 to 6,868 million L due to the industrial and public preference for renewable and environmentally friendly oil (USDA, 2021). In 2020, the USDA announced US\$100 million in federal support to strengthen infrastructure and build a sustainable biodiesel market, which will result in a substantial increase in soybean oil consumption and production (USDA, 2020). To meet the steady demand for soybean oil, it will be critical to develop new high-yielding soybean cultivars with elevated oil content.

Soybean production is largely suppressed by abiotic and biotic stressors. Ranked among the major soybean stem diseases, charcoal rot (CRT; caused by *Macrophomina phaseolina* Tassi Goid) and stem canker (SC; caused by *Diaporthe aspalathi* Jansen, Castlebury & Crous) were responsible for yield losses of 234,600 and 82,700 t, respectively, in the top 29 soybean-producing states in the United States in 2020 (Bradley et al., 2021). Although different crop management strategies have been used to control these diseases, including crop rotation, soil management, and the mixture of several chemical and biological approaches, the introgression of genetic resistance into soybean cultivars remains the most effective strategy (Gaige et al., 2010; Hartman et al., 2016; Holmes et al., 2020). Thus, public and private soybean breeding programs have made tremendous efforts in identifying and incorporating genetic diversity for disease resistance to

develop high-yielding soybean cultivars with resistance to multiple diseases (Chen, Shannon, Ali, et al., 2020; Chen et al., 2021a; Shannon et al., 2019).

‘S17-2243C’ (Reg. no. CV-557, PI 700003), a maturity group (MG) IV (relative maturity [RM] 4.9), non-genetically modified (non-GM) soybean cultivar, was developed and released by the University of Missouri-Fisher Delta Research, Extension, and Education Center (MU-FDREEC) to fit the current market needs for high-yielding soybean cultivars with elevated seed oil content. S17-2243C demonstrated a potential for high yield, with resistance to CRT and SC and tolerance to salinity conditions. It contains 232 and 388 g kg<sup>-1</sup> of seed oil and protein contents on a dry weight basis, respectively. The high yield potential, broad adaptability, early maturity advantage, and increased seed oil content, combined with a non-GM genetic background, make S17-2243C an excellent cultivar choice for growers in the mid-southern United States, adopting alternative soybean growing systems and benefiting from premium prices offered for non-GM soybean products, the availability of seed saving, and the flexibility of harvest (USSEC, 2021).

## 2 | METHODS

### 2.1 | Breeding scheme

#### 2.1.1 | Pedigree and parental information

S17-2243C originated from the cross ‘S11-20124C’ (Shannon et al., 2019) × S13-11434 made in the summer of 2015 at the MU-FDREEC at Lee Farm, Portageville, MO. The cross between these two parental lines was designed to combine high-yield allelic combinations, disease resistance, salt tolerance, and high oil content. The female parent S11-20124C is a MG V (RM 5.1) non-GM soybean cultivar developed and commercially released by the MU-FDREEC in 2017. S11-20124C has a broad disease resistance package

including sudden death syndrome (SDS; caused by *Fusarium virguliforme* O'Donell & T. Aoki); southern root-knot nematode [SRKN; *Meloidogyne incognita* (Kofoid and White) Chitwood]; and soybean cyst nematode (*Heterodera glycines* Ichinohe) (SCN) race 1 (HG Type 2.5.7), race 2 (HG Type 1.2.5.7), race 3 (HG Type 5.7), race 5 (HG Type 2.5.7), and race 14 (HG Type 1.3.6.7). It has protein and oil contents of 416 and 245 g kg<sup>-1</sup> on a dry weight basis, respectively. S11-20124C is derived from the cross 'S05-11482' (Shannon et al., 2015) × 'S06-4649RR' (Shannon, 2013). Released in 2015 by the MU-FDREEC, S05-11482 is a MG V non-GM soybean cultivar resistant to SCN and SRKN; it is moderately resistant to SC and SDS and carries the resistance gene (*Rcs3*) for frogeye leaf spot (caused by *Cercospora sojina* K. Hara). S06-4649RR is a MG V, glyphosate-tolerant (Roundup Ready 1, Monsanto Co.) soybean cultivar released in 2013 by the MU-FDREEC. It has resistance to reniform nematode (*Rotylenchulus reniformis* Linford & Oliveira) and SC and moderate resistance to SCN, SRKN, and SDS. The male parent S13-11434 is a MG IV, non-GM, high-yielding soybean breeding line resistant to SCN and frogeye leaf spot with elevated seed oil content (230 g kg<sup>-1</sup> on a dry weight basis). S13-11434 was derived from the cross S08-17361 × LD04-13265 made at the MU-FDREEC. S08-17361, developed by MU-FDREEC, is a MG IV non-GM soybean breeding line with resistance to SC. LD04-13265, developed by the University of Illinois, is a MG III, non-GM, high-yielding breeding line with SCN resistance.

### 2.1.2 | Population development

The F<sub>1</sub> to F<sub>4</sub> generations were advanced from 2016 to 2018 in an off-season nursery (Upala, Costa Rica 21301) by bulk-harvesting the F<sub>1</sub> plants and using the modified single-pod descent method (Fehr, 1987) to advance the F<sub>2</sub> to F<sub>4</sub> generations. The F<sub>1</sub> generation was grown with prolonged daylight hours using artificial lights, allowing extended vegetative stages and maximizing F<sub>2</sub> seed production. A total of 150 F<sub>4</sub> single plants were harvested and threshed individually in Costa Rica. In the 2018 crop season, F<sub>4.5</sub> seeds were grown in nonreplicated progeny rows at the Lee farm in Portageville, MO. Visual selection was conducted based on plant height, growth habit, lodging, uniformity, and pod load at maturity. The progeny row designated as 'S17-2243C' was selected and harvested in bulk for evaluation of yield performance in geographically different locations and agronomic traits, including plant height, maturity, lodging, 100-seed weight, seed quality, seed compositions, and reactions to biotic and abiotic stressors.

### Core Ideas

- 'S17-2243C' is a non-genetically modified soybean.
- 'S17-2243C' is resistant to stem canker and charcoal rot and tolerant to salinity.
- 'S17-2243C' has high oil content.
- 'S17-2243C' has been tested across 80 locations across 12 states.

## 2.2 | Multi-environmental yield performance evaluation

### 2.2.1 | MU-FDREEC yield test (2018–2019)

S17-2243C entered the MU-FDREEC internal yield tests in 2018 and 2019. S17-2243C was initially tested in the 2018 preliminary yield trial (PYT). The 2018 PYT was a non-replicated randomized test conducted in four environments (two on loam soil and two on clay soil) at the Lee Farm in Portageville, MO. S17-2243C was subsequently evaluated in the 2019 advanced yield trial (AYT). The AYT was conducted using a randomized complete block design with three replications in five environments, including two on loam soil and two on clay soil at the Lee Farm in Portageville, MO, and one on sandy soil at the Rhodes Farm in Clarkton, MO.

### 2.2.2 | Cooperative yield trials (2019 frogeye leaf spot 2020)

To minimize data noise and distortion of yield caused by the uncontrolled and prolonged off-target dicamba (3,6-dichloro-2-methoxybenzoic acid) exposure throughout the growing season at the MU-FDREEC locations (Chen, Shannon, Scaboo, et al., 2020; Chen et al., 2021b, 2021c; Vieira et al., 2022), S17-2243C was entered in cooperative yield trials (COOPs) using dicamba-free locations with replicated and unreplicated designs. In the 2019 COOP, S17-2243C was tested in eight locations across six states, including Arkansas, Louisiana, Kansas, Mississippi, Missouri, and Virginia. In the 2020 COOP, S17-2243C was tested in six locations across five states, including Arkansas, Illinois, Louisiana, Mississippi, and Missouri.

### 2.2.3 | USDA Uniform Soybean Test (2020)

In 2020, S17-2243C was tested in the USDA Uniform Soybean Tests, Southern States (UT) in the UIV-S-Early test, conducted using a randomized complete block design with

**TABLE 1** Check cultivars used in the multi-environmental yield tests

Year	Test	Check cultivars <sup>a</sup>	
		Non-Xtend	Xtend
2018	PYT	AG 4135b <sup>c</sup>	AG 42X6, AG43X7
2019	AYT	AG 4135	AG 43X7, AG 45X8
2019	COOP	AG 4135	AG 38X8, AG 41X8, AG 42X6, AG 43X7, AG 45X7, AG 46X6
2020	COOP	AG 4135	AG 41X8, AG 43X7, AG 45X8, AG 46X6
2020	UT	LD06-7620 <sup>c</sup>	AG 38X8, AG 43X7, AG 45X8

Note. PYT, preliminary yield test; AYT, advanced yield test; COOP, cooperative yield test; UT, USDA Uniform Soybean Tests, Southern States.

<sup>a</sup>Non-Xtend, soybean check cultivars, not containing the herbicide trait technology of Roundup Ready 2 Xtend; Xtend, soybean check cultivars, containing the herbicide trait technology of Roundup Ready 2 Xtend.

<sup>b</sup>Check cultivars beginning with AG are released by Bayer Crop Science.

<sup>c</sup>LD06-7620 was released by the University of Illinois.

**TABLE 2** Agronomic traits of soybean cultivar 'S17-2243C' from USDA Uniform Soybean Tests, Southern States

Characteristics	S17-2243C	AG 43X7 <sup>a</sup>	Test mean	LSD
Plant height, cm	84	94	79	7.6
Maturity, d	+6	0	+1	5
Plant lodging, 1–5	1.4	1.9	2.0	0.6
100-seed weight, g	14.7	14.8	14.4	1.3
Seed quality, 1–5	1.5	1.8	1.7	0.4
Locations, <i>n</i>	8			

<sup>a</sup>AG 43X7 is a reference check with relative maturity of 4.3 in the 2020 USDA Uniform Soybean Tests, Southern States.

three replications in eight environments across four states, including Alabama, Arkansas, Missouri, and Tennessee (Gillen, 2021).

## 2.2.4 | Check cultivars

From 2018 to 2020, S17-2243C was tested with nine different check cultivars of similar MG in the PYT, AYT, COOP, and UT (Table 1). Check cultivars were categorized into two groups based on the herbicide-tolerance trait for comparisons with non-GM soybean S17-2243C, including Non-Xtend (without herbicide-tolerance trait of Roundup Ready 2 Xtend, Bayer Crop Science) and Xtend (with herbicide-tolerance trait of Roundup Ready 2 Xtend). In the 2018 PYT, 'AG 4135' was used as a Non-Xtend check cultivar, and 'AG 42X6' and 'AG 43X7' were used as Xtend check cultivars. In 2019 AYT, AG 4135 was used as a Non-Xtend check cultivar, and AG 43X7 and 'AG 45X8' were Xtend check cultivars. In the 2019 COOP, AG 4135 was used as a Non-Xtend check cultivar, and 'AG 38X8', 'AG 41X8', AG 42X6, AG 43X7, 'AG 45X7', and 'AG 46X6' were Xtend check cultivars. In the 2020 COOP, AG 4135 was used as a Non-Xtend check, and AG 41X8, AG 43X7, AG 45X8, and AG 46X6 were Xtend check cultivars. In the 2020 UT, 'LD06-

7620' was used as a Non-Xtend check cultivar, while AG 38X8, AG 43X7, and AG 45X8 were used as Xtend check cultivars.

## 2.2.5 | Multi-state variety test (2021)

In 2021, S17-2243C was tested with promising and newly released high-yielding soybean lines predominantly developed by private commercial breeding programs in state variety tests (SVTs) in 49 environments across 10 states, including Alabama (three locations) (Jordan, 2021), Arkansas (six locations) (Carlin et al., 2021), Illinois (four locations) (Joos, 2021), Kentucky (eight locations) (Venard & Mertz, 2020), Louisiana (seven locations) (Moseley et al., 2021), Mississippi (four locations) (Burgess et al., 2021), North Carolina (six locations) (Heiniger, 2021), Ohio (two locations) (Geyer et al., 2021), South Carolina (four locations) (Smith et al., 2021), and Virginia (five locations) (Holshouser et al., 2021). The experimental designs varied in each SVT.

## 2.3 | Agronomic traits and reactions to biotic and abiotic stressors

### 2.3.1 | Agronomic traits and seed quality

The agronomic traits of S17-2243C, including plant height; maturity; lodging; 100-seed weight; seed quality and composition (seed oil, protein, and meal protein contents); and flower, pod, and pubescence colors, were evaluated in the UT in 2020 (Gillen, 2021). Plant height was measured as the average length of plants (cm) in a plot from the ground to the top extremity at maturity. Maturity was expressed as the date when 95% of the pods had reached their mature pod color (Fehr et al., 1971) and was determined as days earlier (–) or later (+) than the reference check (AG 43X7, RM 4.3). Lodging was evaluated on a visual scale of 1–5, where 1 =

**TABLE 3** Seed compositions of soybean cultivar 'S17-2243C' from USDA Uniform Soybean Tests, Southern States

Line	Protein <sup>a</sup>	Oil <sup>a</sup>	Meal protein <sup>b</sup>
	—g kg <sup>-1</sup> —		%
S17-2243C	388	232	45.7
AG 43X7	391	222	45.7
AG 45X8	400	217	46.4
AG 38X8	404	224	47.3
LD06-7620	403	224	47.2
Test mean	400	223	46.9
LSD	10.4	6.9	1.2
Locations	7		

<sup>a</sup>Seed oil and protein contents reported on a dry weight basis.

<sup>b</sup>Meal protein content reported on a 13% moisture basis.

all plants erect and 5 = all plants lodged. Seed quality was reported on a scale of 1–5, where 1 = very good and 5 = very poor, based on the overall appearance of the seeds (seed coat damage and seed infections). Seed protein and oil concentrations were measured by near-infrared transmittance analysis with an IM 9500 Grain Analyzer (Perten Instruments AB) using 20 g of whole seed and reported on a dry weight basis (Gillen, 2021). Meal protein concentration was reported at a 13% moisture basis (Gillen, 2021).

### 2.3.2 | Biotic and abiotic reactions

S17-2243C was evaluated for resistance to SCN, SRKN, and SC in the 2020 UT (Gillen, 2021). Disease screening for SCN races 2 (HG type 1.2.5.7) and 5 (HG Type 2.5.7) was conducted in a greenhouse at the ARS-Crop Genetics Research Unit in Jackson, TN, using a protocol described by Niblack et al. (2002). One seed of each genotype was planted in a sterile soil mix with 2,500 eggs of each tested SCN population with seven replications. The soybean '5601T' (Pantalone et al., 2003) was used as the reference susceptible check. About 4 wk after planting, disease score was determined on a scale of 1–5 based on the number of cysts on the roots, where 1 = 0–5, 2 = 6–10, 3 = 11–20, 4 = 21–40, and 5 = 40+ cysts on the root.

The SRKN screening was conducted in a greenhouse with four replications at the University of Georgia based on a protocol described by Maillhot et al. (2021). Three seeds of each genotype were planted in cone-tainers filled with fumigated sandy loam soil in a greenhouse. About 10 d after planting, seedlings were thinned to one and inoculated with 3,000 SRKN eggs using a digital dispensing pump. G93-9009 (PI 591825) (Luzzi et al., 1996a), G93-9106 (PI 593238) (Luzzi et al., 1996b), and 'Haskell' (PI 572238) (Boerma et al., 1994) were included as resistant checks, and 'Bossier' (PI

567789) (Bernard et al., 1988), 'CNS' (PI 548445) (Hartwig & Lehman, 1951), and 'GaSoy 17' (PI 553046) (Baker & Harris, 1979) were included as susceptible checks. Thirty days later, the response of the genotype was measured based on the gall indices (estimated as the number of galls on the roots per plant) on a scale of 1–5, where 1 = 0–10, 2 = 11–20, 3 = 21–30, 4 = 31–40, and 5 = 41+ galls in the roots.

The disease screening for SC was conducted at the Delta Research and Extension Center in Stoneville, MS. About eight plants grown in a nonreplicated, single-row plot were inoculated with autoclaved flat toothpicks containing a single isolate known as *LiDA18-2* by forcing a toothpick through the stem in the upper one-third of a young plant. The final disease score (1–5) was determined based on the leaf symptoms and main stem lesions of all inoculated plants, where 1 = no exhibition of external lesions (resistant) and 5 = exhibition of external lesions on all plants and all dead (susceptible). 'AG 4403' (Bayer Crop Science) and 'Ellis' (Pantalone et al., 2017) were used as susceptible and resistant reference checks, respectively.

Additionally, S17-2243C was tested for CRT under field conditions at the USDA-ARS laboratory in Jackson, TN, using an established protocol described by Mengistu et al. (2007) in 2020. Briefly, the colony-forming unit values obtained from five individual plants were used to determine disease severity on a scale of 1–5, where 1 = resistant and 5 = susceptible. 'DT97-4290' (Paris et al., 2006) and 'LS98-0358' were included as resistant and susceptible checks, respectively.

Salinity testing was conducted in a greenhouse at the MU-FDREEC using an established protocol by Lee et al. (2008) in 2019. Briefly, five seedlings (V2-3 stage) with two replications grown in cone-tainers with sandy soil were exposed to 100 mM salt solution. 'S05-11482' (tolerance inherited from S-100 [PI 548488]) was used as a tolerant check, and 'S13-1955C' (Chen et al., 2021a) was used as a susceptible check. The salinity screening was reported based on a scale of 1–5, where 1 = no external symptoms and 5 = plants are dead with necrosis.

### 2.4 | Statistical analysis

Yields of individual trials in the MU-FDREEC trials were analyzed with the Agrobases Generation II software (Agronomix Software) using the mixed linear model fitted using "genotype" (unique entries) as a fixed effect and "environment" and "replication" as random effects. In addition, the  $LSD_{.05}$  was calculated to determine the statistical differences in yield among all the genotypes tested in a given trial.

Statistical analysis in UT was performed using the PROC MIXED function in SAS 9.4 (SAS Institute). The linear mixed model used "genotype" (unique entries) as a fixed effect and

**TABLE 4** Yield of soybean cultivar 'S17-2243C' in the MU-FDREEC yield tests and cooperative yield tests (2018–2020)

Entry	Yield tests				Mean <sup>a</sup>
	2018 PYT	2019 AYT	2019 COOP	2020 COOP	
	kg ha <sup>-1b</sup>				
S17-2243C	4,102	3,356	4,145	4,049	3,941
Non-Xtend <sup>c</sup>					
AG 4135	3,147	2,434	3,629	3,549	3,265
Xtend <sup>c</sup>					
AG 38X8	– <sup>d</sup>	–	3,708	–	3,708
AG 41X8	–	–	3,944	4,241	4,071
AG 42X6	4,075	–	4,297	–	4,223
AG 43X7	4,600	4,102	4,513	4,261	4,373
AG 45X7	–	–	4,455	–	4,455
AG 45X8	–	4,082	–	4,204	4,149
AG 46X6	–	–	4,257	3,853	4,084
Test mean	3,904	2,994	3,820	3,480	3,566
LSD	288	137	907	1,412	–
Environment	4	5	8	6	–
Replication	1	3	1	1	–
Entry	48	32	51	50	–
Rank	11	8	10	4	–

Note. AYT, advanced yield test; COOP, cooperative yield test; PYT, preliminary yield test.

<sup>a</sup>Weighted average calculated across all environments and years of testing.

<sup>b</sup>Yield based on the average across all replications and environments.

<sup>c</sup>Non-Xtend, soybean check cultivars, not containing the herbicide trait technology of Roundup Ready 2 Xtend.

<sup>d</sup>Data not available.

<sup>e</sup>Xtend, soybean check cultivars, containing the herbicide trait technology of Roundup Ready 2 Xtend.

“environment,” “replication (environment),” and “genotype × environment” as random effects. The LSD<sub>.05</sub> was used to determine the statistical difference in yield between genotypes (Gillen, 2021). In SVTs, each state used the software of their preference to analyze and compare yield data.

### 3 | CHARACTERISTICS

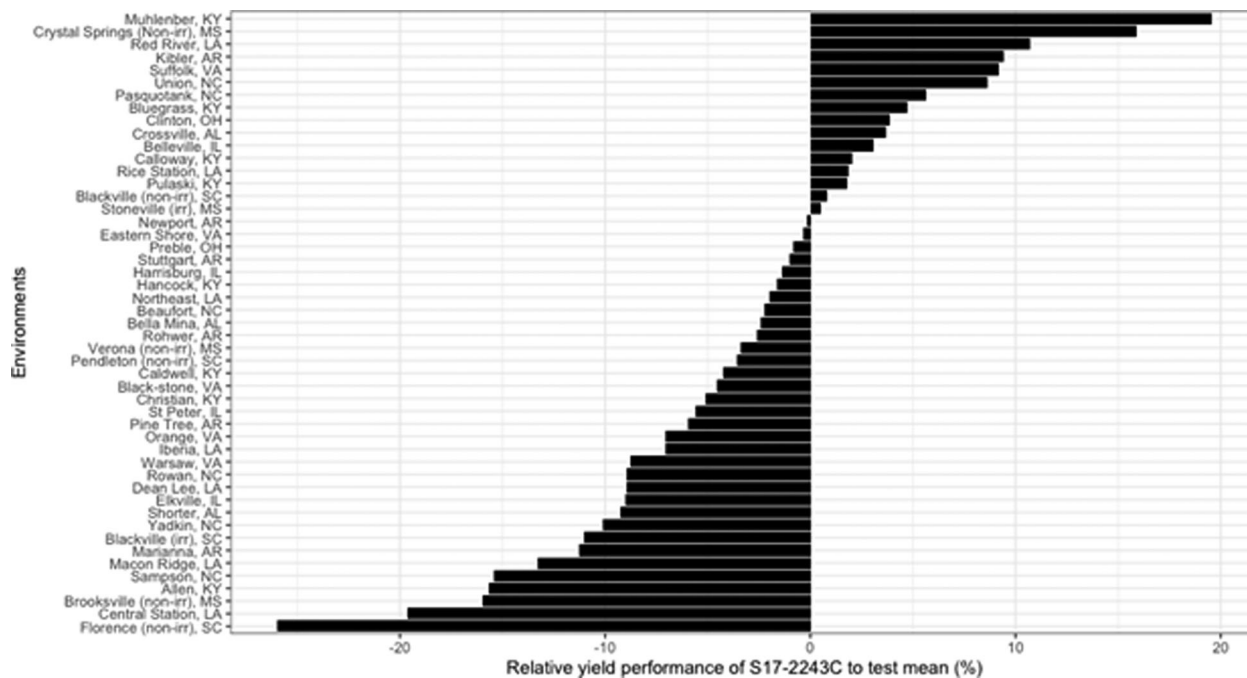
#### 3.1 | Agronomic and seed composition traits

S17-2243C exhibited semi-determinate growth habit, with an average height of 84 cm and a lodging score of 1.4 (Table 2). Plants of S17-2243C have purple flowers, tawny pubescence, tan pod wall, and a relative maturity of 4.9, maturing 6 d after the check cultivar AG 43X7 (RM 4.3) (Table 2). Seed of S17-2243C has black hilum, yellow seed coat, and intermediate seed luster with a 100-seed weight of 14.7 g and seed quality of 1.5 (Table 2). Seed of S17-2243C has averaged 388 g kg<sup>-1</sup> of protein and 232 g kg<sup>-1</sup> of oil on a dry weight basis and 45.7% meal protein at 13% moisture (Table 3). The seed oil content of S17-2243C was significantly higher than all check cultivars, including AG 43X7 (222 g kg<sup>-1</sup>), AG 45X8 (217 g

kg<sup>-1</sup>), AG 38X8 (224 g kg<sup>-1</sup>), and LD06-7620 (224 g kg<sup>-1</sup>) (Table 3).

#### 3.2 | Yield performance

In the 2018 PYT, S17-2243C ranked 11th out of 48 entries, with an average yield of 4,102 kg ha<sup>-1</sup>, which was significantly higher than AG 4135 (3,147 kg ha<sup>-1</sup>), numerically greater than AG 42X6 (4,075 kg ha<sup>-1</sup>), and significantly lower than AG 43X7 (4,600 kg ha<sup>-1</sup>) (Table 4). In the 2019 AYT, S17-2243C ranked 8th out of 32 entries, with an average yield of 3,356 kg ha<sup>-1</sup>, which was significantly higher than AG 4135 (2,434 kg ha<sup>-1</sup>) but significantly lower than AG 43X7 (4,102 kg ha<sup>-1</sup>) and AG 45X8 (4,082 kg ha<sup>-1</sup>) (Table 4). In the 2019 COOP, S17-2243C ranked 10th out of 51 entries, with an average yield of 4,145 kg ha<sup>-1</sup>, which was numerically higher than AG 4135 (3,629 kg ha<sup>-1</sup>), AG 38X8 (3,708 kg ha<sup>-1</sup>), and AG 41X8 (3,944 kg ha<sup>-1</sup>) and statistically similar to AG 42X6 (4,297 kg ha<sup>-1</sup>), AG 43X7 (4,513 kg ha<sup>-1</sup>), AG 45X7 (4,455 kg ha<sup>-1</sup>), and AG 46X6 (4,257 kg ha<sup>-1</sup>) (Table 4). In the 2020 COOP, S17-2243C ranked 4th out of 50 entries, with an average yield of 4,049 kg



**FIGURE 1** Relative yield performance of soybean cultivar 'S17-2243C' compared with the test mean in each testing environment in soybean state variety tests in 2021. The "irr" and "non-irr" refer to irrigated field condition and non-irrigated field condition, respectively

**TABLE 5** Yield of soybean cultivar 'S17-2243C' in the USDA Uniform Soybean Tests (UT), Southern States in 2020

Trait	2020 USDA UT Entry	Yield (kg ha <sup>-1</sup> )
Non-Xtend <sup>b</sup>	S17-2243C	4,116
Non-Xtend <sup>b</sup>	LD06-7620	2,885
Xtend <sup>c</sup>	AG 38X8	4,237
	AG 43X7	4,607
	AG 45X8	4,546
Test mean		3,685
LSD		585
Environments	8	
Replications	2	
Entries	18	
Rank	5	

Note. UT, USDA Uniform Soybean Test.

<sup>a</sup>Yield based on the average across all replications and environments.

<sup>b</sup>Non-Xtend, soybean check cultivars not containing the herbicide trait technology of Roundup Ready 2 Xtend.

<sup>c</sup>Xtend, soybean check cultivars containing the herbicide trait technology of Roundup Ready 2 Xtend.

ha<sup>-1</sup>, which was numerically higher than AG 4135 (3,549 kg ha<sup>-1</sup>) and AG 46X6 (3,853 kg ha<sup>-1</sup>) and statistically similar to AG 41X8 (4,241 kg ha<sup>-1</sup>), AG 43X7 (4,261 kg ha<sup>-1</sup>), and AG 45X8 (4,204 kg ha<sup>-1</sup>) (Table 4). Overall, S17-2243C was consistently superior to the Non-Xtend check cultivar in environments with high exposure to off-target dicamba,

and it yielded significantly or numerically higher than Xtend check cultivars in environments without dicamba off-target exposure (2019 and 2020 COOP).

In the 2020 UT, S17-2243C ranked 5th out of 18 entries, with an average yield of 4,116 kg ha<sup>-1</sup>, which was significantly higher than LD06-7620 (2,885 kg ha<sup>-1</sup>) and statistically similar to AG 38X8 (4,237 kg ha<sup>-1</sup>), AG 43X7 (4,607 kg ha<sup>-1</sup>), and AG 45X8 (4,546 kg ha<sup>-1</sup>) (Table 5).

In the 2021 SVT, S17-2243C averaged 4,538 kg ha<sup>-1</sup> in a total of 49 environments across 10 states, including Alabama, Arkansas, Illinois, Kentucky, Louisiana, Mississippi, North Carolina, Ohio, South Carolina, and Virginia (Table 6). The relative yield of S17-2243C to the test mean in each SVT ranged from 91 to 102%. S17-2243C averaged 5,175 kg ha<sup>-1</sup> in Ohio, which was equivalent to 102% of the test mean (5,091 kg ha<sup>-1</sup>), and it yielded 3,300 kg ha<sup>-1</sup> in South Carolina, which was equivalent to 91% of the test mean (3,611 kg ha<sup>-1</sup>) (Table 6). In individual environments, S17-2243C was superior to the test means in 16 out of 49 environments (Figure 1). S17-2243C yielded ~20% greater than the test mean in Muhlenber, KY, and 26% less than the test mean in Florence, SC (Figure 1).

S17-2243C was repeatedly compared with AG 4135 (Non-Xtend check) and AG 43X7 (Xtend check) over the 3 yr of yield trials. In comparison to AG 4135, S17-2243C continuously demonstrated significantly or numerically higher yields, which were equivalent to 114–138% of the yield of AG 4135 (Table 7). On the other hand, S17-2243C yielded significantly

**TABLE 6** Yield of soybean cultivar 'S17-2243C' in the soybean state variety tests in 2021

Entry	State variety tests										
	AL	AR	IL	KY	LA	MS	NC	OH	SC	VA	Mean <sup>a</sup>
	kg ha <sup>-1b</sup>										
S17-2243C	4,035	4,314	4,705	4,907	3,444	5,269	5,564	5,175	3,300	5,053	4,538
Test mean	4,174	4,393	4,889	4,872	3,626	5,266	5,770	5,091	3,611	5,177	4,652
% Test mean <sup>c</sup>	97	98	96	101	95	100	96	102	91	98	97
Environments	3	6	4	8	7	4	6	2	4	5	— <sup>d</sup>
Entries	54	55	39	44	38	13	64	35	29	42	—
Rank	31	30	31	10	29	7	46	15	26	31	—

<sup>a</sup>Weighted average calculated across all environments.

<sup>b</sup>Yield is based on the average across all environments in each state.

<sup>c</sup>Percentage of the yield performance of S17-2243C compared with test mean. For example, if the % test mean is 97, it means S17-2243C yielded 3% lower than the test mean.

<sup>d</sup>Data not available.

**TABLE 7** Yield of soybean cultivar S17-2243C compared with AG 4135 and AG 43X7 during the yield testing period (2018–2020)

Year	Test	Env <sup>a</sup>	S17-2243C	AG 4135		AG 43X7		LSD
				kg ha <sup>-1b</sup> (% check) <sup>c</sup>				
2018	PYT	4	4,102	3,147 (130)		4,600 (89)		288
2019	AYT	5	3,356	2,434 (138)		4,102 (82)		137
2019	COOP	8	4,145	3,629 (114)		4,513 (92)		907
2020	COOP	6	4,049	3,549 (114)		4,261 (95)		1,412
2020	UT	8	4,116	— <sup>d</sup>		4,607 (89)		585
Mean <sup>e</sup>			3,986	3,265 (122)		4,433 (90)		—

Note. AYT, advanced yield test; COOP, cooperative yield test; PYT, preliminary yield test; UT, USDA Uniform Soybean Tests, Southern States.

<sup>a</sup>Number of environments.

<sup>b</sup>Yield based on the average across all replications and environments.

<sup>c</sup>Percentage of yield performance of S17-2243C compared with AG 4135 and AG 43X7. For example, if the % check is 130, it means S17-2243C yielded 30% higher than the check.

<sup>d</sup>Data not available.

<sup>e</sup>Weighted average calculated across all years of testing across all environments and years of testing.

or numerically lower than AG 43X7, performing in a range of 89–95% of the yield of AG 43X7 throughout the yield testing period (Table 7).

### 3.3 | Biotic and abiotic reactions

S17-2243C is resistant to SC and CRT, with scores of 1 for each SC and CRT, which were the same as the resistant checks (Ellis scored 1 in the SC screening; DT97-4290 scored 1 in the CRT screening) (Table 8). S17-2243C is also tolerant to saline soils, with a score of 1.0, which was the same as the resistant check (S05-11482 scored 1), as opposed to the susceptible check (S13-1955C scored 5) (Table 8). Based on the unfavorable scores for SCN races 2 (score 5) and 5 (score 5) and SRKN (score 4.5), S17-2243C is not recommended for areas where severe nematode pressures are expected (Table 8).

## 4 | AVAILABILITY

Breeder seed of S17-2243C will be maintained by the Missouri Agriculture Experiment Station (MOAES) at the University of Missouri-Fisher Delta Research, Extension, and Education Center, 147 State Hwy T, Portageville, MO 63873. Seed samples of S17-2243C will be deposited in the USDA Soybean Germplasm Collection at Urbana, IL, and the USDA-ARS National Laboratory for Genetic Resources Preservation at Fort Collins, CO. A small amount of seed for research purposes, including the development of new cultivars, may be obtained from the corresponding author during the next 5 years through a material transfer agreement (MTA). It is requested that proper recognition be made if S17-2243C is used for breeding and contributes to the release of a germplasm or cultivar.

**TABLE 8** Disease responses of soybean cultivar S17-2243C to soybean cyst nematode (SCN), southern root-knot nematode (SRKN), stem canker (SC), charcoal rot (CRT), and salinity

Lines	SCN <sup>a</sup>		SRKN <sup>b</sup>	SC <sup>c</sup>	CRT <sup>d</sup>	Salinity <sup>e</sup>
	Race 2	Race 5				
	—1–5—					
S17-2243C	5	5	4.5	1	1	1
AG 43X7	5	5	5	1	–	–
AG 45X8	4	4	4	1	–	–
AG 38X8	4	5	5	1	–	–
LD06-7620	5	4	2.3	3	–	–
AG 4403	–	–	–	5	–	–
Ellis	–	–	–	1	–	–
S05-11482	–	–	–	–	–	1
S13-1955C	–	–	–	–	–	5
DT97-4290	–	–	–	–	1	–
LS98-0358	–	–	–	–	3.4	–

<sup>a</sup>Soybean cyst nematode screening was performed in the USDA Uniform Trials using SCN populations races 2 (HG Type 1.2.5.7) and 5 (HG Type 2.5.7). Resistance was rated on a scale of 1–5, where 1 = 0–5, 2 = 6–10, 3 = 11–20, 4 = 21–40, and 5 = 40+ cysts on the root.

<sup>b</sup>Southern root-knot nematode screening was performed at University of Georgia (Mailhot et al., 2021). Resistance was rated on a scale of 1–5, where 1 = 0–10, 2 = 11–20, 3 = 21–30, 4 = 31–40, and 5 = 41+ galls on the roots.

<sup>c</sup>Stem canker screening was performed in the USDA Uniform Trials, and scored on a scale of 1–5, where 1 = no plants exhibited external lesions, no leaf damage, and no dead plants and 5 = all plants exhibited external lesions and all plants are dead.

<sup>d</sup>Charcoal rot screening was performed in the USDA-ARS laboratory (Jackson, TN) (Mengistu et al., 2007). Resistance was scored on a scale of 1–5, where 1 = resistant and 5 = susceptible.

<sup>e</sup>Salinity, salinity test was performed at MU-FDREEC (Lee et al., 2008). Tolerance was scored on a scale of 1–5, where 1 = no external symptoms and 5 = plants are dead with necrosis.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.


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