KANSAS SOYBEAN COMMISSION FINAL REPORT OF PROGRESS

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Harold Trick – Plant Pathology

Title: "Integrating Germplasm Evaluation, Genetic Engineering, Breeding and High-Throughput Phenotyping to Improve Sustainability of Soybean Production"

Amount of Funding: $265,959

Department Heads: Michel Ransom (Interim Head), Marty Draper

Accomplishments for FY2019 (March 1, 2018 – February 28, 2019)

SCN Breeding and Management

SCN Screening Populations

Primary SCN screening populations included HG Types 7, 2.7, and 1.2.3.5.6.7 (Figure 1). Female indices (FI) on the HG Type 1.2.3.5.6.7 population were >10% on all indicator lines except PI 437654 (line 4), while female indices on the HG Type 7 population were <10% on all indicator lines except PI 548316 (line 7). The third screening population, HG Type 2.5.7, is characterized by female indices >10% on PI88788 (line 2), PI209332 (line 5) and PI 548316 (line 7). Variation in female indices on PI 88788 (line 2) is of particular importance, since this line is the most common source of deployed SCN resistance.

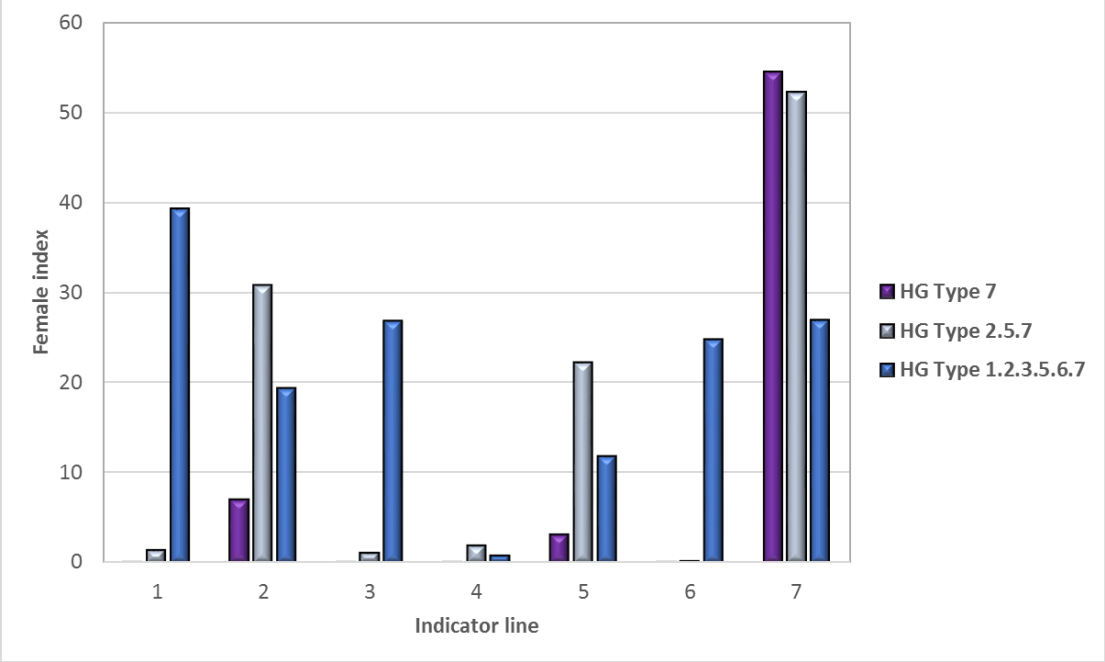


Figure 1. HG Type designations for primary SCN screening populations

SCN Resistance Screening

Breeding lines: Soybean resistance to HG Type 7 was evaluated in replicated screening trials for 180 advanced breeding lines. Those lines with good to moderate levels of resistance were subsequently evaluated for resistance to HG Type 2.5.7. Approximately half of early maturity (KAE) and late maturity (KAL) breeding lines displayed moderate or better levels of resistance, with FI < 30 (Figure 2). Of those lines expressing resistance to HG Type 7, >25% of KAE lines and >50% of KAL lines were resistant to moderately resistant to the HG Type 2.5.7 population. Differences in performance were due to greater diversity in KAL lines (i.e. sources of resistance other than PI 88788).

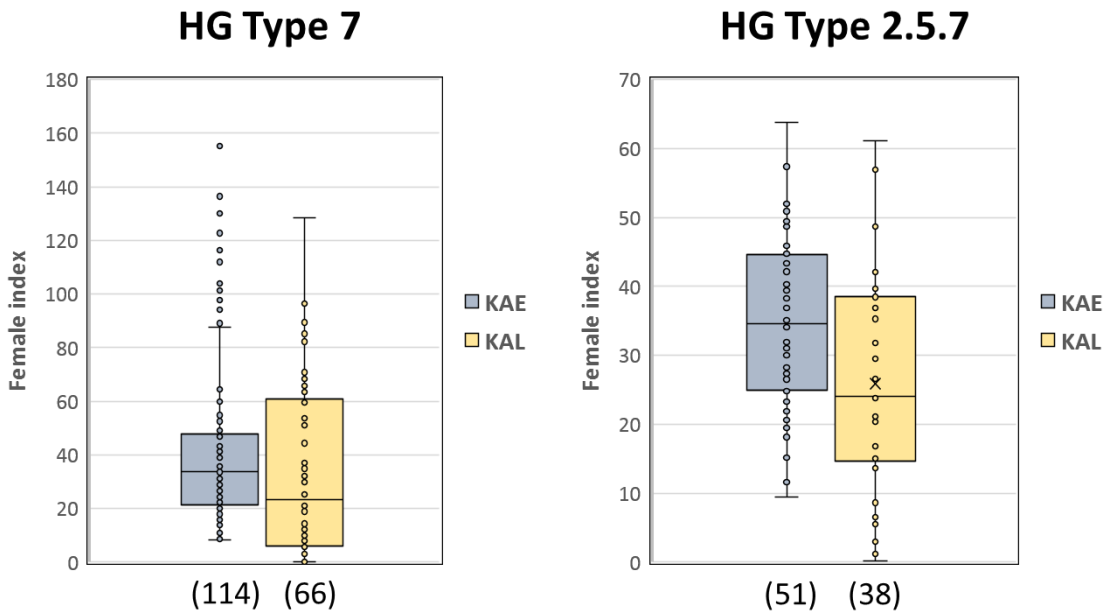


Figure 2. Summary of 2018 SCN screening results for K-State soybean breeding lines.

Kansas Soybean Performance Test: Soybean resistance to soybean cyst nematode (SCN) in commercial varieties was evaluated in replicated screening trials for 85 entries in the Kansas Soybean Variety Performance Tests (KSVPT). Results were posted on the KSVPT website and in Appendix 1. Evaluations involved SCN populations that varied in their virulence to the common resistance source PI 88788: HG Type 7, with a PI 88788 female index (FI) of 7.1, HG Type 2.7, with a PI 88788 female index (FI) of 34.4, and HG Type 1.2.3.5.6.7, with a PI 88788 FI of 19.5. Most of the variation (69%) in female indices was explained by correlations among HG Type populations, indicating that most cultivars performed similarly (relative to other cultivars) for all HG Type populations. Female indices averaged ~60% for HG Type 2 populations compared to 27% for the HG Type 7 population, however, confirming that most KSPT entries shared a common source of resistance (PI 88788).

Variety Development/Genetics

Development of new populations

- A total of about 90 new populations were created in 2018 using over 20 different parents (Appendices 2 and 3).
- Thirteen single cross populations involved **drought resistant** parents.
- Over 2/3s of the single cross populations involved parents tolerant to **STS** herbicides.
- About 2/3s of the single cross populations involved at least one parent resistant to **SCN**.
- About nine single cross populations involved at least one parent that possessed genes from a plant introduction that has not contributed to the genetic improvement of US northern soybean varieties. The goal of using these parents is to increase the **genetic diversity** of US germplasm to increase, or at least, maintain genetic gain.
- Five populations involved converting a conventional line to a line possessing the **glyphosate resistance** or developing an entirely new GR line.
- Twenty-three populations involved parents with higher **protein**.
- Several populations were developed to incorporate the **NON-NODULATING** trait into adapted germplasm to better characterize the importance of nitrogen fixation and nitrogen fertility in modern soybean varieties.

Yield trials

- We completed evaluations of nearly **5000 genotypes** in over 16,000 plots in Kansas (APPENDIX 4).
- Over 1600 K-lines were evaluated in our preliminary trials.
- Over 180 K-lines were evaluated in our KS advanced yield trials.
- Over 600 (including 28 K-lines) breeding lines from programs across the country were evaluated in our KS Uniform Tests and Uniform Preliminary yield trials.
- Over 700 genotypes, (experimental breeding lines and **plant introductions**) were evaluated in our drought, remote sensing, and diversity yield trials.

Seed Increases

- All K-lines entered into the 2018 Uniform Preliminary, Uniform Tests or final testing in KS were place in seed increase blocks (APPENDIX 5). Of these experimental varieties under increase, five will be advanced for more testing and increase, four will be advanced to a large-scale increase, with the intent to release in 2020, and one has been released.

Outcomes of Research on Genetic Diversity, Drought, Remote Sensing and Variety Development

- **Genetic diversity.** We continue to evaluate plant introductions to identify new genetic variability for response to drought and heat stress, seed composition and improved yield potential. The past several seasons we have conducted evaluations on over 2500 maturity groups 3 through 10 plant introductions. Data collected on the plots included traits such as: maturity, lodging, height, seed yield, shattering, 100 seed weight, seed quality, seed protein and oil concentrations, and canopy wilting scores. Based on these evaluations we develop single cross populations involving plant introductions that have not contributed to the genetic improvement of US soybean varieties. The goal of using these parents is to increase the genetic diversity of US germplasm to increase, or at least, maintain genetic gain.

- **Canopy reflectance represents high-throughput opportunity for phenotyping in stress environments.** We continue to develop models utilizing canopy reflectance and canopy thermal properties to estimate relative soybean maturity, seed yield, drought stress, and disease resistance. The focus on 2017 was obtaining remote sensing data on SDS screening trials, on our progeny rows and on germplasm and varieties evaluated for drought stress. All spectral data collected in 2017 and 2018 was accomplished using UAVs. Selections based on data collected using the UAVs were made in 2017 and 2018 and are being evaluated in replicated yield trials to characterize the benefits of using this technology.

- **Slow wilting QTL analysis.** Our assessment of slow wilting in genotypes under drought stress may help improve drought tolerance in soybean. In work with the Univ. of Arkansas, we characterized canopy wilting of 373 maturity group (MG) IV soybean genotypes to identify new and previously reported QTLs for canopy wilting. Over 60, environment-specific significant SNP – canopy wilting associations were identified. Some of the associations were located near previously reported chromosomal regions associated with canopy wilting, and other associations were new. This information will be important for pyramiding beneficial genes into the same genotype, and identifying parents to use in developing populations with improved drought tolerance.

- **Commercial wilting trials.** Seventy-five maturity group 4 and 5 soybean genotypes, consisting of commercial varieties and checks, were evaluated for wilting in replicated trials at Salina KS in 2018. These evaluations included several of the new Roundup Ready Xtend soybean varieties. Between two to four wilting scores were taken on each plot during late vegetative and early reproductive growth. In addition to the wilting ratings, seed yield, maturity, lodging and plant height were collected on all plots. The plants experienced severe drought and heat stress during late vegetative and early reproductive growth. Cultivar wilting scores ranged from near 0 to 65 across rating times. A score of 0 indicated

no wilting present and a score of 25 indicated moderate wilting and rolling of leaves in the top of the canopy. Wilting scores of the slow-wilting checks ranged from 0 to 5, while wilting scores of the fast-wilting checks averaged from 40 to 50. The most severe rating of a cultivar on any day was 65, indicating severe leaf rolling throughout the canopy. Most of the commercial soybean varieties possessed wilting ratings similar to, or more severe, than the fast wilting checks, which possessed average wilting scores around 20. However, one commercial group 4 variety, and 2 commercial group 5 varieties possessed wilting scores similar to the slow wilting checks. Out of these 3 commercial varieties which exhibited slow-wilting characteristics in KS, the yield of the group 4 variety, and one of the group 5 varieties were similar in seed yield to the highest yielding entries across the two locations. Commercial Wilting Trials were evaluated in Missouri, Arkansas, South Carolina, Georgia and North Carolina. Data from these trials will be used to develop a robust assessment of the wilting and drought resistant characteristics of currently available soybean varieties and help guide our breeding activities.

- **Release of KS4919N.** The Kansas Agricultural Experiment Station approved the release of K14-1686. The release announcement and description of the line are in Appendix 6.

Opportunities for Training and Professional Development

- One graduate student worked on objectives related to this project in Agronomy, and two others in Bio and Ag Engineering worked cooperatively using the field plots developed and evaluated through this project.

Dissemination of Results

- Extension publications, news releases, and experiment station reports, field days, extension meetings and tours are used to share the results of this project. Web pages have been developed to disseminate information on new releases and germplasm and pests. Distribution of results of genotype characterization for resistance published online. Distribution of SCN survey results to cliental will provide much-needed information for making informed decisions by producers regarding variety selections for SCN management and by soybean breeders for the development of varieties with improved levels of resistance. Effects of high temperature stress on soybean, and evaluations of host plant resistance were published at scientific conferences and published in peer reviewed publications.

Publications for 2018

Journal articles

Avjinder S. Kaler, Jeffery D. Ray, William T. Schapaugh, Antonio R. Asebedo, C. Andy King, E. E. Gbur, and Larry C. Purcell. 2018. Association mapping identifies loci for canopy temperature under drought in diverse soybean genotypes. Euphytica 214:135, https://doi.org/10.1007/s10681-018-2215-2.

Maduraimuthu Djanaguiraman, William Schapaugh, Felix Fritschi, Henry Nguyen and P.V. Vara Prasad. 2018. Reproductive success of soybean cultivars and exotic lines under high daytime temperature. Plant, Cell and Environment. https://doi.org/10.1111/pce.13421.

Diers B.W., Specht J., Rainey K.M., Cregan P., Song Q., Ramasubramanian V., Graef G., Nelson R., Schapaugh W., Wang D., Shannon G., Mchale L., Kantartzi S.K., Xavier A., Mian R., Stupar R.M., Michno J.-M., An Y.-Q.C., Goettel W., Ward R., Fox C., Lipka A.E., Hyten D., Cary T., Beavis W.D. 2018. Genetic architecture of soybean yield and agronomic traits. G3 8: 3367-3375.

Xavier A., Jarquin D., Howard R., Ramasubramanian V., Specht J.E., Graef G.L., Beavis W.D., Diers B.W., Song Q., Cregan P.B., Nelson R., Mian R., Grover Shannon J., McHale L., Wang D., Schapaugh W., Lorenz A.J., Xu S., Muir W.M., Rainey K.M. 2018. Genome-wide analysis of grain yield stability and environmental interactions in a multiparental soybean population. G3 8: 519-529.

Acknowledgment

The researchers cooperating in this project greatly appreciate the opportunity to interact with the Kansas Soybean Commission. We also appreciate the financial support of the Kansas Soybean farmer to develop new varieties, germplasm and information that supports the improvement of soybean production.

Appendix 1. Summary of SCN reactions for entries in the Kansas Soybean Performance tests from 2016 through 2018.

		2018 SCN Female Index*			2017 SCN Female Index		2016 SCN Female Index	
SOURCE	ENTRY	Race 3 (HG Type 7)	Race 4 (HG Type 1.2.3.5.6.7)	HG Type 2.5.7	Race 3 (HG Type 7)	Race 4 (HG Type 1.2.3.5.6.7)	Race 3 (HG Type 7)	Race 4 (HG Type 1.2.3.5.6.7)
ASGROW	AG34X7	26	52	60	-	-	-	-
ASGROW	AG43X7	41	76	67	-	-	-	-
ASGROW	AG48X7	0	35	9	-	-	-	-
CHECK	MG3.1	19	35	111	-	-	-	-
CHECK	MG3.9	30	86	88	34	60	21	68
CHECK	MG4.9	24	69	80	18	27	15	42
CREDENZ	CZ 2928 LL	15	28	66	-	-	-	-
CREDENZ	CZ 3233 LL	10	46	43	-	-	-	-
CREDENZ	CZ 3548 LL	17	42	26	18	37	-	-
CREDENZ	CZ 3601 LL	40	50	61	23	29	-	-
CREDENZ	CZ 3841 LL	16	31	69	30	41	-	-
CREDENZ	CZ 4105 LL	7	22	39	7	62	-	-
CREDENZ	CZ 4222 LL	25	37	32	13	16	-	-
CREDENZ	CZ 4308 LL	20	21	21	16	35	-	-
CREDENZ	CZ 4548 LL	2	15	13	10	32	-	-
CREDENZ	CZ 4748 LL	9	17	21	4	7	-	-
CREDENZ	CZ 4918 LL	24	33	39	12	11	-	-
CREDENZ	CZ 4820 LL	12	38	37	-	-	-	-
CREDENZ	CZ 4938 LL	13	34	51	22	19	-	-
EMERGE GENETICS	e3796	36	57	85	10	52	-	-
EMERGE GENETICS	e4394	35	59	90	19	96	9	55
EMERGE GENETICS	e4993	46	121	92	38	100	15	80
EMERGE GENETICS	e4996s	33	73	45	25	94	25	67
GOLDEN HARVE	GH3982X	19	91	69	-	-	-	-
GOLDEN HARVE	GH4307X	16	56	43	-	-	-	-
HEFTY	H31x9	18	55	34	-	-	-	-
HEFTY	H35x8	8	17	68	-	-	-	-
HEFTY	H37x7	30	99	66	-	-	-	-
HEFTY	H39x8	44	68	109	-	-	-	-
HEFTY	H42x9	63	59	88	-	-	-	-
HEFTY	H49x7	60	95	106	-	-	-	-
KANSAS AES	K15-1303	49	108	67	-	-	-	-
KANSAS AES	K15-1310	24	104	55	-	-	-	-
KANSAS AES	K15-1681	40	86	97	-	-	-	-
KANSAS AES	K14-1686	64	23	37	-	-	-	-
KANSAS AES	K15-1788	38	110	94	-	-	-	-
KANSAS AES	K15-1800	37	82	75	-	-	-	-
KANSAS AES	K15-1809	38	100	84	-	-	-	-
KANSAS AES	K13-1830	39	75	55	39	58	31	61
KANSAS AES	K15-1855	25	45	42	-	-	-	-
KANSAS AES	K15-1874	0	69	12	-	-	-	-
KANSAS AES	KS3406RR	107	124	105	106	102	78	89
KANSAS AES	KS4117Ns	43	53	66	25	69	20	49
KANSAS AES	KS3618Ngr	12	43	45	14	60	7	13
KANSAS AES	KS5004N	3	128	56	1	59	1	51
KANSAS AES	KS5518	34	89	23	-	-	-	-
LG SEEDS	C3489RX	3	22	53	2	9	-	-
LG SEEDS	C3550RX	12	47	27	5	54	13	50
LG SEEDS	C3985RX	21	36	40	16	19	-	-
LG SEEDS	C4227RX	12	28	39	25	24	-	-
LG SEEDS	C4615RX	5	31	65	10	40	11	42
LG SEEDS	LGS3140RX	8	45	46	-	-	-	-
LG SEEDS	LGS3357RX	21	26	69	-	-	-	-
LG SEEDS	LGS3660RX	25	37	43	-	-	-	-
LG SEEDS	LGS3777RX	12	50	46	-	-	-	-
LG SEEDS	LGS4141RX	4	14	19	-	-	-	-
LG SEEDS	LGS4573RX	17	50	21	-	-	-	-
MIDLAND	3537NX	18	74	68	12	69	9	57
MIDLAND	3779NXS	26	64	88	-	-	-	-
MIDLAND	3938NX	32	71	96	32	67	-	-
MIDLAND	4328NX	32	56	80	23	63	-	-
MIDLAND	4488NXS	12	67	29	-	-	-	-
MIDLAND	4677NXS	24	93	54	37	92	12	57
MIDLAND	4956NXS	23	91	64	13	96	-	-
MISSOURI	S13-10590C	65	-	56	65	90	-	-
MISSOURI	S13-3851C	67	43	38	106	61	-	-
MISSOURI	S14-15138R	13	21	13	-	-	-	-
MISSOURI	S14-9051R	19	17	17	85	42	-	-
MORSOY	4846 RXT	68	85	102	-	-	-	-
PHILLIPS	328 NR2X	36	50	-	-	-	-	-
PHILLIPS	348NR2X	28	69	58	12	18	-	-
PHILLIPS	379 NR2XSE	24	60	50	-	-	-	-
PHILLIPS	387NR2X	27	69	63	19	59	14	30
PHILLIPS	408NR2XS	26	70	49	11	50	-	-
PHILLIPS	456NR2XS	45	73	76	48	61	25	57
PHILLIPS	478NR2XSE	14	69	48	25	109	-	-
PHILLIPS	506NR2XS	31	63	45	14	68	7	51
PRIZE	DINAMO	48	75	79	-	-	-	-
STRATTON	AGS GS46X17	35	80	48	-	-	-	-
STRATTON	AGS GS51X18S	50	87	115	-	-	-	-
STRATTON	Go Soy 43C17	18	36	40	-	-	-	-
STRATTON	Go Soy 49G16	35	15	21	-	-	-	-
STRATTON	Go Soy 50G17	16	6	20	-	-	-	-
STRATTON	Go Soy E4510	23	68	53	-	-	-	-
WILLCROSS	WX3388N	24	80	118	-	-	-	-
WILLCROSS	WX3467NS	33	86	70	-	-	-	-
WILLCROSS	WXE3487NS	36	95	74	25	76	-	-
CV		50.8	46.9	42.0	70.7	48.2	57	45
GRAND MEAN		28.0	59.2	57.6	29.6	57.9	25	51
LSD		23.6	46.5	48.6	28.3	37.6	19	31
No. of Reps		3	3	3	3	3	3	3

* SCN Female Index = Soybean Cyst Nematode female index, where the female index (FI) = (mean # of cysts on tested variety/mean # of cysts on susceptible checks) x 100. A low FI (<10) means that the SCN population was not able to reproduce well on the differential line, and a high FI means that the SCN population was able to reproduce well. Reproduction rates were measured on plants grown in the greenhouse.

APPENDIX 2. Parents used in 2018 crossing block.			
2018 CROSSING BLOCK			
NAME	MG	TRAITS	PEDIGREE
HM11-W192	3	PRO, Y	OHS305/OHS303
KS4117Ns	4	SCN, STS, Y	435.TCS / LD05-30578a
K13-1830	5	Y, SCN,SC	DS-880/R04-357
N05-7432 (N8002)	7	DR, DIV	N7002 x N98-7265 (12.5% PI)
N10-7404	7	DR, DIV	N01-11136 x N98-7265 (25% PI471938)
KS4103sp	4	PRO	Flyer/BARC 6
KS5202sp	5	PRO	Hutcheson/BARC 9
46X714	4.6	YLD, STS, SDS, SCN	
49X715	4.9	YLD, STS, SCN	
e4993	5.2	YLD, SCN, PRO	
PI 661090	4	YLD, DR, DIV	
PI 597387	3	YLD, DIV	
K15-1283	4	YLD, SCN, STS	LD06-7620 / 435.TCS
K15-1310	4	YLD, SCN, STS	LD06-7620 / 435.TCS
K15-1681	4s	YLD, SCN, STS	KS5004N / 435.TCS
K15-1874	4s	YLD, SCN, STS	KS5004N / 435.TCS
K16-1692	4	YLD, SCN, STS	K10-8556/435.TCS
K16-1785	5	YLD, SCN, STS	KS5004N/R05-374
KS4607	4	PRO, Y	K1433 / HS93-4118
KS5005sp	5	PRO, Y	
K17-63 BC4F2:3 RR	4	RR, STS, Y	KS4117Ns / K17-2 BC3 F1 RR1
K18-3 BC2F1 RR NN	4	NN, RR	K17-72(K17-63xK17-56(Williams NN x K17-2bc3f1rr))/K17-63
K18-4 BC1 F1 RR NN	4	NN, RR	K17-68(HarosoyNNxK17-63)/K17-63
K18-1 GH F1 RR	4	NN, RR	KS4117Ns/KS4607
DESCRIPTIVE CODE:			
PRO = PROTEIN, SCN = SOYBEAN CYST NEMATODE RESISTANCE			
STS = SULFUNREYL HERBICIDE RESISTANCE, Y = YIELD, NN = NON-NODULATING			
DIV = DIVERSITY, HO = HIGH OLEIC, RR = ROUNDUP READY 1, SC = STEM CANKER			
SDS = SUDDEN DEATH SYNDROME, DR = DROUGHT, MG = MATURITY GROUP			

APPENDIX 3. Populations created in 2018.			
POPULATION		PEDIGREE	PRIMARY FOCUS
K18-	**1 GH**	KS4117Ns / KS4607	PRO, SCN, STS, Y
K18-	**2 GH**	K15-1800 / KS4607	PRO, Y
K18-	**3-1 NN RR GH**	K17-72-10 BC1F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**3-2 NN RR GH**	K17-72-11 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**3-3 NN RR GH**	K17-72-12 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**3-4 NN RR GH**	K17-72-13 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**3-5 NN RR GH**	K17-72-14 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**3-6 NN RR GH**	K17-72-15 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**3-7 NN RR GH**	K17-72-17 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**3-8 NN RR GH**	K17-72-19 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**3-9 NN RR GH**	K17-72-20 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**3-10 NN RR GH**	K17-72-21 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**3-11 NN RR GH**	K17-72-22 BC1F1 RR NN/ K17-63 BC4F2:3 RR	RR, NN
K18-	**4-1 NN RR GH**	K17-68-5 / K17-63 BC4F2:3 RR	RR, NN
K18-	**4-2 NN RR GH**	K17-68-8 / K17-63 BC4F2:3 RR	RR, NN
K18-	**4-3 NN RR GH**	K17-68-9 / K17-63 BC4F2:3 RR	RR, NN
K18-	**4-4 NN RR GH**	K17-68-7 / K17-63 BC4F2:3 RR	RR, NN
K18-	**5**	HM11-W192 / KS4103sp	PRO, Y
K18-	**6**	46X714 / KS4103sp	Y, STS, SDS, PRO
K18-	**7**	e4993 / KS4103sp	Y, PRO
K18-	**8**	49X715 / KS4103sp	Y, STS, PRO
K18-	**9**	K13-1830 / KS4103sp	Y, PRO
K18-	**10**	KS4117Ns / PI 661090	SCN, STS, DR, DIV
K18-	**11**	e4993 / KS5202sp	Y, PRO

K18-	**12**	K13-1830 / N05-7432 (N8002)	Y, DR, DIV
K18-	**13**	49X715 / KS5202sp	Y, STS, PRO
K18-	**14**	N05-7432 (N8002) / PI 661090	Y, DIV, DR
K18-	**15**	K15-1283 / PI 661090	SCN, STS Y, DR, DIV
K18-	**16**	K15-1681 / PI 661090	SCN, STS Y, DR, DIV
K18-	**17**	N10-7404 / PI 597387	Y, DIV, DR
K18-	**18**	K16-1785 / PI 597387	SCN, STS Y, DIV
K18-	**19**	K16-1692 / PI 597387	SCN, STS Y, DIV
K18-	**20**	KS4117Ns / K13-1830	SCN, STS, Y
K18-	**21**	KS4117Ns / K15-1283	SCN, STS, Y
K18-	**22**	KS4117Ns / K15-1310	SCN, STS, Y
K18-	**23**	KS4117Ns / K15-1681	SCN, STS, Y
K18-	**24**	KS4117Ns / K15-1874	SCN, STS, Y
K18-	**25**	KS4117Ns / K16-1692	SCN, STS, Y
K18-	**26**	KS4117Ns / K16-1785	SCN, STS, Y
K18-	**27**	K13-1830 / K15-1283	Y, SCN, STS
K18-	**28**	K13-1830 / K15-1310	Y, SCN, STS
K18-	**29**	K13-1830 / K15-1681	Y, SCN, STS
K18-	**30**	K13-1830 / K15-1874	Y, SCN, STS
K18-	**31**	K13-1830 / K16-1692	Y, SCN, STS
K18-	**32**	K13-1830 / K16-1785	Y, SCN, STS
K18-	**33**	K15-1283 / K15-1681	Y, SCN, STS
K18-	**34**	K15-1283 / K15-1874	Y, SCN, STS
K18-	**35**	K15-1283 / K16-1692	Y, SCN, STS
K18-	**36**	K15-1283 / K16-1785	Y, SCN, STS

K18-	**37**	K15-1310 / K15-1681	Y, SCN, STS
K18-	**38**	K15-1310 / K15-1874	Y, SCN, STS
K18-	**39**	K15-1310 / K16-1692	Y, SCN, STS
K18-	**40**	K15-1310 / K16-1785	Y, SCN, STS
K18-	**41**	K15-1681 / K15-1874	Y, SCN, STS
K18-	**42**	K15-1681 / K16-1692	Y, SCN, STS
K18-	**43**	K15-1681 / K16-1785	Y, SCN, STS
K18-	**44**	K15-1874 / K16-1692	Y, SCN, STS
K18-	**45**	K15-1874 / K16-1785	Y, SCN, STS
K18-	**46**	K16-1692 / K16-1785	Y, SCN, STS
K18-	**47**	K13-1830 / HM11-W192	Y PRO
K18-	**48**	K15-1283 / HM11-W192	Y, SCN, STS PRO
K18-	**49**	K15-1310 / HM11-W192	Y, SCN, STS, PRO
K18-	**50**	K15-1681 / HM11-W192	Y, SCN, STS, PRO
K18-	**51**	K15-1874 / HM11-W192	Y, SCN, STS, PRO
K18-	**52**	K16-1692 / HM11-W192	Y, SCN, STS, PRO
K18-	**53**	K16-1785 / HM11-W192	Y, SCN, STS, PRO
K18-	**54**	K15-1283 / 46X714	Y, SCN, STS
K18-	**55**	K15-1310 / 46X714	Y, SCN, STS
K18-	**56**	K15-1681 / 46X714	Y, SCN, STS
K18-	**57**	K15-1874 / 46X714	Y, SCN, STS
K18-	**58**	K16-1692 / 46X714	Y, SCN, STS
K18-	**59**	K16-1785 / 46X714	Y, SCN, STS
K18-	**60**	K15-1283 / 49X715	Y, SCN, STS
K18-	**61**	K15-1310 / 49X715	Y, SCN, STS

K18-	**62**	K15-1681 / 49X715	Y, SCN, STS
K18-	**63**	K15-1874 / 49X715	Y, SCN, STS
K18-	**64**	K16-1692 / 49X715	Y, SCN, STS
K18-	**65**	K16-1785 / 49X715	Y, SCN, STS
K18-	**66**	K15-1283 / e4993	Y, SCN, STS
K18-	**67**	K15-1310 / e4993	Y, SCN, STS
K18-	**68**	K15-1681 / e4993	Y, SCN, STS
K18-	**69**	K15-1874 / e4993	Y, SCN, STS
K18-	**70**	K16-1692 / e4993	Y, SCN, STS
K18-	**71**	K16-1785 / e4993	Y, SCN, STS
K18-	**72**	KS5202sp / K15-1681	PRO Y, SCN, STS
K18-	**73**	KS5202sp / K15-1874	PRO Y, SCN, STS
K18-	**74**	KS5202sp / K16-1785	PRO Y, SCN, STS
K18-	**75**	K15-1681 / N05-7432 (N8002)	Y, SCN, STS, DR, DIV
K18-	**76**	K15-1874 / N10-7404	Y, SCN, STS, DR, DIV
K18-	**77**	K16-1785 / N05-7432 (N8002)	Y, SCN, STS, DR, DIV
K18-	**78**	K13-1830 / N10-7404	Y, DR, DIV
K18-	**79**	46X714 / N05-7432 (N8002)	Y, STS, SDS, DR, DIV
K18-	**80**	46X714 / N10-7404	Y, STS, SDS Drought
K18-	**81**	KS5005sp / KS4607	PRO Y
K18-	**82**	KS5005sp / KS4117Ns	SCN, STS, Y
K18-	**83**	KS5005sp / K15-1681	Y, SCN, STS
K18-	**84**	KS4607 / HM11-W192	PRO
K18-	**85 RR**	KS4607 / K17-63 BC4F2:3 RR	RR
K18-	**86**	KS4607 / K16-1785	Y, SCN, STS

K18-	**87 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88 RR NN**	K18-4 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**87-1 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**87-2 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**87-3 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**87-4 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**87-5 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**87-6 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**87 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**87 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**87 RR NN**	K18-3 BC2F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-7 RR NN**	K18-4-4 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-8 RR NN**	K18-4-4 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-9 RR NN**	K18-4-1 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-11 RR NN**	K18-4-1 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-13 RR NN**	K18-4-2 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-14 RR NN**	K18-4-2 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-16 RR NN**	K18-4-3 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-17 RR NN**	K18-4-3 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-18 RR NN**	K18-4-3 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**88-19 RR NN**	K18-4-3 BC1 F1 RR NN / K17-63 BC4F2:3 RR	RR, NN
K18-	**89**	K13-1830 / KS4607	Y, PRO
K18-	**90**	KS5202sp / K16-1692	Y, PRO, SCN, STS
K18-	**91**	N05-7432 (N8002) / PI 597387	Y, DR, DIV
DESCRIPTIVE CODE:			

PRO = PROTEIN, SCN = SOYBEAN CYST NEMATODE RESISTANCE
STS = SULFUNREYL HERBICIDE RESISTANCE, Y = YIELD
DIV = DIVERSITY, HO = HIGH OLEIC, RR = ROUNDUP READY 1
SDS = SUDDEN DEATH SYNDROME, DR = DROUGHT
NN = NON-NODULATING

APPENDIX 4. 2018 FIELD TRIALS														
file: 2018yieldtrials.xls														
			Entries	PLOTS/										
EXPT	TEST		Total	TEST	AB	AT	NE	F2	OT	MC	PI	PD	SA	OTHER
KANSAS ADVANCED TESTS														
18 KAE	KAE, 3 and 4		120	240	*240*	*240*	240		*240*				240	
18 KAL	KAL, 4S and 5		70	140		*140*			140	*140*	*140*		140	
KANSAS PRELIMINARY TESTS														
18 KPE			1440	1440		*1440*	1440		*1440*					
18 KPL			306	306		*306*				306	*306*			
18 KPE-2			10	200				*40*						
18 KPE -3 RR			30	200				*120*						
18 KPL-2			50	200				*200*						
18 KPL3-3 RR			10	200				*40*						
PROGENY ROWS			6720	6720	*6720*									
NORTHERN UNIFORM TESTS														
18 U3				105	*105*									
18 P3A				60	*60*									
18 P3B				60	*60*									
18 U4				60	*60*		*60*		60					
18 P4				50	*50*		*50*		50					
18 UT SHAT			448	448	*448*									
CYST NEMATODE UNIFORM TESTS														
18 SCN U3				60	*60*									
18 SCN P3				60	*60*									
18 SCN P3B				0	*0*									
18 SCN U4				30	*30*		*30*		30					
18 SCN P4				40	*40*		*40*		40					
SOUTHERN UNIFORM TESTS														
18 U4S				60						*60*	*60*			
18 P4S				62						*62*	*62*			
18 U5				93						*93*	*93*			
18 P5E				72						*72*	*72*			
18 P5L				40						*40*	*40*			
SOYBEAN PERFORMANCE, MISC TESTS														
18	SP1	ONAGA	31	124			*124*							
18	SP6E	MCCUNE 4'S	10	40						*40*				
18	SP6L	MCCUNE 5'S	21	84						*84*				
18	SP12	COLBY	26	104										*104*
18	SP14	PIDC	29	116								*116*		
18	SP16, 6 FOOT PLOTS		111	444										444
DROUGHT/DIVERSITY TESTS														
18 WGS3	DROUGHT		200	200		*200*								
18 WGS4	DROUGHT		254	254		*254*								
18 WGS5	DROUGHT		90	90		*90*								
18 MO D	MO Drought		24	72		*72*							*72*	
18 MO J	MO Drought		202	404									*404*	
18 MO DYT-4	MO DRT, WILTING ONLY		20	60									*60*	
18 DTFK	Arkansas DRT, wilt only		15	60									60	
18 DT-1	Georgia DRT, WILT ONLY		160	480									480	
18 KS WILT	WILT ONLY		30	120									120	
18 SC WILT	WILT ONLY		15	60									60	
18 TCLP 503B	WILT ONLY		12	48									48	
18 TCLP 747A	WILT ONLY		34	136									136	
18 TCLP 751A	WILT ONLY		20	80									80	
18 TCLP 752A	WILT ONLY		25	100									100	
18 TCLP 753A	WILT ONLY		20	80									80	
18 TCLP 777	WILT ONLY		30	120									120	
18 COMM WILT 3/4	DROUGHT		50	200									200	
18 COMM WILT 5	DROUGHT		25	100									100	
18 CJ3	PROTEIN/YIELD		37	74	*74*									
18 CS3	PROTEIN/YIELD		37	74	*74*									
18 CS4	PROTEIN/YIELD		44	88	*88*									
18 83GERM	NCRSPdiversity		70	140	*140*									
18 84GERM	NCRSPdiversity		69	138	*138*									
					AB	AT	NE	F2	OT	MC	PI	PD	SA	OTHER
	Total # yield plots at each location, 2018				1279	2198	1984	400	2000	897	773	116	752	104

APPENDIX 5. 2018 seed increases.					
ENTRY					
	2018 TEST*/STATUS	**PEDIGREE**	**2019 STATUS**	***Advance to Foundation Seed IN 2019***	**TRAITS**
Breeder's Seed plots					
NON-GMO CONVENTIONAL ENTRIES					
K15-1008	***U4***	AR10-305003 / 435.TCS	**D****		
K15-1283	***U4***	LD06-7620 / 435.TCS	**U4/WN INC, S INC**	***YES, USE 19 WN***	STS SCN
K15-1303	***SCN U4***	LD06-7620 / 435.TCS	**D**		
K15-1310	***SCN U4***	LD06-7620 / 435.TCS	**D**		
K15-1681	***U4S***	KS5004N/435.TCS	**D**		
K15-1874	***U4S***	KS5004N / 435.TCS	**U4S/WN INC, S INC**	***YES, USE 19 WN***	STS SCN
K15-1788	***U5***	NCC05-1261 / 435.TCS	**D**		
K15-1800	***U5***	NCC05-1261 / 435.TCS	**D**		
K15-1809	***U5***	NCC05-1261 / 435.TCS	**U5**		
K15-1855	***KA***	NCC05-1261 / 435.TCS	**KAL/SVPT/WN INC, S INC**	***YES, USE 19 WN***	STS SCN
K16-1234	SCN P3	LS07-3125/K10-8556	**D**		
K16-1424	SCN P3	S08-17361/K10-8556	**D**		
K16-1390	SCN P4	K07-1633/S08-17361	**D**		
K16-1403	SCN P4	K07-1633/S08-17361	**D**		
K16-1430	SCN P4	S08-17361/K10-8556	**D**		
K16-1444	SCN P4	S08-17361/K10-8556	**D**		
K16-1445	SCN P4	S08-17361/K10-8556	**D**		
K16-1543	SCN P4	S08-17361/LS07-3125	**D**		
K16-1412	P4	K07-1633/S08-17361	**D**		
K16-1425	P4	S08-17361/K10-8556	**D**		
K16-1427	P4	S08-17361/K10-8556	**D**		
K16-1433	P4	S08-17361/K10-8556	**D**		
K16-1443	P4	S08-17361/K10-8556	**D**		
K16-1692	P4	K10-8556/435.TCS	**D**		
K16-2167	P4S	S08-17361/K10-8556	**D**		
K16-2185	P4S	S08-17361/LS07-3125	**D**		
K16-1785	P5E	KS5004N/R05-374	**D**		
Foundation Seed Production					
CONVENTIONAL					
K13-1830	***INCREASE, RETEST, MG5***	DS-880 / R04-357	**D**		
K14-1686	***U5***	S05-11482 / DS-880	**RELEASE/F INC**		SCN, Y
K15-1800	***U5***	NCC05-1261 / 435.TCS	**D**		
KS4607	***SVPT***		**distribute/SVPT**		HIGH PRO
KS4103sp	***SVPT***		**distribute/SVPT**		HIGH PRO
GMO ENTRIES (RR1)					
K4117Nsgr	***U4GR***		**U4RR/WN INC, S INC**	***Yes, use seed from 19 WN***	**RR1, STS, SCH**

*** U, P, SVPT, KA = Uniform Tests, Preliminary Tests, Soybean Variety Performance Tests, Kansas Advance Tests, respectively. ** D = discard.**

APPENDIX 6. Release of KS4919N.

Kansas Agricultural Experiment Station
Kansas State University
Manhattan, KS 66506

Notice of Release of KS4919N Conventional (non-GMO) Soybean

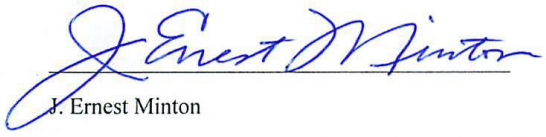
The Kansas Agricultural Experiment Station announces the release of 'KS4919N' soybean [*Glycine max* (L.) Merr. Scientists contributing to this release are William Schapaugh, Professor, Jacob Petersen, Assistant Scientist and Rene Hessel, Assistant Scientist, Department of Agronomy, and Tim Todd, Instructor and Tom Oakley, Assistant Scientist, Department of Plant Pathology.

KS4919N is an F4 single plant selection from the cross S05-11482 by DS-880. KS4919N has white flowers, tawny pubescence, tan pods at maturity, determinate growth habit, and seeds with black hila. KS4919N is a late group 4 maturity variety. It is well adapted to a wide range of soil types and climates throughout Southeast KS, Southern MO, Northern AR and where other late maturity group 4 varieties are grown.

KS4919N was tested as experimental line, K14-1686, in the Southern Uniform Soybean tests, the K-State Breeding program and the Kansas Soybean Variety Performance Tests from 2014 through 2018. In 2016, KS4919N performed well in the Uniform Preliminary 5 Test and possessed moderate resistance to Soybean Cyst Nematode. In 2017 and 2018, KS4919N was entered into the Uniform 5 Test. Seed yield of K14-1686 has been statistically equal to the early maturing checks in the Uniform 5 Test. In Kansas breeding plots and the Soybean Variety Performance Tests the past five years, KS4919N has performed well, yielding approximately 7% and 6% higher than KS5005N and KS5518, respectively. Seed yield, and moderate resistance to a range of Soybean Cyst Nematode HG Types including: HG Type 1.2.5.7, HG Type 5.7 and HG Type 2.5.7 are advantages that KS4919N has over KS5004N and KS5518.

The Foundation Seed Program, Department of Agronomy, Kansas State University will maintain breeder's seed of this cultivar. Information on licensing for commercialization can be obtained from Christopher D. Brandt, President/CEO, Kansas State University Research Foundation, 2005 Research Park Circle, Suite 105, Manhattan, KS 66502-5020 (phone: 785-532-5720; email: tech.transfer@k-state.edu).

Small quantities of seed for research purposes can be obtained by request from William Schapaugh, Department of Agronomy, Kansas State University, Manhattan, KS (phone: 785-770-7906; email: wts@ksu.edu).



J. Ernest Minton

3-14-2019

Date

Interim Director, Kansas Agricultural Experiment Station

1

K14-1686 is an F4 single plant selection from the cross S05-11482 by DS-880. K14-1686 has white flowers, tawny pubescence, tan pods at maturity, determinate growth habit, and seeds with black hila. K14-1686 is a late group 4 maturity variety. It is well adapted to a wide range of soil types and climates throughout Southeast KS, Southern MO, Northern AR and where other late maturity group 4 varieties are grown.

K14-1686 has been tested in Kansas and the Southern Uniform Soybean tests. In 2016, K14-1686 performed well in the Uniform Preliminary 5 Test (Table 1) and possessed above average resistance to Soybean Cyst Nematode. In 2017 and 2018, K14-1686 was entered into the Uniform 5 Test (Tables 2-5). Seed yield of K14-1686 has been statistically equal to the early maturing checks in the Uniform 5 Test. In Kansas breeding plots and the Soybean Variety Performance Tests the past four years, K14-1686 has performed well, yielding about 7% and 6% higher than KS5005N and KS5518, respectively (Tables 6 and 7). Seed yield, and moderate resistance to a range of Soybean Cyst Nematode HG types are the advantages that K14-1686 has over KS5004N and KS5518.

Table 1. General summary of performance Uniform Preliminary V 2016.

STRAIN/ VARIETY	SEED YIELD	RANK	AVG. RANK	MAT. INDEX	LOD	HT	SCN Cyst Score (1-5)† Race 2	Race 3	Race 5	SC RATING	SC SCORE
OSAGE	52.8	42	33	0	1.4	25	3	1	4	MR	2
Ellis	62.8	8	16	-2	1.4	30	5	4	5	R	1
JTN-5203	60.8	15	20	-3	1.6	30	1	2	1	SS	3
S11-20124	66.5	2	8	-3	3.2	37	1	2	1	MS	4
UA 5612	60.5	18	22	2	2.6	36	5	4	3	MR	2
AG 5534RR2	58.5	27	26	1	1.8	33	4	4	3	MR	2
AG 5335	66.7	1	9	0	1.8	39	3	2	3	R	1
DA10x05-17F	62.5	10	17	-3	2.0	34	5	5	4	R	1
DA10x05-19F	61.8	11	20	-3	2.2	34	5	5	5	R	1
DA10x25-06	58.0	30	27	-3	2.9	38	4	4	5	R	1
DS46-2	54.5	38	32	0	1.9	43	4	4	5	R	1
DS788-212	49.1	46	41	2	2.4	42	4	5	5	R	1
JTN-5116	50.4	44	40	-6	2.0	36	2	1	1	MS	4
JTN-5216	53.2	41	36	-4	1.9	34	1	1	1	MS	4
JTN-5316	46.7	48	44	-7	1.7	32	1	1	1	MR	2
JTN-5416	45.4	49	44	-4	1.8	36	1	1	1	R	1
JTN-5516	50.2	45	39	-6	2.0	36	1	1	1	R	1
K14-1657	58.1	28	25	-4	1.8	30	3	3	2	R	1
K14-1661	53.8	40	36	-5	1.4	27	4	1	3	R	1
K14-1686	60.1	20	21	-2	1.6	29	1	1	1	SS	3
K14-1694	57.4	32	23	-3	1.7	30	1	1	1	SS	3
K14-1707	59.1	21	23	-3	1.4	28	1	3	1	MS	4
K14-1726	60.6	17	22	-6	1.6	31	2	2	1	R	1
R11-6870	62.8	7	16	1	1.9	33	5	2	4	R	1
R13-335	60.5	19	23	4	1.6	33	5	3	5	R	1
R13-359	60.8	13	19	1	2.3	37	5	1	4	R	1
R13-532	62.7	9	16	2	1.9	33	4	3	5	R	1
R13-818	64.5	5	11	0	2.2	35	4	3	4	R	1
R13-1419	61.5	12	18	2	1.9	35	4	3	5	R	1
R13-4638RY	62.9	6	13	2	2.2	35	4	5	5	R	1
S13-1955	58.6	24	24	2	2.3	32	1	4	1	S	5
S14-9017	66.0	3	8	1	1.8	32	1	1	2	R	1
S14-14441	58.7	23	22	-4	1.8	36	3	4	5	R	1
S14-15084	58.5	26	26	1	2.0	39	4	5	4	R	1
S14-15156	56.7	35	30	-1	1.8	36	4	4	5	R	1
S14-15164	60.8	14	19	-2	1.7	36	4	3	5	R	1
TN13-5531RR1	60.8	16	20	-3	1.6	34	1	1	1	SS	3
TN15-4606	47.6	47	36	-3	1.7	34	4	4	5	MS	4
TN15-5008	58.6	25	27	-3	1.5	32	2	4	4	S	5
TN15-5016	56.6	36	27	-1	1.5	30	1	2	1	S	5
TN15-5514	54.9	37	27	-4	1.4	27	3	2	4	S	5
TN15-5806	54.1	39	33	-2	1.5	29	2	1	2	MR	2
V11-0119	57.2	34	26	-6	1.7	33	5	2	5	R	1
V11-0695	59.1	22	25	-5	1.7	28	5	2	5	R	1
V12-0045R2	64.6	4	14	-1	1.7	30	5	1	5	R	1
V12-0063R2	58.0	29	25	0	1.6	29	4	3	5	R	1
V12-1048	57.2	33	28	-3	1.5	30	4	4	5	R	1
V12-1416	50.6	43	38	0	1.4	30	3	5	4	R	1
V12-3684	57.4	31	29	-3	1.4	26	4	5	5	R	1
Mean	58.0	.	.	-2	1.8	33	.	.	.	.	.
LSD(0.05)	6.8	.	.	2	.	3	.	.	.	.	.
CV(%)	12.7	.	.	160	.	11	.	.	.	.	.

†The race 2, 3, and 5 SCN populations used in these tests were typed as HG (*Heterodera glycines*) Type 1.2.5.7, HG Type 5.7, and HG Type 2.5.7, respectively.
‡Protein percentage and oil percentage are reported on a 13% moisture basis beginning in 2015.

Seed yield: bushels per acre, Mat index: maturity, days relative to check, Lod: Lodging score 1 best to 5 worst, Ht: Plant height in inches, Soybean Cyst Nematode (SCN) ratings: 1 = 0-5 cysts on the root, 2=6-10 cysts on the root, 3=11-20 cysts on the root, 4=21-40 cysts on the root, and 5=> 40 cysts on the root, stem Canker (SC): R = resistant, MR = moderately resistant, SS = segregating or somewhat susceptible, MS = moderately susceptible or S = susceptible

Table 2. General summary of performance Uniform Test V 2017.

STRAIN/ VARIETY	MAT. INDEX	LODGING	HEIGHT	SEED QUALITY	SEED SIZE	FL. COLOR	PUB. COLOR	POD COLOR
Ellis	0	1.3	27	1.6	13.5	W	G	T
JTN-5203	0	1.6	28	1.7	13.4	W	G	T
AG 5335	1	1.7	37	1.9	15.7	W	G	T
GoSoy 54G16	2	1.6	32	1.7	14.7	W	G	T
UA 5612	5	2.4	34	2.0	13.7	P	G	T
TN11-5140	8	1.8	35	1.8	14.8	W	G	T
DA09x39-26F	1	1.8	31	1.8	14.2	P	S	T
K14-1686	0	1.5	29	1.9	13.8	W	T	T
K14-1726	-3	1.4	29	1.7	13.9	S	G	T
R10-298	0	1.9	30	1.8	15.1	W	G	T
R13-4638RY	5	1.7	33	1.9	14.8	W	G	T
R13-9687	2	1.6	29	1.7	14.3	P	G	T
R13-13997	4	1.8	33	1.8	15.9	W	T	T
R13-14635RR	3	2.0	42	2.1	14.4	S	G	T
S13-1955C	4	2.1	30	2.2	14.3	W	T	T
S14-9017R	2	1.4	32	2.4	15.0	W	Lt	T
S15-10434C	4	2.2	30	1.9	13.6	P	T	T
S15-16499C	2	2.8	32	2.0	15.2	W	G	T
S15-16505C	6	3.3	36	2.0	16.0	W	G	T
S15-16569C	1	1.6	28	1.9	17.1	W	T	T
TN11-5102	2	1.5	32	1.7	14.6	W	G	T
TN13-5531RR1	1	1.5	30	1.7	15.0	W	G	T
TN15-5008	1	1.7	31	1.8	14.7	P	G	T
TN16-521	1	1.6	30	1.8	12.3	W	G	T
TN16-645	0	1.4	28	1.7	12.1	W	G	Br
V10-0262	3	1.7	32	1.7	15.1	W	T	T
V11-3485	3	1.9	29	1.8	15.1	P	T	T
V12-0045R2	1	1.5	29	2.0	17.4	P	G	T
V12-1416	4	1.3	29	1.8	14.0	W	G	T
Mean	2	1.8	31	1.9	14.6			
LSD(0.05)	2	0.3	2	0.2	0.6			
CV(%)	126	29.0	10	21.0	6.0			

Table 3. General summary of botanical traits Uniform Test V 2017.

STRAIN/ VARIETY	RANK	AVG. RANK	YIELD† 2017	YIELD† 16-17	YIELD† 15-17	PROTEIN‡ 2017	PROTEIN‡ 16-17	PROTEIN‡ 15-17	OIL‡ 2017	OIL‡ 16-17	OIL‡ 15-17
Ellis	15	15	61.7	61.0	60.6	34.6	34.9	35.0	18.5	18.9	18.8
JTN-5203	25	18	58.6	58.1	56.8	34.9	35.1	35.2	19.2	19.4	19.2
AG 5335	13	14	62.0	60.9	59.0	34.6	35.3	35.5	19.5	19.7	19.5
GoSoy 54G16	27	20	58.2	.	.	32.9	.	.	19.5	.	.
UA 5612	10	14	62.6	62.1	60.3	34.7	35.2	35.2	18.9	19.1	19.0
TN11-5140	8	12	62.8	.	.	35.4	.	.	19.3	.	.
DA09x39-26F	14	15	61.7	59.5	.	34.6	35.0	.	19.0	19.2	.
K14-1686	7	12	63.2	.	.	34.7	.	.	19.3	.	.
K14-1726	19	17	60.9	.	.	36.1	.	.	18.4	.	.
R10-298	24	19	58.6	.	.	35.4	.	.	18.4	.	.
R13-4638RY	1	9	65.1	.	.	34.9	.	.	18.7	.	.
R13-9687	9	13	62.7	61.2	.	35.7	35.9	.	17.9	18.3	.
R13-13997	2	10	64.6	64.1	.	34.6	35.1	.	19.7	19.8	.
R13-14635RR	21	17	60.2	.	.	34.8	.	.	18.8	.	.
S13-1955C	6	12	63.5	.	.	33.9	.	.	19.4	.	.
S14-9017R	4	11	64.1	.	.	31.9	.	.	21.4	.	.
S15-10434C	3	10	64.6	.	.	35.6	.	.	18.5	.	.
S15-16499C	20	17	60.3	.	.	32.2	.	.	19.3	.	.
S15-16505C	23	18	59.2	.	.	33.7	.	.	19.2	.	.
S15-16569C	16	15	61.3	.	.	34.1	.	.	19.7	.	.
TN11-5102	5	10	63.7	61.6	60.4	36.6	36.7	36.7	18.3	18.6	18.6
TN13-5531RR1	29	22	56.2	.	.	32.6	.	.	19.5	.	.
TN15-5008	22	16	59.9	.	.	37.0	.	.	18.3	.	.
TN16-521	17	15	61.3	.	.	34.3	.	.	18.7	.	.
TN16-645	18	15	61.0	.	.	34.6	.	.	18.5	.	.
V10-0262	11	13	62.4	60.3	59.7	36.4	36.8	36.8	18.8	19.0	18.9
V11-3485	26	20	58.3	56.2	.	35.4	35.8	.	18.6	18.8	.
V12-0045R2	12	14	62.0	.	.	34.5	.	.	18.4	.	.
V12-1416	28	21	57.9	.	.	33.6	.	.	19.3	.	.
Mean	.	.	61.3	.	.	34.6	.	.	19.0	.	.
LSD(0.05)	.	.	3.9	.	.	0.7	.	.	0.5	.	.
CV(%)	.	.	11.3	.	.	2.5	.	.	3.2	.	.

† Data not included in mean: 2017 - Tallassee, AL
2016 - Kinston, VA; Knoxville, TN; Warsau, VA
2015 - Orange, VA; Springfield, TN; Bossier City, LA

‡ Protein percentage and oil percentage reported on a 13% moisture basis beginning in 2015.

Table 4. General summary of pest reaction Uniform Test V 2017

STRAIN/ VARIETY	SCN Cyst Score (1-5 Scale)†			PRK	SRK	SC	SC
	Race 1	Race 3	Race 5	GA	GA	RATING	SCORE
Ellis	.	4	5	1.5	1.0	R	1.0
JTN-5203	.	1	1	4.3	5.0	SS	3.0
AG 5335	.	3	4	1.0	4.7	R	1.0
GoSoy 54G16	.	1	2	1.0	3.0	S	5.0
UA 5612	.	3	5	1.7	5.0	SS	3.0
TN11-5140	.	4	5	3.0	1.0	R	1.0
DA09x39-26F	.	4	5	3.4	4.5	MS	4.0
K14-1686	.	1	1	2.3	5.0	MS	4.0
K14-1726	.	1	1	1.5	5.0	R	1.0
R10-298	.	4	5	2.1	1.4	R	1.0
R13-4638RY	.	3	5	2.0	1.0	R	1.0
R13-9687	.	3	4	1.3	5.0	R	1.0
R13-13997	.	3	3	2.8	1.0	R	1.0
R13-14635RR	.	4	5	2.1	4.8	R	1.0
S13-1955C	.	3	1	2.5	1.0	SS	3.0
S14-9017R	.	1	2	2.0	5.0	R	1.0
S15-10434C	.	2	1	1.8	1.1	SS	3.0
S15-16499C	.	4	4	1.3	5.0	S	5.0
S15-16505C	.	4	4	2.8	5.0	S	5.0
S15-16569C	.	4	3	3.0	4.8	MS	4.0
TN11-5102	.	4	4	2.0	1.0	R	1.0
TN13-5531RR1	.	1	1	3.5	5.0	MS	4.0
TN15-5008	.	4	3	2.0	5.0	MS	4.0
TN16-521	.	4	5	2.0	1.0	R	1.0
TN16-645	.	4	5	1.3	1.0	R	1.0
V10-0262	.	4	5	1.0	5.0	R	1.0
V11-3485	.	3	5	2.0	4.5	R	1.0
V12-0045R2	.	2	5	1.0	5.0	R	1.0
V12-1416	.	3	4	4.3	5.0	SS	3.0

†The race 3 and 5 SCN populations used in these tests were typed as HG (Heterodera glycines) HG Type 5.7 and HG Type 2.5.7, respectively. The race 1 test was not sucessful due to hail damage to the greenhouse.

Table 5. Summary of yield (bu/a) performance in Uniform Test V 2018 at 16 locations.

STRAIN/ VARIETY	Test Mean
Ellis	55.9
JTN-5203	53.4
K14-1686	53.2
LSD(0.05)	5.4
CV (%)	14.2

Table 6. Performance of K14-1686 across 16 KS locations (2015-2018).

					Seed		
	Yield	Maturity	Lodging	Height	Protein	Oil	Weight
Entry	bu/a	date	score	inches	%	%	g/100
LOCATIONS	16	8	16	15	4	4	15
K14-1686	57.4a†	44a	1.4a	35a	35a	19a	13.3ab
KS5004N	53.4b	46b	1.8b	34ab	35a	19a	12.5b
KS5518	54.0b	47b	2.4c	33b	34a	18a	14.3a
C.V. %	9.6	3.5	36.8	9.4	2.6	1.6	4.7

Table 7. Seed yield (bu/a) of K14-1686 in KS breeding trials, by location (2015-2018).

Entry	Erie 2017, 2018	McCune 2015, 2016, 2018	Ottawa 2016 - 2018	Parsons 2016 - 2018	Pittsburg double crop 2018	Pittsburg 2015-2018
K14-1686	51.6ab†	55.4a	63.6a	50.4a	57.3a	60.4a
Ellis	-	54.2a	-	-	-	53.0b
KS5004N	55.2a	53.7a	59.8a	45.6b	55.8a	53.0b
KS5518	45.5b	55.8a	63.2a	51.8a	52.0b	51.3b
C.V. %	8.6	7.5	9.4	6.9	4.6	10.8

† Numbers within a column, or within a location, followed by the same letter,

not significantly different at the 0.05 level of probability.