Final Report for 2020 National Peanut Board funding to the Texas Peanut Producers Board.

I. **Subject area**: Molecular Genetics & Breeding

Project Title: Breeding to Increase Peanut Yields and Production Efficiency by Developing Breeding Lines with Improved Drought and Heat Tolerance combined with Multiple Disease Resistance

Funding Year: 2020

Co-PIs:

Mark D. Burow, Professor, Texas A&M AgriLife REC, Lubbock, 79403; and Dept. of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409. mburow@tamu.edu

John M. Cason, Assistant Professor, Texas A&M AgriLife REC, Stephenville, TX 76401. j-cason@tamu.edu

Michael R. Baring, Assistant Research Scientist, Dept. of Soil and Crop Sciences Dept. Texas A&M University College Station, TX. 77843. m-baring@tamu.edu

Charles E. Simpson, Professor Emeritus, Texas A&M AgriLife REC, Stephenville, TX 76401. c-simpson@tamu.edu

Paxton Payton, Research Plant Physiologist, 3810 4th Street, Lubbock, TX, 79415; *Adjunct Assistant Professor,* Dept. of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409. paxton.payton@ars.usda.gov

Proposal Coordinator:

John M. Cason, Assistant Professor, Texas A&M AgriLife REC, Stephenville, TX 76401. j-cason@tamu.edu Phone: 254-396-0653

Sub-Project I-1 Multiple Disease Resistant Runner-type trials

The TAMU Peanut project had replicated yield trials located in South Texas, (Pearsall, Dilley, and Derby), in Central Texas (Proctor and Highland), in North West Texas, (Seminole, Seagraves, Plains and Tokio) and in the Rolling Plains (Collingsworth Co.). We conducted 8 Advanced Line Tests (ALT's) across Texas in 2020 as well as two replicated screening nurseries for Sclerotinia and Leafspot resistance. We continued to move lines developed for drought tolerance, into the more widespread ALT test in order to get more accurate information on each of the lines performance across the state. A total of 5 breeding lines were included from the drought tolerance program as well as 2 lines that are focused on higher yield and grade. There are also 7 lines developed for Root knot nematode resistance and Sclerotinia resistance, and 6 commercial checks Tamrun OL11, AG18, Georgia 09B, Georgia 14N, Webb and NemaTAM II. Table 1 is a combined analysis of the ALT's across Texas in 2020. Testing in 2020 was highly variable due to hot and dry conditions across the state resulting in several ALT not being statistically significant. The only line in the top statistical grouping was from the drought crossing program. It should be noted that the lines developed for drought tolerance are some of the first generation of crossing completed for the drought project and while they are not the most drought tolerant lines in the project, they appear to have excellent yield potential under normal irrigation to the point that they continue to perform at the top of the tests. The best performing lines are currently being used as parents for development of future breeding lines.

Table 1. Combined Advanced Line Test 3 locations in 2020

Cultivar	Pods/Ac Lbs.		Value/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs	
TxL100212-03-03	8152	A	1459.80	A	69.0	CDEFG	71.2	BCD	642	GH
Tx144370	7350	B	1297.12	B	67.5	FGHI	65.5	EFG	695	CDE
TxL100212-05-09	7280	BC	1239.67	BCD	67.8	EFGHI	73.2	BC	621	HI
Georgia 09B	7255	BC	1287.71	BC	69.0	CDEFG	61.9	G	735	C
TxL100225-03-13	7123	BCD	1242.66	BCD	66.3	I	56.0	H	812	AB
Webb	6983	BCDE	1196.59	CDEF	67.3	GHI	77.2	A	588	I
NemaTAM II	6946	BCDEF	1203.90	CDEF	67.4	GHI	70.0	CD	649	FGH
TP200609-1-5	6927	BCDEF	1252.07	BCD	69.8	BCDE	65.9	EF	691	DEF
Tx144485	6902	CDEF	1215.56	BCDEF	68.7	DEFG	74.3	AB	612	HI
AG18	6887	CDEF	1253.57	BCD	70.9	ABC	64.7	EFG	704	CDE
TP200610-3-7	6796	DEFG	1223.03	BCDE	68.6	DEFGH	62.2	FG	731	CD
Tamrun OL11	6622	EFGH	1208.94	BCDEF	71.4	AB	65.0	EFG	698	CDE
TP200606-3-3	6537	FGH	1201.02	CDEF	72.1	A	68.1	DE	669	EFG
TP200606-2-11	6508	FGHI	1174.52	DEFG	70.5	ABCD	65.0	EFG	700	CDE
TP200610-4-8	6502	FGHI	1171.07	DEFG	68.4	DEFGHI	64.0	FG	715	CD
TP200610-2-9	6415	GHI	1135.31	EFGH	66.4	HI	54.2	H	841	A
TxL100212-07-07	6236	HI	1046.44	H	63.8	J	57.8	H	787	B
Georgia 14N	6197	HI	1130.40	FGH	69.6	BCDEF	57.9	H	787	B
TP200610-1-14	6075	I	1089.02	GH	67.7	EFGHI	56.3	H	816	AB
Mean	6826		1212.02		68.5		64.8		710	
CV(%)	15.0		16.6		5.5		11.7		11.8	
Entry "F"	<.0001		<.0001		<.0001		<.0001		<.0001	

We also conducted 2 trials with new materials bred for increased yield and grade, as well as. 5 multiple disease resistance trials. This is the first year of testing for all these materials and the lines were divided up across the state at random. As more seed becomes available we will move the best performing lines forward in testing and test them in additional areas of the state. All these new tests were significant and are presented in summary charts 2-7 although in some cases variability between replications was higher than we would have liked which again we are attributing to environmental effects during the season. TP200607-1-17 performed at the top of the West Texas location (Table 2) for yield and for grade with a yield of 6257 lbs/ac and a grade of 74.5%. Given the challenging production year this was very encouraging to seed new breeding lines performing well in this test.

Table 2. Yield Test #1 in West Texas for 2020

	Pods/Ac Lbs.		Value/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs	
Cultivar										
TP200607-1-17	6257	A	1304.63	A	74.5	A	62.9	FG	722	AB
Georgia 14N	5957	AB	1195.85	AB	69.7	DEFGH	62.8	FG	722	AB
TP200607-1-2	5871	AB	1166.17	AB	69.5	DEFGH	64.2	EFG	707	ABC
TP200606-6-15	5852	ABC	1128.55	BC	67.0	H	64.9	DEFG	699	BCD
TP200606-6-10	5824	ABC	1201.42	AB	73.8	ABC	71.4	AB	637	FG
TP200606-3-8	5787	ABCD	1181.94	AB	71.6	BCD	60.6	G	750	A
TP200606-6-13	5767	ABCD	1163.40	AB	72.1	ABCD	70.0	ABC	648	EFG
TP200606-6-4	5665	ABCD	1137.89	BC	70.9	DEF	70.1	ABC	649	EFG
AG18	5621	ABCDEF	1106.11	BCD	68.7	EFGH	63.2	FG	719	AB
Georgia 09B	5612	ABCDE	1112.34	BC	69.7	DEFGH	64.3	EFG	706	ABC
Tx144370	5455	BCDEF	1089.21	BCD	70.3	DEFG	66.2	CDEF	686	BCDEF
TP200607-1-15	5407	ABCDEF	1035.39	BCD	67.4	H	67.6	BCDEF	674	BCDEFG
TP200607-1-14	5331	BCDEF	1074.88	BCD	71.3	CDE	68.6	ABCDE	661	CDEFG
TP200606-2-1	5131	BCDEF	1056.70	BCD	72.2	ABCD	68.1	ABCDE	666	CDEFG
TP200606-6-12	5084	CDEF	985.73	CDE	67.7	GH	64.2	EFG	706	ABC
TP200606-7-11	5048	DEF	987.40	CDE	68.3	FGH	68.2	ABCDE	668	CDEFG
Tamrun OL11	4889	EFG	989.57	CDE	71.7	BCD	70.2	ABC	648	EFG
NemaTAM II	4831	FG	933.93	DE	67.8	GH	72.5	A	626	G
TP200607-1-16	4111	G	817.88	E	69.3	DEFGH	66.0	CDEF	687	BCDE
Mean	6061		1091.54		70.4		66.8		682	
CV(%)	11.0		12.0		3.8		6.1		6.1	
Entry "F"	0.003		0.0005		<.0001		0.0002		0.0002	

The second yield trial (Table 3) was conducted in South Texas. The top three positions for yield in this trial were all new breeding lines with TP200606-7-10, TP 200606-3-10 and TP200606-2-9 producing 6914 lbs/ac, 6577 lbs/ac and 6353 lbs/ac respectively. All three also performed in the top statistical grouping for yield with grades of 74.9%, 73.6% and 75.5% respectively.

Table 3.Yield Test #2 in South Texas for 2020

	Pods/Ac Lbs.		Value/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs	
Cultivar										
TP200606-7-10	6914	A	1290.51	A	74.9	ABC	82.7	A	549	G
TP200606-3-10	6577	AB	1209.48	AB	73.6	ABCD	65.7	DEF	690	CDE
TP200606-2-9	6353	ABC	1200.46	ABC	75.5	A	65.2	DEF	696	BCD
Tx144370	6343	ABCD	1147.74	BCD	68.9	E	61.2	FG	742	B
TP200606-7-12	6291	ABCD	1167.17	ABCD	74.7	ABC	75.6	B	600	F
TP200606-1-8	6247	ABCDE	1121.05	BCDE	71.3	DE	68.0	CDE	668	DE
Georgia 09B	6134	BCDEF	1130.57	BCDE	73.6	ABCD	66.1	CDEF	686	CDE
TP200606-4-7	6117	BCDEF	1113.00	BCDE	72.3	BCD	66.8	CDE	680	CDE
TP200606-2-4	6070	BCDEF	1122.73	BCDE	73.1	ABCD	70.8	BC	643	EF
Georgia 14N	6008	BCDEF	1133.84	BCDE	75.2	AB	57.3	G	792	A
TP200606-3-7	5989	BCDEF	1098.11	BCDEF	73.4	ABCD	65.6	DEF	692	CDE
TP200607-1-6	5959	BCDEF	1082.67	BCDEFG	72.0	CDE	70.0	CD	649	DE
TP200606-4-5	5913	BCDEF	1100.38	BCDEF	72.9	ABCD	65.3	DEF	695	BCD
AG18	5833	CDEF	1083.20	BCDEFG	72.3	ABCD	63.2	EF	719	BC
TP200606-3-6	5704	CDEFG	1067.61	CDEFG	74.2	ABCD	66.9	CDE	678	CDE
TP200606-7-5	5645	DEFG	1049.27	DEFG	73.8	ABCD	69.1	CD	657	DE
TP200606-7-6	5573	EFG	1033.91	DEFG	73.1	ABCD	68.0	CDE	667	DE
TP200606-6-5	5536	FG	1006.01	EFG	72.6	ABCD	68.7	CD	661	DE
TP200607-1-10	5097	G	953.55	G	73.9	ABCD	65.7	DEF	696	BCD
Tamrun OL11	5092	G	963.33	FG	74.9	ABC	66.1	CDEF	686	CDE
Mean	5970		1103.73		73.3		67.4		677	
CV(%)	10.6		11.0		3.1		8.4		8.0	
Entry "F"	0.0007		0.0043		0.0469		<.0001		<.0001	

In addition to conducting trials for improved yield and grade the also began testing several new populations that were created in an effort to combine sclerotinia resistance and nematode resistance. Multiple Disease Resistance Trial #1 (Table 4) was grown in West Texas and contained lines from several crossing programs. This location was harvested early and the yields were overall disappointing. However, the best yielding line at this location was a breeding line Tx191203 that yielded 3481 lbs/ac. While yields were below average we were well above the commercial check Georgia 09B which had yield of 6134 lbs/ac. However, grades for this line were below acceptable levels and while this line will not be acceptable for release one of the parents is a highly resistant Sclerotinia breeding line which makes this breeding line valuable for crossing to improve sclerotinia resistance.

Multiple Disease Resistance test #2 (Table 5) was grown in South Texas were growing conditions were much better than in West Texas. Again, at this location several new breeding lines performed very well with respect to yield with TP200610-3-2 yielding the most at 7044 lbs/ac. It was in the top statistical grouping for grade with a TSMK of 75.5%. This and two other breeding lines (TP200610-4-5 and TP200610-2-13) outperformed the commercial checks Georgia 90B and AG18 for both yield and grade which were 6351 lbs/ac and 6257 lbs/ac and 73.6% and 72.2% respectively.

Table 4. Multiple Disease Resistance Test #1 in West Texas for 2020

Cultivar	Pods/Ac Lbs.		Value/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs	
Tx191203	3481	A	610.87	A	67.8	FGHI	58.2	DE	780	HIJ
TP200610-1-13	3287	AB	632.01	A	74.0	AB	50.5	JK	898	BC
TP200610-1-2	3239	AB	618.09	A	74.7	A	49.8	K	911	BC
TP200610-2-8	3223	ABC	606.06	AB	74.0	AB	53.2	HIJ	853	DE
TP200606-1-6	3215	ABC	571.35	ABC	69.0	DEFG	56.1	EFG	808	FGHI
Tx191201	3183	ABC	576.06	ABC	71.7	ABCDE	75.4	A	602	M
Webb	3098	ABCD	542.90	ABCD	69.6	CDEFG	70.0	B	648	L
Georgia 14N	3074	ABCD	571.17	ABC	72.6	ABCD	49.5	K	916	B
TP200606-2-11	2968	ABCDE	543.49	ABCD	72.7	ABC	54.0	GHI	841	DEF
TP200610-2-3	2859	ABCDE	517.98	ABCD	70.1	CDEFG	53.2	HIJ	852	DE
Georgia 09B	2755	BCDEF	473.58	BCDE	71.6	ABCDE	58.2	DE	779	HIJ
Tx131901-030	2710	BCDEF	457.50	CDE	64.3	I	63.2	C	718	K
TP200606-2-3	2580	CDEFG	452.07	CDE	68.1	EFGH	60.6	CD	751	JK
Tamrun OL11	2511	DEFG	448.77	CDE	69.5	CDEFG	57.3	EF	792	GHI
Tx191001	2460	DEFG	447.94	CDE	70.8	BCDEF	53.4	GHI	849	DE
AG18	2328	EFGH	412.75	DEF	68.0	FGH	54.7	FGHI	829	EFG
Tx191306	2045	FGHI	350.93	EFG	66.4	GHI	59.1	DE	768	IJ
TP200606-6-10	2033	GHI	358.58	EFG	67.9	FGH	52.0	IJK	873	CD
TP200606-2-5	1735	HI	279.54	FG	65.2	HI	55.3	FGH	820	EFGH
Tx191003	1505	I	269.26	G	69.2	CDEFG	44.3	L	1026	A
Mean	2726		489.35		69.9		56.4		817	
CV(%)	23.2		26.0		4.8		12.7		11.8	
Entry "F"	<.0001		<.0001		<.0001		<.0001		<.0001	

Table 5. Multiple Disease Resistance #2 in South Texas for 2020

Cultivar	Pods/Ac Lbs.		Value/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs	
TP200610-3-2	7044	A	1336.36	A	75.5	ABC	65.7	B	691	D
Webb	6903	AB	1242.92	ABCDE	71.5	FG	78.2	A	581	E
TP200610-3-1	6857	ABC	1266.61	ABCDE	72.7	EFG	60.5	C	756	BC
TP200610-4-5	6848	ABC	1311.74	AB	75.2	ABCDE	59.9	CD	759	BC
TP200610-2-13	6783	ABC	1303.61	ABC	75.9	AB	55.8	D	813	A
Georgia 14N	6728	ABC	1290.72	ABCD	75.9	AB	56.9	CD	797	AB
TP200610-1-16	6562	ABCD	1266.56	ABCDE	76.7	A	57.5	CD	790	ABC
TP200610-2-2	6416	ABCDE	1225.24	ABCDEF	75.3	ABCD	57.4	CD	792	ABC
Georgia 09B	6351	ABCDEF	1167.80	BCDEFG	73.6	BCDEF	66.4	B	683	D
TP200610-4-6	6277	ABCDEF	1147.73	CDEFGH	71.5	FG	59.6	CD	761	BC
AG18	6257	ABCDEF	1150.39	CDEFGH	72.2	FG	65.4	B	694	D
TP200610-3-14	6219	BCDEF	1157.82	BCDEFG	73.7	BCDEF	57.8	CD	785	ABC
Tamrun OL11	6172	BCDEF	1169.82	BCDEFG	75.7	AB	65.9	B	689	D
TP200610-3-12	6136	BCDEF	1138.55	DEFGHI	72.9	DEFG	57.0	CD	796	ABC
TP200610-3-6	6093	CDEF	1126.65	EFGHI	73.1	CDEFG	68.5	B	663	D
TP200608-1-7	5898	DEF	1076.41	FGHI	71.7	FG	68.4	B	664	D
TP200608-1-15	5822	DEF	1046.94	GHIJ	70.9	G	66.5	B	682	D
TP200608-1-10	5673	EF	1008.24	HIJ	71.0	G	58.8	CD	772	ABC
TP200608-1-1	5590	F	998.53	IJ	71.1	G	60.7	C	748	C
TP200610-3-13	4759	G	888.58	J	72.9	DEFG	67.1	B	677	D
Mean	6269		1166.06		73.4		62.7		730	
CV(%)	10.7		12.1		3.1		9.5		9.0	
Entry "F"	0.0002		<.0001		<.0001		<.0001		<.0001	

Table 6. Multiple Disease Resistance Test #3 in South Texas for 2020

Cultivar	Pods/Ac Lbs.		Value/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs	
Webb	8200	A	1518.54	A	74.5	ABCD	77.3	A	588	E
TP200608-1-14	8014	AB	1501.79	AB	74.6	ABCD	64.2	DE	707	BC
TP200608-1-6	7479	ABC	1358.81	ABCDE	72.7	CD	68.7	BC	660	CD
TP200609-2-15	7387	ABCD	1352.84	ABCDE	71.7	D	56.2	F	808	A
Georgia 09B	7379	ABCD	1383.77	ABC	74.9	ABCD	66.2	CDE	686	BCD
AG18	7198	BCDE	1371.41	ABCD	76.1	AB	63.5	E	714	B
TP200610-3-3	7006	CDEF	1350.90	ABCDE	76.9	A	64.8	CDE	700	BC
TP200610-4-4	6995	CDEF	1340.10	BCDE	76.9	A	63.9	DE	710	B
TP200610-4-1	6909	CDEF	1286.67	CDEF	72.9	BCD	64.3	DE	707	BC
TP200609-3-11	6754	CDEFG	1230.47	CDEFG	72.5	CD	71.2	B	637	D
TP200610-1-17	6501	DEFG	1239.80	CDEFG	75.4	ABC	56.2	F	808	A
TP200610-3-5	6467	EFG	1199.78	DEFG	73.6	BCD	64.7	CDE	703	BC
TP200610-2-10	6405	EFG	1196.42	EFG	72.2	CD	54.9	F	826	A
TP200610-2-4	6339	EFG	1205.38	DEFG	74.5	ABCD	56.1	F	810	A
TP200608-3-7	6323	EFG	1213.10	CDEFG	76.0	AB	56.6	F	803	A
TP200609-2-1	6172	FGH	1162.75	FGH	74.1	ABCD	68.1	BCD	670	BCD
TP200610-2-11	6008	GH	1109.14	GH	71.7	D	55.2	F	822	A
Georgia 14N	5926	GH	1110.27	GH	73.0	BCD	54.2	F	839	A
Tamrun OL11	5863	GH	1125.58	FGH	77.0	A	68.0	BCD	667	BCD
TP200610-1-15	5344	H	1011.35	H	74.1	ABCD	55.8	F	814	A
Mean	6733		1263.44		74.3		62.5		734	
CV(%)	14.0		14.2		3.2		10.9		10.6	
Entry "F"	0.0001		0.0003		0.01		<.0001		<.0001	

Table 7. Multiple Disease Resistance Test # 4 in Central Texas for 2020

Cultivar	Pods/Ac Lbs.		Value/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs	
TP200606-2-14	6750	A	1180.99	AB	70.7	ABC	83.0	A	547	I
TP200625-3-2	6726	A	1205.64	A	71.3	A	70.3	BC	645	GH
TP200608-3-9	6626	AB	1132.09	ABCD	66.9	BCDEF	66.8	CDE	682	EFG
Webb	6522	ABC	1090.89	ABCD	65.7	DEF	79.2	A	573	I
Tx144370	6495	ABC	1160.60	ABC	70.3	ABC	67.1	CDE	676	EFG
TP200609-2-11	6252	ABCD	1088.46	ABCD	67.3	BCDEF	68.8	BCD	659	FGH
TP200608-2-4	6068	ABCDE	1009.34	ABCD	68.1	ABCDE	78.7	A	577	I
NemaTAM II	6052	ABCDE	998.49	ABCD	67.0	BCDEF	72.7	B	625	H
TP200610-4-9	6000	ABCDE	1062.07	ABCD	68.4	ABCD	62.1	FGH	733	CD
TP200608-1-3	5966	ABCDE	1006.50	ABCD	64.2	EF	60.1	GHI	755	BC
AG18	5909	ABCDE	1043.76	ABCD	68.9	ABCD	64.4	EFG	705	DE
TP200609-1-2	5836	ABCDE	986.45	BCDE	64.4	EF	56.3	I	806	A
Georgia 09B	5805	ABCDE	926.50	DEF	69.0	ABCD	67.6	CDE	671	EFG
TP200610-2-6	5780	ABCDE	1054.41	ABCD	71.7	A	57.6	I	787	AB
TP200609-3-18	5694	BCDE	984.57	BCDE	66.7	CDEF	59.2	HI	767	ABC
Tamrun OL11	5560	CDE	992.41	ABCDE	69.4	ABCD	69.0	BCD	658	FGH
TP200609-3-12	5481	DEF	930.25	DEF	65.8	DEF	65.6	DEF	692	DEF
TP200608-1-11	5306	DEF	777.09	EF	63.5	F	68.5	BCDE	662	FGH
Georgia 14N	5243	EF	945.65	CDEF	70.7	AB	60.4	GHI	751	BC
TP200606-7-4	4572	F	735.45	F	66.1	DEF	70.7	BC	644	GH
Mean	5932		1015.58		67.8		67.4		681	
CV(%)	15.2		18.6		4.6		11.0		10.7	
Entry "F"	0.006		0.0072		0		<.0001		<.0001	

Multiple Disease Resistance test #3 (Table 6) we also grown in South Texas. Interestingly at this location the cultivar Webb topped the test with a yield of 8200 lbs/ac. Additionally, a new breeding lines (TP200608-1-14) also was in the top statistical grouping for both yield and grade. With both being statistically equal or better than the commercial checks Georgia 09B and AG18. Finally, Multiple Disease Resistance test #4 was planted in Central Texas where breeding line TP200606-2-14 was the highest yielding line with a yield of 6750 lbs/ac and in the top statistical grouping for grade with a grade of 70.7%.

Sub-Project I-2 Initial Drought Tolerant Runner-type yield trials

We continued testing the drought populations again in 2020 which represented the fourth year of replicated trials for this material. The best performing lines for yield and grade were combined into one replicated trial in 2020. In addition to these original tests the best performing lines from previous years continue to be included in the statewide advanced line trials. The dedicated drought trials were tested in South Texas near Pearsall under full to estimated yield potential for the population.

Drought Yield Test South Texas

Table 8. South Texas Drought Test under full irrigation for 2020

	Pods/Ac Lbs.		Value/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs.	
Cultivar										
TxL100225-06-04	7914	A	1431.41	AB	71.1	EF	54.2	I	837	CD
TxL100212-03-03	7896	A	1466.56	A	73.4	BCDE	70.5	AB	645	I
Tx144370	7529	AB	1416.27	ABC	74.3	BC	63.4	EF	716	EF
Ga09B	7465	AB	1388.50	ABCD	74.0	BCD	64.4	DEF	704	EFGH
TxL100225-05-11	7453	AB	1305.04	ABCDEF	68.5	GH	61.5	FG	738	E
TxL100212-05-09	7441	AB	1348.00	ABCD	71.2	EF	70.6	A	643	I
TxL100212-03-06	7438	AB	1417.71	ABC	75.5	AB	67.1	BCD	677	FGHI
TxL100212-03-08	7367	AB	1335.42	ABCDE	71.0	EF	66.8	CDE	680	FGHI
AG-18	7202	ABC	1335.87	ABCDE	72.5	CDEF	63.1	F	719	EF
IGCV-76	7179	ABC	1251.43	BCDEF	67.1	HI	55.1	HI	825	D
TxL100212-05-03	7031	ABC	1280.02	BCDEF	71.7	DEF	63.8	DEF	711	EFG
TxL100225-06-05	7020	ABC	1294.07	ABCDEF	71.9	CDEF	58.2	GH	794	D
TxL100225-03-03	6994	ABC	1218.13	DEF	65.3	I	45.9	JK	990	B
TxL100225-03-13	6971	ABC	1237.25	CDEF	68.1	GH	51.6	I	879	C
Tx071304	6864	BC	1274.85	BCDEF	73.3	BCDE	68.7	ABC	662	HI
TxL131901-030	6566	BC	1164.99	EF	70.5	FG	67.9	ABC	668	GHI
TxL100212-02-10	6550	BC	1125.97	F	65.5	I	47.0	J	967	B
Tamrun OL11	6329	C	1217.33	DEF	76.9	A	62.9	F	722	EF
TxL131901-096	6289	C	1137.38	F	70.5	FG	63.2	F	718	EF
COC-270	3820	D	641.88	G	61.5	J	43.3	K	1047	A
Mean	6966		1264.40		70.7		60.5		767	
CV(%)	14.2		15.5		5.5		14.2		16.0	
Entry "F"	<.0001		<.0001		<.0001		<.0001		0.0108	

The Drought Trial consisted of 13 breeding lines plus the donor parent for the drought tolerance trait (ICGV-76 and COC-270) and the elite parents (Tamrun OL11 and Tx071304). The breeding line Tx071304 was an elite nematode resistant line that was used the combine nematode resistance with the drought tolerance traits. In addition, commercial checks Georgia

09B, AG18 were included. The 2020 Drought trial was statistically significant. However, the data was variable, as shown by the coefficient of variation (CV) of 14.2 but was within acceptable limits (Table 2).

TxL100225-06-04 had the highest yield in the test at 7914 lbs/ac. However, 11 other breeding lines performed in the top statistical grouping for yield as well. Many of the lines in the test performed superior to the parent Tamrun OL11 which only yielded 6329 lbs/ac. TxL100212-03-03, TxL100212-05-09 and TxL100222-03-13 were also previously mentioned in the ALT (Table 1). The breeding line TxL100212-03-03 performed very well in this trial with a yield of 7896 g/plot. The breeding line that combined nematode resistance and drought tolerance (TxL131901-030 and TxL131901-096) performed near the bottom of the test for yield and grade. Although not acceptable as a release candidate they will be carried forward in crossing. In addition the breeding line TxL225-03-13 was identified as a possible parental candidate for a hybrid Runner x Spanish population that will be crossed in 2021 crossing.

Other Drought Tolerance Trials.

Runner trials – Population #1.

We began testing a different set of materials in previous years, designed to combine tolerance to water deficit, nematode resistance, and the high oleic trait. We received NIFA funding for this project beginning in 2017, and so are continuing the project under that funding source. However, we made additional selections from breeding lines using markers for all three traits, and are presenting data for the selected breeding lines below (**Table 9**).

This was the second year of the test. The trial was conducted in West Texas, at a target of 25% ET replacement (essentially dryland) from June through August–40 to 105 days after planting. These were chosen to represent the times of greatest water deficit on farms with limited irrigation. The low yields, grades and seed weights demonstrate the degree of water deficit stress that the test was under. But what is important is that yields of several of the breeding lines were statistically higher than Tamrun OL11 and numerically higher than Flavorunner 458, suggesting that some of these could be more tolerant to water deficit than standard varieties.

The table shows the top-performing lines. Five (TxL144301-001, TxL144301-016, TxL144301-100, TxL144301-025, and TxL144301-103) were statistically better for yield than the parents and the variety Tamrun OL11, and one (TxL144301-001) was higher yielding than Flavorunner 458, which

Table 9. Yield of the new selections under water deficit stress, 2020.

Accession	Pod Yield (lb/acre)		Shellout (% TSMK)		Seed Wgt (g/100)	
TxL144301-001	1431	a	51.8	a-d	41.45	e-j
TxL144301-016	1287	ab	37.9	g-k	37.55	jk
TxL144301-100	1263	a-c	38.8	f-k	46.95	b-d
TxL144301-025	1196	a-d	40.7	e-j	41.75	d-j
TxL144301-103	1181	a-d	46.9	b-g	42.65	c-j
TxL144301-128	1164	a-e	53.3	a-c	48.10	b
TxL144301-133	1102	a-f	40.2	e-j	38.80	h-k
TxL144301-044	1071	a-f	55.1	ab	43.15	b-i
TxL144301-119	1068	a-f	36.6	i-l	45.90	b-e
TxL144301-192	1066	a-f	54.1	ab	44.35	b-g
TxL144301-170	934	b-h	58.8	a	54.35	a
FlvRun458	927	b-h	39.5	e-j	38.50	i-k
COC270	739	e-i	21.8	m	33.60	k
TamrunOL11	682	f-i	46.6	b-h	37.55	jk
Tx071304	562	g-i	44.0	c-i	45.40	b-f
TxL144301-098	535	hi	36.9	h-l	44.30	b-g
TxL144301-123	499	i	29.2	k-m	38.85	h-j
p	0.0106		<0.0001		<0.0001	
Mean	904		41.4		42.03	
LSD	426		9.8		5.20	
CV	28.6%		11.7%		6.1%	

generally yields relatively well compared to other varieties under water deficit. Four of the lines (TxL144301-016, TxL144301-100, TxL144301-025, and TxL144301-128) were also at or near the top of the test in 2019. There was also another indication of tolerance to water deficit. Usually Tamrun OL11 and Flavorunner 458 grade well under well-irrigated plots, but their grades under severe water deficit was poor (46.6% and 39.5% TSMK). However, five lines (TxL144301-001, TxL144301-128, TxL144301-044, TxL144301-192, and TxL144301-170) also had superior grades, over 50%. Two of these lines were also at or near top of the test in 2019. The low grades and lower seed weights compared to irrigated plots is due to the presence of many small kernels that graded as Other Kernels. We expect that this is because there was either not enough water for many of the kernels to fill out, or development of pegs was delayed by lack of water so that the seeds could not mature by harvest. These conditions were more extreme than we expect growers to experience, but were chosen to put the different breeding lines under high stress to find which can survive water deficit the best.

This and the second population have been grown and tested at two locations – the USDA-ARS in Lubbock, and at the Lubbock AgriLife Center. The materials at the ARS have been photographed using weekly UAS overflights scheduled by Dr. Payton. (Because the AgriLife Center is at the north end of the airport runway, we are not allowed to fly drones there). We expect that, when aerial images are analyzed and correlated with ground-based measurements and pod yield at harvest, this will give us new ways to measure and select for favorable responses of peanut to water deficit stress.

<u>Runner trials – Second population</u>**.**

A second population was developed to combine tolerance to water deficit stress with high oleic seed content. Because of its size, it was split into three tests, performed under water deficit stress at two locations. Results are presented in Tables 10-12.

In all three tests, standard check varieties Tamrun OL02 and Tamrun OL11, when present, had yields near the bottom of the test. In all three tests, the best-yielding accessions yielded about three times as much as the standard checks. Flavorunner 458, which we have previously observed to fare relatively well under water deficit, was near the middle of tests #2 and #3, and the best accessions yielded about 50% more. Variability for shellout was high, but in all three tests, there were several breeding lines with mean grades (% TSMK) at least as good as or better than all check varieties.

Among the best lines combining yield and grade in test #1 were TxL100212-03-06, TxL100212-02-02, TxL100212-03-12, and TxL100212-05-03 (Table 10). This test also included TxL100212-03-03, which as demonstrated in Table 1 and Table 8, performed very well

Table 10. Yield of the Drought #1 population, 2020.

Accession	Pod Yield (lb/ac)		Shellout (% TSMK)		Seed Wgt (g/100 SMK)	
TxL100212-03-06	1604	a	59.4	a-d	51.3	a-c
TxL100212-02-02	1390	ab	57.6	a-e	52.5	ab
TxL100212-03-12	1376	ab	63.2	ab	53.2	a
TxL100212-02-05	1371	ab	56.8	a-e	48.6	a-e
TxL100212-02-04	1246	a-c	48.7	b-i	45.4	d-g
TxL100212-05-02	1232	a-c	40.2	g-i	46.1	c-g
TxL100212-02-01	1220	a-c	41.0	f-i	43.9	e-g
TxL100212-02-09	1208	a-c	44.8	d-i	46.1	c-g
TxL100212-04-07	1198	a-c	52.1	a-h	46.8	b-g
TxL100212-05-03	1152	a-c	61.6	a-c	48.0	a-e
TxL100212-02-03	1136	a-c	51.0	a-i	47.2	b-f
TxL100212-03-09	1133	a-c	45.7	d-i	45.3	d-g
TxL100212-02-06	1126	a-c	49.4	a-i	45.8	c-g
TxL100212-02-07	1124	a-c	56.2	a-f	46.4	c-g
TxL100212-04-02R	1030	b-d	53.5	a-g	37.6	h
TxL100212-03-03	987	b-d	64.6	a	50.8	a-d
TxL100212-05-01	975	b-d	37.6	hi	42.1	f-h
TxL100212-03-10	795	cd	42.6	e-i	45.6	d-g
TxL100212-03-01	771	cd	39.5	g-i	44.6	e-g
TxL100212-03-08	759	cd	36.1	i	42.9	e-h
TamrunOL02	540	d	47.0	c-i	41.3	gh
p	0.025		0.0142		0.002	
Mean	1113		49.9		46.3	
LSD	493		15.5		5.7	
CV	26.9%		14.9%		5.9%	

under full irrigation. This entry was not among the better lines in the drought test for yield, but had the highest grade in the test. This is consistent with what we have seen in earlier drought tests – the best lines under full irrigation are not the ones with the greatest drought tolerance. The opposite is true also.

In the second drought test (Table 11), three lines (TxL100225-03-08, TxL100225-03-5, and TxL100212-07-01) were as good as or better than all check varieties for both yield and grade.

In the third drought test (Table 12), there were four lines (TxL100212-07-04, TxL100225-05-02, TxL100225-06-03, and TxL100225-06-12) that had combinations of yield and grade as good as or better than the check varieties.

Table 11. Yield of the Drought #2 population, 2020.

Accession	Pod Yield (lb/ac)		Shellout (% TSMK)		Seed Wgt (g/100 SMK)	
TxL100225-03-08	1868	a	54.2	a-c	43.5	b-e
TxL100225-03-09	1541	ab	49.0	a-d	42.7	b-f
TxL100225-03-05	1513	a-c	56.1	a-c	43.9	b-d
TxL100225-03-04	1481	a-c	42.7	c-f	39.0	e-h
TxL100225-03-02	1426	a-c	39.9	d-g	40.0	c-h
TxL100225-03-13	1385	a-d	47.0	a-e	45.8	b
TxL100225-03-07	1371	a-d	33.0	e-h	41.0	c-h
TxL100212-07-01	1325	b-e	59.3	a	41.6	b-g
TxL100225-03-10	1316	b-e	43.4	b-f	41.0	c-h
TxL100212-07-03	1311	b-e	44.5	b-f	44.4	bc
FlvRun458	1167	b-f	47.1	a-e	39.3	e-h
TxL100212-07-05	1066	b-g	31.7	f-h	40.0	c-h
TxL100212-05-10	1047	b-h	57.5	ab	52.5	a
TxL100225-03-12	1035	b-h	31.3	f-h	43.1	b-f
TxL100212-07-08	1006	c-h	37.6	d-g	39.7	d-h
TxL100225-03-06	879	d-h	33.4	e-h	39.9	c-h
TxL100212-07-09	811	e-h	32.4	f-h	39.4	d-h
TxL100212-07-12	711	f-h	28.0	gh	37.5	gh
TxL100212-07-07	684	f-h	19.8	h	36.7	h
TxL100212-07-02	587	gh	23.3	h	39.7	d-h
TamrunOL02	520	h	45.3	a-f	38.9	f-h
p	<0.001		<0.001		<0.001	
Mean	1145		40.8		41.4	
LSD	531		14.2		4.6	
CV	27.7%		16.7%		5.3%	

Table 12. Yield of the Drought #3 population, 2020.

Accession	Pod Yield (lb/ac)		Shellout (% TSMK)		Seed Wgt (g/100 SMK)	
TxL100212-07-04	2867	a	66.0	ab	50.1	ns
TxL100225-05-02	2720	ab	64.5	ab	48.6	
TxL100225-06-10	2619	a-c	58.7	a-d	49.6	
TxL100225-05-10	2427	a-d	53.5	b-d	45.5	
TxL100225-06-03	2310	a-d	60.4	a-d	44.4	
TxL100225-06-12	2144	a-e	64.4	ab	49.5	
FlvRun458	2000	a-f	48.6	d	42.2	
TxL100225-06-02	1993	a-f	66.8	ab	50.7	
TxL100225-06-11	1913	a-g	50.7	cd	45.5	
TxL100225-05-01	1772	b-h	61.0	a-d	43.6	
TxL100225-06-07	1597	c-h	62.0	a-d	46.2	
TxL100225-06-06	1508	d-h	62.9	a-c	47.1	
TxL100225-06-13	1229	e-h	50.3	cd	42.6	
TxL100225-06-09	1066	f-h	68.6	a	46.9	
TamrunOL02	871	gh	50.0	cd	46.9	
TamrunOL11	844	h	58.7	a-d	48.3	
p	0.004		0.078		0.626	
Mean	1867		59.2		46.7	
LSD	1064		13.7		8.7	
CV	34.2%		10.9%		8.7%	

Virginia trials. Likewise, we have tested leading high oleic Virginia release candidates for under water deficit stress to see if any of these have promise as a variety for growers with limited irrigation water. Previously, a multiyear test was made of several high oleic Virginia breeding lines, check varieties, and a minicore accession over 3 years. The high oleic release candidate TxL090105-07 as well as TxL090206-41 and Champs were in the top yield categories under high and mid irrigation levels. Differences under low irrigation were not significant statistically, but TxL090246-41 was numerically at the top.

This past year (2020), we planted an expanded test with more experimental entries and check varieties at two locations under low irrigation to determine whether additional data will give evidence that one or more of the Virginia breeding lines can be released as drought-tolerant varieties that will be useful to growers who have less irrigation water available. Release candidates TxL090105-07 and TxL090206-41 were in the middle of the test, but didn't yield higher statistically than checks such as Champs or Wynne. However, TxL090206-41 did have a higher shellout. Several other breeding lines had numerically but not statistically higher yields, and TxL090105-18 had numerically the highest yield, although differences were not significant statistically. Additional testing will be needed to make any decision about suitability of Virginia breeding lines for growth under reduced irrigation.

Table 13. Yield of Leading Virginia release candidate lines under water deficit stress, 2020.

Accession	Pod Yield (lb/ac)		Shellout (% TSMK)		Seed Wgt (g/100 SMK)		% ELK	
TxL090105-18	3090	ns	69.2	a-d	87.5	ab	36.6	ab
NC-7	2689		71.7	a	99.0	a	43.8	a
TxL090106-05	2658		69.3	a-d	78.0	b-f	36.2	ab
TxL090106-15	2653		69.6	a-c	74.7	c-f	33.4	bc
Bailey	2367		71.2	ab	77.7	b-f	29.2	bc
TxL090206-41	2230		70.3	a-c	77.9	b-f	29.8	bc
TxL090105-07	2202		68.7	b-d	82.2	b-d	37.4	ab
TxL090106-52	2103		67.5	c-e	81.2	b-e	27.8	b-d
TxL090105-38	2038		70.1	a-c	69.0	f	31.7	bc
Champs	2022		66.4	de	72.0	d-f	18.7	d
Tx107844-5	1983		67.3	c-e	76.8	b-f	28.3	b-d
Wynne	1975		65.1	e	85.6	bc	24.1	cd
08X09	1569		61.4	f	70.2	ef	23.6	cd
p	0.123		<0.001		0.007		0.011	
Mean	2275		68.3		79.4		30.8	
LSD	911		3.0		11.8		10.4	
CV	22.8%		1.9%		6.5%		14.8%	

Current Runner releases

We have received final approval from the Texas A&M Plant Release Committee for a proposal for release of a nematode resistant runner varieties, to be named NemaTAM II, which is a high-yielding, high oleic fatty acid, runner-type peanut cultivar with resistance to root-knot nematodes. The cultivar was developed to provide growers with a nematode resistant replacement option for the former Webb cultivar which had excellent nematode resistance, but also had a very large vine size that made harvest difficult for peanut farmers. NemaTAM II maintains the resistance to root-knot nematodes of Webb, has proven to yield equal to or better than Webb, and has higher grade potential. NemaTAM II has a shorter canopy than Webb which leads to easier digging and inverting at harvest than its predecessor. In 2021 approximately 30 acres of Foundation seed is being grown at the Texas A&M Foundation Seed offices in Vernon, TX.

We have also received approval for release of Tamrun OL18L which is a high oleic early maturing runner with a large seed from our early maturity program, and Tamrun OL19 which has a somewhat smaller seeded early maturing runner. Tamrun OL18L is a high yielding, high-oleic, early maturing runner-type peanut cultivar with a larger than average seed size. Its maturity is comparable to Tamrun OL12 which is 14 days earlier maturing than Flavorunner 458. Yield was similar to Georgia 09B, but was higher than Tamrun OL11. The seed size was similar to Tamrun OL07 and Webb. There were no differences in flavors noted in flavor analysis between Tamrun OL18L and check cultivars. Tamrun OL19 is a high-yielding, high oleic, early-maturing runner-type peanut cultivar that is approximately 7 days earlier maturing than Tamrun OL07 and 7 days later than Tamrun OL12 in five years of testing. Yield was similar to Georgia 09B, but was higher than Tamrun OL11. The seed size is similar to Tamrun OL11, but larger than Georgia 09B. There were no differences in flavors noted in flavor analysis between Tamrun OL18L and check cultivars.

Future Runner Releases

Tx144370 were developed for resistance to Root knot nematodes and Sclerotinia. While it performed lower in yield to the drought lines mentioned above, it has performed well in South Texas which is where they were developed to give growers a nematode resistant line with better characteristics than the previously released Webb and NemaTAM II variety. It has yielded from 400-600 lbs/a better than Webb and graded 1-3 percentage points higher. Additionally, they have a much shorter growth habit than NemaTAM II and a slightly smaller seed size in most of the trials over the past four years. The decision was made to move forward with the breeding lines for release. Tx144370 is in plant row increase in the 2021 season.

Of materials developed from the runner drought testing, several lines have done well in irrigated trials. In particular, TxL100212-03-03 has been in advanced trials for a couple of years now and has always done well. We are testing this line again this year, and are considering releasing it because of its high yield potential. It is in a row increase this year, approx. ¼ acre.

For a runner tolerant to reduced irrigation, we are conducting additional testing in 2021. This is because the number of locations that we can use for testing under controlled limited irrigation is limited, and so more years of testing are needed than for the irrigated trials. We plan to reduce the number of breeding lines in the future, and test under both the severe water deficit that we have been using, and under reduced water deficit that may be more typical of conditions that a grower with limited irrigation might encounter to see if the lines identified under severe water deficit will also be good choices under more moderate water deficit.

Spanish-type Yield Trials

We continued testing advanced Spanish-type lines in West Texas during the 2020 growing season which is the fourth year of testing for these lines. As mentioned previous the the 2020 growing season was very challenging in West Texas and is reflected in the grades. The tests consisted of 17 advanced Spanish breeding lines and three commercial checks; OLin, Schubert, and Tamnut OL06.

In 2020 thirteen breeding lines and two checks, OLin, and Schubert performed in the top grouping for yield with TxL076239-16 having the highest numerical yield at 2858 lbs/ac (Table

9). It graded equal to the commercial OLin with grades of 68.7% and 68.2% respectively but significantly better the Shubert which graded 65.7%. TXL076 236-04 had the highest grade at 71.9 and was statistically better than all other lines in the test. TxL076239-16 was significantly larger that either OLin or Schubert with g/100 seed of 49.0, 43.8 and 42.1 respectively.

Table 14. Spanish Test in West Texas for 2020

	Pods/Ac Lbs.		Val/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs	
Cultivar										
TxL076239-16	2858	A	488.81	AB	68.7	BCD	49.0	A	926.5	GH
OLin	2849	A	490.30	A	68.2	BCDE	43.8	CDE	1035.8	CDEF
Tx144932	2826	AB	482.72	ABC	67.2	CDEFG	42.8	DEFG	1064.9	BCDE
TxL076225-48	2826	AB	485.52	ABC	67.3	BCDEFG	38.0	H	1195.6	A
TxL076224-24	2704	ABC	458.60	ABCD	68.0	BCDEF	44.6	BCD	1017.0	DEF
TxL076221-06	2687	ABC	457.60	ABCD	66.5	DEFG	38.3	H	1185.3	A
TxL076229-53	2653	ABC	444.27	ABCD	65.5	G	36.9	H	1235.1	A
TxL076236-04	2650	ABC	469.98	ABC	71.9	A	46.6	B	974.4	FG
TxL076224-15	2643	ABC	456.55	ABCD	69.1	BC	43.4	CDEF	1046.4	BCDE
Schubert	2641	ABC	439.46	ABCD	65.7	FG	42.1	EFG	1078.6	BCD
TxL076221-34	2628	ABC	451.66	ABCD	67.9	BCDEFG	38.0	H	1197.7	A
TxL076225-24	2607	ABC	444.16	ABCD	67.4	BCDEFG	37.9	H	1198.5	A
Tx144923	2506	ABC	430.22	ABCD	67.5	BCDEFG	38.3	H	1186.3	A
TxL076239-12	2499	ABC	432.87	ABCD	69.0	BC	45.4	BC	999.9	EF
TxL076225-28	2471	ABC	420.38	ABCD	66.7	CDEFG	37.9	H	1199.7	A
TxL076224-08	2417	BC	410.23	CD	66.7	CDEFG	37.9	H	1201.8	A
TxL076225-04	2415	BC	414.54	BCD	67.0	CDEFG	36.2	H	1252.8	A
Tamnut OL06	2368	C	388.04	DE	66.1	EFG	51.1	A	887.1	H
TxL076226-18	2289	C	387.14	DE	67.2	CDEFG	40.9	G	1109.4	B
TxL076239-21	1828	D	320.92	E	69.7	AB	41.3	FG	1098.9	BC
Mean	2568		438.70		67.7		41.5		1104.6	
CV(%)	14.3		14.9		3.0		10.7		10.4	
Entry "F"	0.017		0.0189		0.0016		<.0001		<.0001	

Virginia Type Yield Trials

Testing of Virginia type lines continued in 2020 (Table 10). A replicated trial with 7 breeding lines and 3 checks was planted in West Texas and evaluated for yield and grade. Analysis of Variance for yields and seed size was not statistically significant, however did show statistical differences for grade. TxL09105-38 was at the top of the test both numerically and statistically in the 2020 test with a grade of 71.7% compared to 67.1% for the commercial check Bailey. Again, as stated previously the environmental effects on the 2020 growing season were very evident in our West Texas plot locations.

This year, we will add pod sizing and pod piece counts to our Virginia testing, because some shellers have expressed a desire for this type of data. We have obtained the oversized screens needed for this analysis. We are also discussing the possibility of shellers running pod brightness measurements on their equipment, as we lack the colorimeter needed to make this measurement.

Table 15. Virginia Trial in West Texas for 2020

	Pods/Ac Lbs.		Value/Ac $		TSMK %		Seed Wt g/100		Seed/Lbs	
Cultivar										
TxL090106-52	5339	A	1124.80	BC	66.9	DE	94.1	AB	486	AB
TxL090106-15	5840	A	1275.24	AB	69.5	ABC	99.7	AB	456	AB
TxL090106-05	5885	A	1267.88	AB	68.8	BCD	95.4	AB	477	AB
TxL090105-38	5773	A	1307.09	A	71.7	A	92.7	B	490	A
TxL090105-18	5778	A	1241.12	AB	68.2	BCD	97.5	AB	466	AB
TxL090105-07	5636	A	1227.88	AB	69.8	AB	98.0	AB	464	AB
Tx107844-5	5209	A	1060.92	C	68.6	BCD	99.8	AB	455	AB
NC-7	5727	A	1247.67	AB	68.5	BCD	104.3	A	435	B
Champs	5740	A	1155.28	ABC	65.6	E	95.7	AB	477	AB
Bailey	5769	A	1224.01	AB	67.1	CDE	99.4	AB	457	AB
Mean	5669		1213.19		68.5		97.7		466	
CV(%)	7.12		8.94		3.15		6.01		6.24	
Entry "F"	ns		ns		0.0055		ns		ns	

Developing Wild Species Pathway for Introgression of Drought Tolerance

This project continues as part of the long-term drought project. It was initially funded through internal funding but has been absorbed into our overall drought program. The initial phase of this project was to identify 14 candidate genes associated with drought tolerance by conducting an imposed drought transcriptomics study. Specifically, we identified transcription factors that occur early in genetic pathways and represent excellent candidates for marker development. We received funding for the Peanut Research Foundation to validate the presence of the candidate genes in the original drought tolerant species and to expand the study to include other related species. This project remains a vital part of our overall drought program. Transcriptomics is a powerful tool that can not only tell if a gene is present but can also determine how strongly a gene is expressed. Once the genes are validated for expression level then marker development can be conducted which will by used to aid in introgression of the genes into

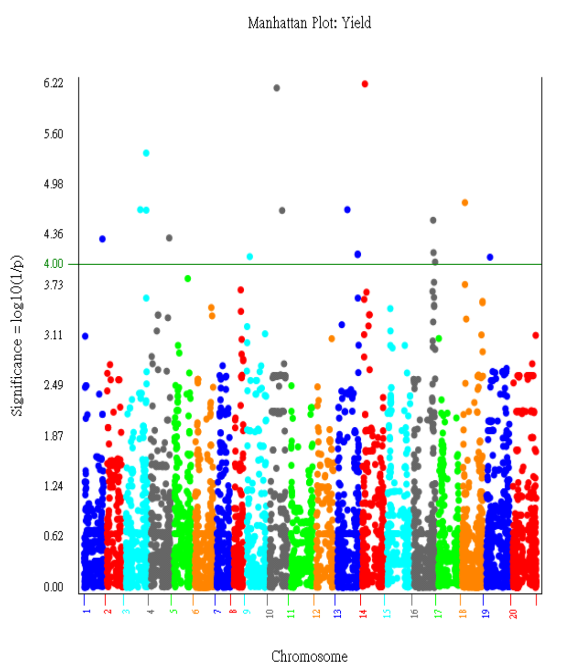


Figure 1. Manhattan plot of association by field across locations shows 17 significant SNPs for yield above the threshold (P-value = 10^{-4}).

our elite material.

Crossing and chromosome doubling continues as part of the wild species introgression pathway is under development. When completed it will allow the genes identified to be moved into the cultivated peanut. At this point we have made the initial cross and confirmed hybridization. The next step in pathway development is to double the chromosome number. This is proving to be very challenging. However, progress is being made and we remain hopeful. In addition, we are exploring alternate pathways using alternative species and or accessions to move the genes if the original route is not successful. One related complex hybrid has already been doubled and has cultivated materials that are being backcrossed into more advanced materials. Tamrun OL11 is the recurrent parent in this crossing program however several more backcrosses are needed to make the lines commercial viable.

Identify Markers for Drought Tolerance in Mini-core Collection

Minicore accessions were sent for analysis on the peanut community SNP chip. Of 47,837 SNPs, there were 8,189 SNPs that we selected for analysis. We performed GWAS (Genome-Wide Association Scanning) analysis using these SNPs on the U. S. minicore collection with phenotypic data from TX, OK, and VA in 2017. This reduced set of SNPs was selected from the larger set based on standard selection criteria. Using the Tassel program, we have identified 120 SNPs at p-value $< 10^{-4}$ and 558 SNPs at p-value $< 10^{-3}$ (Table 16) significantly associated with the phenotypic data. Of these, 71 SNPs are significantly associated with more than one trait. Overall, 163 SNPs are considered the most reliable SNPs that are significantly associated with either different locations, or multiple traits, or both. For the sake of comparison, we would expect 0.8 false positives per trait and location at p<0.0001. The Manhattan plot of association by field across locations is shown in Figure 1. We are currently refining the marker analysis to validate markers on a subset of the minicore grown in 2018 and 2019. Once this is completed, we will go back to screen advanced progeny and backcrosses of our breeding population with these markers.

Table 16. Number of SNP marker-trait associations (p-value = 10^{-3}) for various traits (ALL = all locations, TX = Texas, OK= Oklahoma, VA = Virginia). Trait abbreviations: SCMR- SPAD chlorophyll content, NDVI, normalized difference vegetation index, ELK- extra large kernels, Temp- canopy temperature, CTD.

Trait	ALL	TX	OK	VA	Sum
Paraheliotropism	5		3		6
Flowering		90	71	14	161
Height				3	3
SCMR	1	53	16		69
Width	3		8	20	30
Wilt		1	2	1	4
Yield	57	30	84	26	148
NDVI				78	78
Temp		1			1
Wgt100SMK		28	71		79
%ELK		41			41
%Mid		7			7
%No1		9			9
CTD				6	6
Others				15	15
Sum					558

We previously sent DNA of the minicore collection and additional accessions to the Texas A&M AgriLife Bioinformatics and Genomics Center for RAD-Seq sequencing on 144 accessions. An additional 72 accessions have been prepared, but will be sent to the TAMU-Corpus Christi genomics center because AgriLife has discontinued its RAD-Seq service. We will add the new data to complete the data set, and use this also for analysis of another minicore set of data for drought tolerance. To date, we obtained 3,265 SNPs from RAD-Seq using the GATK software. However, some researchers think that the data from RAD-Seq analysis may have some advantages over SNP chip data. To date, we have identified more SNPs by the SNP chip than by RAD-Seq; however, the SNP chip interrogates a single nucleotide only and lacks data on flanking sequences. It is expected that there may be more false SNPs in the SNP chip data due to the presence of unexpected closely-related ("paralogous") genes that are present in other places in the peanut genome. RAD-Seq gives flanking sequences, and so may be better able to identify and filter out these false positive data. We plan to test this hypothesis while working to identify additional markers for tolerance to water deficit.

Leafspot Resistant Spanish-types

We increased a population BC3-43-09-03-02 × Schubert to introduce leafspot resistance into Spanish peanuts. These materials were segregating for market type, with most of the materials being runners (because runner type is dominant to Spanish type). We harvested the different plant types separately and have planted Spanish selections where possible for increase in 2020. These materials have been planted at Yoakum in 2021 for leaf spot evaluation. If need be, we will backcross resistant runner selections by Spanish varieties and use selection for leaf spot resistance markers to obtain additional resistant Spanish breeding lines.

Nematode Resistant Spanish-types

We continue to cross with breeding line Tx144432 which is high oleic and nematode resistant lines from a spanish MDR program. The seed size of the lines is below average and further crossing is needed. In our 2019 and 2020 spring crossing program we made several crosses with released varieties OLin, Tamnut OL06 and Schubert as well as selected other germplasm. These were increased in our greenhouses in summer 2019 and 2020 as well as some individual plants that were planted in Yoakum. These continue to be advance for evaluation beginning in 2021.

Sub-Project IV. SNP Marker Development

Development of a B Genome Mapping Population

This effort is being conducted with other funding but will be important to our efforts in the variety development program when it is completed. We are in the fourth generation of developing a B-genome mapping population involving two diploid (20 chromosome) wild species. The fourth generation (F_3) is actually the third generation of single seed descent which we are conducting. We will carry this project one more generations and then establish the map which will be integrated with the A-genome map and then be used for "prescription breeding."

We cut ends off the seeds of each generation, and the remainder of each seed has been planted for increase. The cut seed ends are used for DNA extraction. It became increasingly difficult to maintain the population. We believe this is due to genetic incompatibility between species. We carried the material forward to the point the population size became to small to collect accurate information. **An alternate population is available and will be planted when greenhouse space is available.**

Screening for Root Knot Nematode Resistance

A total of 480 seeds representing 36 breeding lines were re-screened by SNP markers to test the purity of breeding lines with resistance to root-knot nematodes, drought, and having high oleic seed. In addition, we screened breeding lines made by the Stephenville program to incorporate nematode resistance.

Table 17. Numbers of Seeds screened by KASP Marker Genotyping for the Root Knot Nematode Resistance Trait.

Experiment	**Seeds Screened**
Stephenville Samples	1,056
Runner Drought Tolerant Pop1A (Lubbock)	480
Total	**1,536**

Screening for the High O/L Trait

As part of our continuing efforts to develop high-oleic varieties and maintain purity of breeding lines and TAMU varieties, 4,078 seeds were tested for the high oleic trait by NIR (**Table 18**). A few additional seeds were scored using DNA markers instead, mainly where we were also testing for hybridity for early-generation crosses with markers at the same time (**Table 19**).

Table 18. Numbers of Seeds screened by NIR for the High Oleic Trait.

Experiment	**Seeds Screened**
Runner, Virginia, Valencia Bulk Increase	1,016
Valencia High Oleic Increase	200
Spanish High Oleic Increase	300
Check Variety Testing	26
Stephenville Samples	2,466
Others including F1 and F2 Single Plants	50
Drought Breeding Line (TXL100212-03-03)	20
Total	**4,078**

Table 19. Number of Seeds Screened for the High Oleic Trait using KASP markers.

Experiment	**Seeds Screened**
Aspergillus flavus Resistant Peanut Crosses	10
Total	**10**

Sub-Project IV. High Throughput Phenotyping

Unmanned Aircraft System (UAS) and sensors as an emerging remote sensing technology can provide imagery datasets with very high spatiotemporal resolutions, which was unobtainable by traditional space- and air-borne platforms. UAS can collect images quickly and repeatedly under appropriate weather conditions for agriculture applications. UAS-based imagery data also provide advanced phenotypic data using image processing and computer science algorithms. Especially, UAS-based phenotyping is very useful and practical to extract crop traits. In 2020, UAS data was collected, and UAS-based Hight Throughput Phenotyping system was adopted to extract various crop parameters such as canopy cover, plant height, vegetation indices, etc.

UAS Data Collection

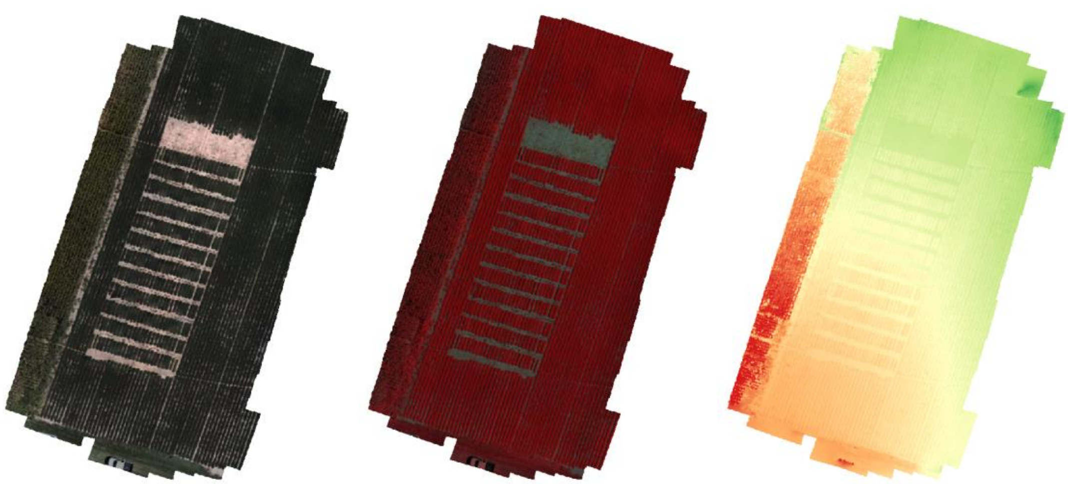
Texas A&M AgriLife Research at Stephenville conducted UAS data collection using DJI Mavic 2 Pro and DJI Matrice 200 equipped with Slantrage 4P+ to acquire RGB and multispectral images, respectively. For 2020 growing season, UAS was flown over four locations to collect RGB and multispectral images with 75% overlap at 30m altitude. Portable ground control points (GCPs) were distributed before UAS flying, and GPS surveying were conducted by the GPS devices, Reach RS. Table 14 shows a summary of UAS data collection for 2020.

Table 20. Summary of UAS data collection

Location	UAS	Camera	# of Flights	Interval	Period
Keith	DJI Matric 200	Slantrange 4P+	20	Weekly	May~Sep.
Martin	DJI Mavic 2 Pro	RGB	5	Weekly	May~June
S5	DJI Mavic 2 Pro	RGB	4	Weekly	May~June
Yoakum	DJI Matric 200	Slantrange 4P+	1	-	November

UAS Image Stitching

All raw data collected from UAS were processed to generate an orthomosaic and DSM (Figure 2). We adopted the Agisoft Metashape software (Agisoft LLC, St. Petersburg, Russia),



(a) (b) (c)

Figure 2. Orthomosaic image with the color composite of (a) RGB and (b) CIR. (c) shows Digital Surface Model (DSM) generated by SfM software.

which is one of famous commercial software to stitch UAS raw images using SfM (Structure from Motion). GCPs' GPS coordinates were also input in image stitching process for removing distortion and precise geo-referencing.

UAS-derived Phenotypic Data

Canopy cover, plant height, canopy volume, and vegetation indices were extracted using plot and grid boundary from the processed RGB and multispectral data. Canopy cover was extracted by the Canopeo and thresholding algorithm from the RGB and multispectral orthomosiac images, respectively, to perform binary classification (canopy vs. non-canopy area) (Figure 3).

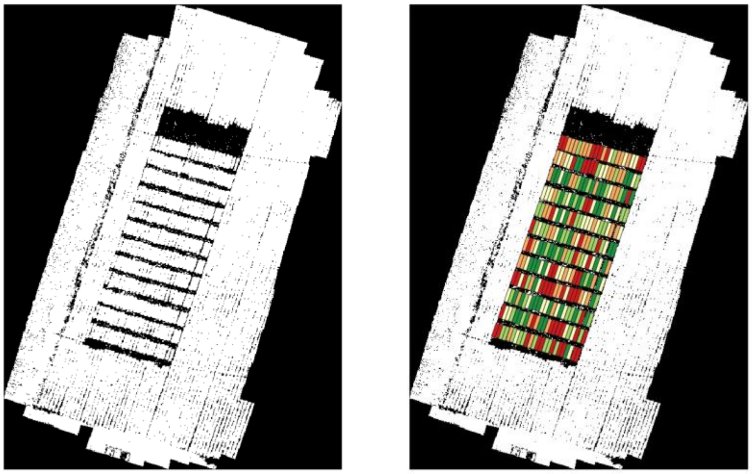


Figure 3. Example of the binary classification map for canopy cover (left) and canopy cover (%) of each row (polygons)

To estimate plant height and canopy volume, CHM (Canopy Height Model) was generated by removing ground elevation, DTM (Digital Terrain Model), from DSM so canopy volume can be estimate. We manually selected the bare ground points to generate the DTM using the interpolation algorithm. CHM were then generated by subtracting corresponded DTM from DSM for each UAS flight. Total of pixel volume calculated by multiplying the height value of the pixel and pixel area within plot boundary was estimated as canopy volume. Various canopy

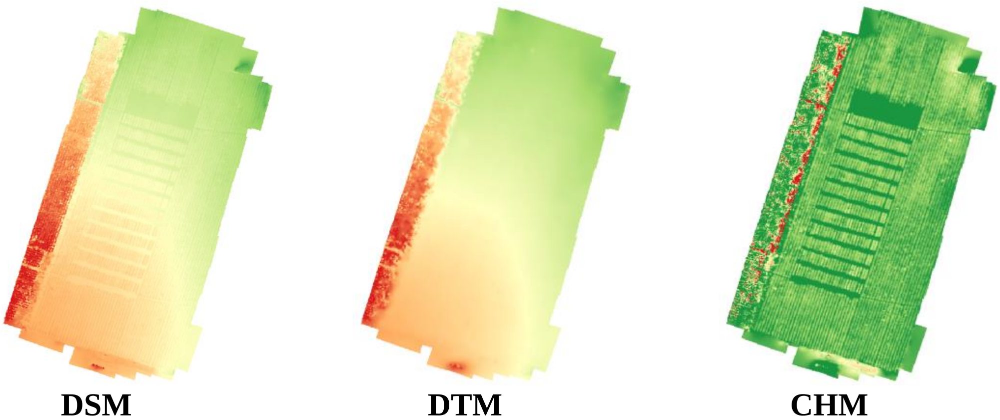


Figure 4. Canopy Height Model (CHM) is determined by subtracting Digital Terrain Model (DTM) from Digital Surface Model (DSM). The measurements in the legend are in meters.

height such as average, 95%, and maximum height within each row and grid boundary were also extracted. Pixel volume was calculated by multiplying the height value of the pixel and pixel area was estimated as CV (Figure 4).

Vegetation indices suggested in previous research were calculated form RGB and Multispectral images. Average of each vegetation indices of pixel values within each plot

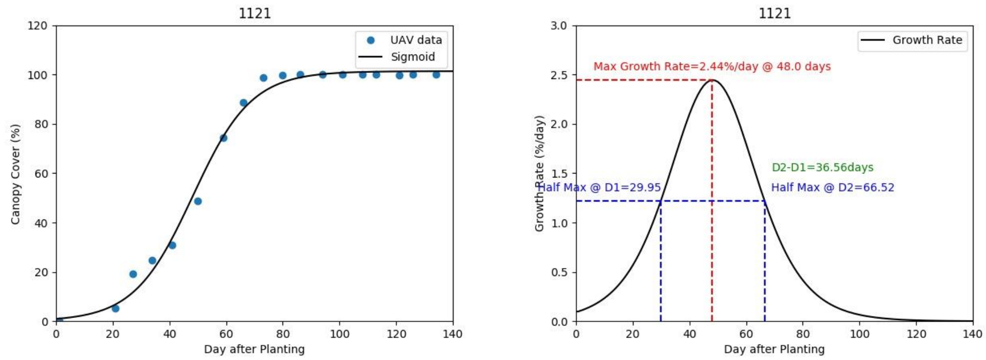


Figure 5. Example (TP200609-3-18) of (a) growth and (b) growth rate curve of canopy cover from multi-temporal (weekly) UAS-based phenotypic data. Traits of each variety such as Max Growth Rate, Date at the Half Maximum, Durations, etc. were extracted.

boundary was extracted as the representative for each plot.

Time-series phenotypes of canopy cover, plant height, and canopy volume were used to fit the optimal sigmoidal function as growth curve for each variety. The first derivatives of the growth curve were generated as the growth rate curves (Figure 5). Peanut crop traits such as maximum growth rate, day after planting at maximum growth rate, and duration over the half maximum period were extracted for each variety and phenotypes. We will develop yield estimation models using the actual tomato yield as a dependent variable and the corresponding multi-temporal phenotypic features as independent variables.

Sub-Project V. Organic Breeding

We initiated an organic breeding program in the spring of 2019 before the funding for this sub-project began and have continued and expanded the program for 2020. The initial crosses were moved grown as plant rows in 2020. In addition, we evaluated some of our current elite breeding lines in a certified organic field in Terry County (Table 21). As part of this evaluation, we included 2 Spanish lines that are nematode resistant and one historic germplasm line that is know to be pod rot resistant. Statistical analysis was able to reveal that Tx1444932 was significantly lower in damaged kernels as did a reported pod rot resistant Plant Introduction number. These will be used as parental materials moving forward. In addition to this we conducted stand counts for these same lines at 2 locations at day 7,14,21 and 28, but observed no statistical differences in emergence or seedling vigor. Weekly UAV flights were also conducted at both locations to begin development of a model to estimate stand counts. These lines will be tested again during the 2020 growing season. In addition, new materials will be tested at another certified organic location in 2021 at the Texas A&M Vernon Research and Extension Center.

Table 21. Organic Spanish Test in West Texas for 2020

	Pods/Ac Lbs.		TSMK %		Seed Wt g/100		Seed/Lbs		Damage Kernels	
Cultivar										
TxL076221-34	4359	A	56.7	ABCD	39.5	FG	1151	ABC	9.6	DEF
TxL076239-12	3883	AB	61.1	A	47.4	ABC	957	FGH	13.1	CDEF
TxL076239-16	3852	AB	54.8	ABCD	45.3	BCD	1005	EFG	21.0	ABCD
TxL076224-08	3692	ABC	55.4	ABCD	38.2	G	1193	AB	11.2	DEF
TxL076226-18	3689	ABC	59.6	ABC	43.2	CDEF	1051	CDEF	6.3	EF
TxL076225-04	3611	ABC	60.6	AB	42.3	DEFG	1073	BCDEF	11.1	DEF
GP of Toalson	3567	ABCD	55.5	ABCD	49.6	AB	916	GH	6.6	EF
TxL076225-28	3399	BCDE	48.3	DEF	41.6	DEFG	1092	ABCDE	17.8	ABCDE
Schubert	3373	BCDE	55.5	ABCD	42.4	DEFG	1076	BCDEF	16.8	ABCDEF
TxL076225-24	3287	BCDE	56.5	ABCD	42.5	DEFG	1067	CDEF	16.0	BCDEF
TxL076229-53	3282	BCDE	51.5	ABCDE	41.3	DEFG	1099	ABCDE	13.9	CDEF
Tamnut OL06	3237	BCDE	50.5	BCDEF	52.0	A	873	H	17.5	ABCDE
OLin	3233	BCDE	47.3	DEF	47.5	ABC	958	FGH	21.6	ABCD
TxL076236-04	3214	BCDE	53.4	ABCD	42.7	DEFG	1063	CDEF	23.7	ABC
TxL076225-48	3101	BCDE	41.7	EF	38.0	G	1200	A	28.6	A
Tx144932	3049	CDE	55.2	ABCD	43.2	CDEF	1052	CDEF	4.7	F
TxL076224-24	2943	CDE	46.3	DEF	44.5	CDE	1019	DEFG	23.8	ABC
TxL076221-06	2810	DE	40.8	F	41.7	DEFG	1109	ABCDE	28.3	AB
TamVal OL14	2735	E	49.9	CDEF	49.6	AB	918	GH	24.9	ABC
Tx144923	2679	E	50.8	ABCDEF	40.3	EFG	1130	ABCD	10.8	DEF
Mean	3350		52.6		43.6		1050		16.4	
CV(%)	17.4		15.0		10.2		10.3		57.8	
Entry "F"	0.0143		.0099		<.0001		<.0001		0.003	

Sub-Project VI. Leafspot Screening and Marker Identification

For the 2020 season we expanded our leafspot program to include additional crossing. The bulk of the work we conducted in the 2020 season was in the form of population development (Table 22). Crosses were made with materials that showed promise for leafspot resistance and will be followed with testing and molecular work. In an effort to establish Leafspot resistance in our most elite materials the Advanced Lines Test was planted at the Texas A&M Yoakum Research sub-Station in Yoakum, TX. Evaluations for resistance were made at harvest based on the Florida 1-10 scale. Statistical differences were found in the plots with the breeding lines
from our MDR program exhibiting the lowest disease ratings and the lines from the drought program having the highest ratings. Tx144485 was found to have the lowest numerical rating for leafspot. This in a large seeded nematode resistant line that is not moving forward as a release candidate but has been used extensively for crossing.

Crossing and marker development for improved leafspot resistance from the Burow lab continues with ongoing projects under other funding and will be evaluated in the field in 2021 (see Leafspot-resistant Spanish types section above). The Cason group will also be moving forward with population development from a different genetic background in additional materials. Crosses are ongoing that focus on solely on leafspot resistance as well as incorporation into the multiple disease resistance program. As field rating and marker development continue the information gathered will help us determine the best candidates to include in our 2021 leafspot crossing program.

Closing Comments

The coronavirus pandemic threatened to put a severe cap on our progress this year, but thanks to the tireless work of our dedicated staff we were able to continue to work and actually increase the testing locations that we had research plots at. The Texas A&M administration saw the vital need for research to continue during the very uncertain first days of the pandemic and granted permission for employees to travel and conduct research as long as precautions were in place to protect employees. Work began on 3 new sub-projects this year that will keep our program at the cutting edge of research and variety development. Projects in high throughput phenotyping using UAS and handheld Raman spectroscopy are underway, as well as development of new populations for drought, yield, leafspot and organic production. In addition, we are also starting new projects that specifically deal with nutrition and health of the peanut that will enable peanuts to be a crop that helps feed the world in the next 30 years. The Texas A&M AgriLife Foundation Seed sheller was constructed in 2020 with a total final cost of $1,300,000. The construction of a dedicated peanut sheller for the Texas A&M University System that will allow the breeding program to provide high quality pure seed to the peanut industry. The program also saw the addition of a organic legume breeder with some peanut responsibilities that will assist in organic research.

Table 22. Advanced Line Resistance Test Leafspot screening in South Texas for 2020

	Rating (Florida Scale)	
Cultivar		
TxL100212-05-09	7.8	A
TxL100212-03-03	7.0	AB
TxL100212-02-05	6.8	ABC
Georgia 09B	6.6	ABC
Georgia 16HO	6.5	ABCD
Tx144370	6.3	ABCD
TP200609-1-5	6.1	ABCDE
TxL100212-07-07	5.9	ABCDEF
TP200606-2-11	5.5	BCDEF
TxL100225-03-13	5.5	BCDEF
Tamrun OL11	5.5	BCDEF
Tx144342	5.2	BCDEF
TP200610-4-8	5.1	BCDEF
TP200606-3-3	5.0	CDEF
Tx121082	4.9	CDEF
TP200610-3-7	4.7	DEF
Georgia 14N	4.7	DEF
TP200610-1-14	4.6	DEF
TP200610-2-9	4.4	EF
Webb	4.4	EF
Tx144485	4.2	F
Mean	6	
CV(%)	24.6	
Entry "F"	0.015	