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Combining ability studies in CMS based and conventional hybrids of cotton (*Gossypium hirsutum* L.)

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ABSTRACT : Cotton is one of the most important fiber and cash crops of India and plays a dominant role in the industrial and agricultural economy of the country. Sixty crosses with thirteen parents and three checks *viz.,* PKV-Hy 4, NHH 206 and NHH 44 were grown in randomized block design with two replications. The results showed that the tester AKH 07R possessed the highest GCA effect for the seed cotton yield/ha and also exhibited high GCA (in desirable direction) for traits, sympodia and bolls/plant, harvest index and cotton seed yield/plant. The line CAK 23 B showed the high GCA effect to the traits, earliness index, boll/ plant, boll weight, seed cotton yield/plant, seed cotton yield/ha, ginning percentage and fiber strength. The CMS cross, CAK 53A x AKH 07 R possessed the highest SCA for the traits sympodia/plant, bolls/plant, boll weight, seed cotton yield/plant also it showed highest *per se* performance for the seed cotton yield/ plant. From the conventional system the highest SCA effect for the trait seed cotton yield/plant was observed for crosses CAK 23B x DHY 286-1R with high mean performance. For the fibe traits in CMS, highest SCA for strength was shown by SRT-1A x R 2000-23 and also high SCA for the traits upper half mean length. In the conventional hybrids, CAK 53B x R 2000-23 exhibited the highest SCA effect for the fiber strength also the high *per se* performance to the seed cot yield.

Key words : Combining ability, fibre strength, GCA, SCA, yield

Cotton is being cultivated in 70 countries of the world with a total coverage 33.14 m ha. China, India, USA and Pakistan are the major cotton producing countries in the world accounting for 70 per cent of the world's cotton area and production. India the is largest cotton growing country in the world with 35.29 per cent of world cotton area followed by China (15.23%). China and India are the major cotton consuming countries in the world (around 55 USA and India constitute 27 and 19.5 per cent of the worlds cotton exports, respectively. There are four cultivated species of cotton viz. *Gossypium arboreum, G.herbaceum, G.hirsutum* and *G.barbadense.* The first two species are diploid (2n=26) and are native to old world. They are also known as Asiatic cottons because they are grown in Asia. The last two species are tetraploid (2n=52) and are also referred to as New World Cottons. *G.hirsutum* is also known as American cotton or upland cotton and *G.barbadense* as Egyptian cotton or Sea Island cotton or Peruvian Cotton or Tanguish Cotton or quality cotton. *G.hirsutum* is the predominant species which alone contributes about 90 per cent to the global production. Perhaps India is the only country in the world where all the four cultivated species are grown on commercial scale.

The present study comprised of three male sterile CMS lines, three maintainer lines and ten male fertile males (testers/ restorers) with three standard checks in two sets *i.e.* CM S and conventional thus making 60 F1s (30 CMS and 30 conventional) using Line x Tester mating design. These lines, testers and hybrids along with three checks were sown during *kharif,* 2016 at three locations *viz.*, Cotton Research Station, Nanded (L-1), Experimental farm of Department of Agricultural Botany, VNM KV, Parbhani (L-2) and Experimental farm, Agricultural Research Station, Badnapur (L-3). The observations were recorded on days to 50 per cent flowering, plant heigh (cm), sympodia/plant, days to 50 per cent boll burst, earliness index, sympodia/ plant, boll/ plant, boll weight (g), seed cotton yield/plant (g) seed index (g), lint index (g), harvest index (%), seed cotton yield/ha (kg), ginning percentage, upper half mean length (mm), uniformity index (%), micronaire value (µg/inch) and fibre strength (g/tex).

The pooled analysis of variance for line x tester was found significant for all th characters. The significance of location x crosses interaction for plant height, days to 50 per cent bol burst, sympodia/plant, bolls/plant, boll weight, seed cotton yield/plant, harvest index, seed cotton yield/ha and ginning percentage showed the diversity between the environments.

The location x line effects were found significant for plant height, days to 50 per cent boll burst, bolls/plant, uniformity index and micronaire value. The significance of location x line x tester interaction effect for plant height, monopodia/plant, days to 50 per cent boll burst, sympodia/plant, bolls/plant, boll weight, seed cotton yield/plant, lint index, harvest index, seed cotton yield/ha, ginning percentage indicated higher interaction of non additive genetic effects with environment. This could be the reason in difference in heterosis over the environment for yield.

GCA effect of parents : The lines CAK 53A, CAK 53B and tester DHY 286-1R had the highest GCA effect for the traits days to 50 per cent flowering and days to 50 per cent boll burst. The tester AKH 07R possessed the highest GCA effect for the seed cotton yield/ha and also exhibited high GCA (in desirable direction) for the traits, sympodia, bolls /, harvest index and cotton seed yield/ha. The line CAK 23 B showed the high GCA effect to the traits, earliness index, bolls/plant, boll weight, seed cotton yield/plant, seed cotton yield/ha, ginning percentage and fiber strength. The tester, R 2000-23 showed highest GCA effect for characters fiber strength, uniformity index and ginning percentage also possessed the significant (in desirable direction) high GCA effect to the traits *i.e.* upper half mean length, seed cotton yield/plant and bolls/plant. Hence, these genotypes can be used in future for improvement of fiber properties.

The line CAK 53 B exhibited the highest GCA effect for the character upper half mean length, uniformity index and bolls/plant and showed the second position among line for the traits fiber strength, days to 50 per cent flowering and days to 50 per cent boll burst. For micronaire value the high GCA effect showed by line CA K 53 A and tester R 1044-13.

SCA effect of crosses : In the CMS set of crosses, according to the pooled data the highest SCA effects were observed for the cross

combination CAK 23A x R 42-8 (42.89) which also exhibited good performance in seed yield. It also exhibited the highest SCA effect for the traits, days to 50 per cent flowering, days to 50 per cent boll burst, earliness index, seed index, cotton seed yield/ha. The CMS cross, CAK 53 A x AKH 07 R possessed the highest SCA for the traits like sympodia/plant (3.32), bolls/plant (0.74), boll weight(0.74), seed cotton yield/plant (33.72) and showed highest *per se* performance for the seed cotton yield/plant, ginning percentage, lint index and harvest index.

In the conventional set of crosses, the highest SCA effect for seed cotton yield/plant was observed for crosses CAK 23B x DHY 286-1R (47.99) with high mean performance. It also recorded high SCA effect in the earliness index and bolls/plant. The cross combination CAK 23B x R 2000-23 exhibited the highest SCA effect for bolls/plant, sympodia/plant and plant height.

For the fiber traits in CMS, highest SCA effects were recorded by SRT 1A x R 2000-23 for fiber strength (3.59) and upper half mean length (1.05). In the conventional hybrids, CAK 53 B x R 2000-23 (3.39) exhibited the highest SCA effect for the fiber strength and high *per se* performance to the seed cotton yield.

Nature of gene action : The ratio of GCA and SCA *i.e.* predictability ratio of micronaire value indicated the predominantly additive gene action in expression of the characters. This ratio for sympodia/plant and boll weight was greater than 0.50 but less than 0.80 which indicated that there was equal importance of the additive as well as non additive gene action, while rest of the traits possessed the lower predictability ratio than 0.50 indicating the non additive gene action as the prime cause in the expression of these traits. So while applying the selection in the further generations, gene action controlling the characters should be taken into consideration *viz.,* where fixable component *i.e.* additive gene action is evident, the selection in the further generations would be rewarding after judging the positive correlation of the characters under investigation with the yield. In the characters where non fixable component is predominant heterosis breeding and recombination breeding with postponement of selection at later generation would be feasible (Laxman and Pradeep, 2003.)

Selection of promising parent and crosses : The lines CAK 23B and SRT 1B appeared to be the best general combiner for seed cotton yield and some fibre properties which may do well in cross combination with other parents. The tester AKH 07 R found to be best general combiner for the seed cotton yield. The tester R 2000-23 was found best general combiner for most of the fibre properties with high seed cotton yield.

Selection of the most encouraging cross combination needs high SCA along with high *per se* and GCA effect of respective parents. The cross combinations CAK 53A x AKH 07R, CAK 23B x AKH 07R, CAK 23B x DHY 286-1R, CAK 23B x R 2000-23, SRT-1A x R-2000-26, CAK 23A x R 42-8, CAK 53B x R-23 and SRT 1A x R 2000-26 showed high SCA effect for seed cotton yield. For fibre strength CAK 53 B x R 2000-23, SRT 1A x R 2000-23 possessed the high SCA effect. (Anandan (2010), Patil *et al.* (2011), Simon (2013), Patel and Kumar (2014), Pushpam *et al.* (2015) and Reddy *et al.* (2016).

Table 1. Pooled estimates of GCA effects of parents and SCA effects of crosses studied over three environments

Sr. No.	Genotype	Days to 50 per cent flowering	Plant height (cm)	Monop-odia/ plant	Days to 50 per cent boll burst	Earli-ness index	Sym-podia/ plant	Bolls/ plant	Boll weight (g)	Seed cotton yield/ plant (g)
GCA Lines										
1	CAK 53A	-3.78**	-1.12	0.04	-1.8**	-0.009*	0.82**	-1.39*	-0.21**	-7.99**
2	CAK 53B	-3.05**	-2.19*	0.12*	-0.98**	-0.008*	0.21	2.95**	-0.05	-0.24
3	CAK 23A	0.71**	-2.77**	-0.084	0.41*	-0.001	0.11	-2.92**	0.01	-8.68**
4	CAK 23B	0.96**	2.49**	0.06	-0.18	0.016**	1.01**	2.90**	0.32**	12.49**
5	SRT 1A	3.56**	-0.938	-0.04	1.43**	0.004	-1.37**	-2.39**	-0.08	-4.59**
6	SRT 1B	1.58**	4.54**	-0.10	1.11**	-0.002	-0.79**	0.85	0.02	9.02**
GCA Testers										
1	R 42-8	0.21	-2.70*	0.05	0.06	-0.006	-1.49**	-1.09	-0.19*	-2.00
2	R 2000-23	0.48*	0.46	0.01	-0.40	-0.004	0.70	2.35**	0.28**	14.56**
3	R 2000-17-2	-0.73**	0.27	-0.07	0.40	0.010	-0.69	0.57	0.18*	-9.29**
4	R 2000-26	-0.28	3.21**	-0.07	0.81**	-0.032**	-0.06	1.90*	0.10	4.00**
5	R 1044-13	1.26**	-3.67**	0.09	-0.07	0.018**	0.02	0.72	-0.01	1.77
6	R 2000-21	-0.20	-1.07	0.004	-1.01**	-0.006	0.30	-3.38**	0.05	-10.81**
7	R 23	1.23**	4.25**	-0.05	0.78**	0.029**	-0.27	-3.93**	-0.14	-14.53**
8	R 53	-0.03	-0.95	-0.06	0.09	-0.021**	-0.30	-0.93	-0.11	0.93
9	AKH 07R	1.04**	1.07	-0.06	0.40	0.019**	1.59**	5.19**	0.12	29.56**
10	DHY 286-1R	-2.98**	-0.86	0.16*	-1.07**	-0.007	0.20	-1.40	-0.29**	-14.18**
	SCA Crosses									
1	CAK 53A x R 42-8	7.08**	3.56	-0.18	3.46**	0.015	1.82	0.84	-0.17	-16.25**
2	CAK 53A x R 2000-23	1.64**	-5.43	-0.13	-1.06	0.022	-2.21*	-3.44	-0.14	-28.49**
3	CAK 53A x R 2000-17-2	-3.96**	1.86	-0.42*	-1.86**	-0.002	-0.81	-0.28	-0.02	-6.80*
4	CAK 53A x R 2000-26	-6.41**	-2.84	-0.28	-2.78**	0.022	-0.02	-2.79	-0.08	22.36**
5	CAK 53A x R 1044-13	1.53**	2.45	-0.21	0.60	-0.032*	-0.09	-1.67	-0.37	14.04**
6	CAK 53A x R 2000-21	2.67 **	-0.08	0.11	1.38*	0.021	-0.38	1.49	0.082	-4.67
7	CAK 53A x R 23	1.89**	3.46	0.60**	-0.25	-0.027*	-0.79	-2.41	-0.133	4.92
8	CAK 53A x R 53	-2.99**	2.81	0.14	0.43	-0.003	-1.09	-2.05	-0.06	-7.11*
9	CAK 53A x AKH 07R	1.75**	-2.71	0.04	-1.53**	0.020	3.32**	15.45**	0.74**	33.72**
10	CAK 53A x DHY 286-1R	-3.21**	-3.07	0.33	1.60**	-0.035**	0.28	-5.13*	0.17	-11.72**

Contd...

Table 1. Contd....

11	CAK 53B x R 42-8	0.18	6.39*	0.12	0.48	-0.033*	0.77	5.09*	0.10	-11.61**
12	CAK 53B x R 2000-23	0.57	1.43	0.11	1.62**	0.048**	0.59	-3.70	0.06	12.03**
13	CAK 53B x R 2000-17-2	-2.70**	2.34	-0.13	-3.35**	0.032*	-0.13	4.59*	0.14	0.55
14	CAK 53B x R 2000-26	-1.64**	1.06	0.24	-1.10	0.020	1.41	6.12**	0.03	6.10
15	CAK 53B x R 1044-13	6.80**	1.30	0.12	4.62**	-0.033*	-0.14	-5.26*	-0.28	-29.64**
16	CAK 53B x R 2000-21	2.77**	-2.61	0.19	-0.10	0.039**	0.84	0.30	-0.37	-10.01**
17	CAK 53B x R 23	-1.50**	-5.98*	-0.42*	-2.23**	-0.034**	-0.04	0.50	0.09	23.62**
18	CAK 53B x R 53	-1.72**	0.23	0.008	-1.37*	-0.010	-1.39	-0.59	0.61**	11.00**
19	CAK 53B x AKH 07R	0.02	2.04	-0.35	1.15*	0.008	-1.35	-0.13	-0.45*	-5.24
20	CAK 53B x DHY 286-1R	-2.78**	-6.22*	0.10	0.28	-0.037**	-0.54	-6.91**	0.05	3.19
21	CAK 23A x R 42-8	-6.74**	-6.62*	-0.09	-4.75**	0.091**	1.23	2.78	0.02	45.89**
22	CAK 23A x R 2000-23	-4.18**	-1.45	-0.06	-1.77 **	-0.026*	0.92	3.63	-0.24	27.92**
23	CAK 23A x R 2000-17-2	2.86**	0.24	0.26	2.25**	-0.049**	0.63	1.71	0.06	17.40**
24	CAK 23A x R 2000-26	6.08**	-6.03*	-0.28	1.33*	0.004	-0.11	-3.79	0.14	-41.49**
25	CAK 23A x R 1044-13	-3.96**	-1.81	0.35	-1.77**	-0.016	1.13	0.65	0.35	15.92**
26	CAK 23A x R 2000-21	-0.16	-4.56	-0.44*	2.00**	-0.026	0.55	1.19	0.25	8.55**
27	CAK 23A x R 23	1.39*	2.92	-0.15	1.02	0.005	-0.72	-1.17	0.25	-15.80**
28	CAK 23A x R 53	3.00**	3.68	0.04	0.05	0.014	0.28	-2.19	-0.12	-2.84
29	CAK 23A x AKH 07R	-0.24	7.10*	0.79**	0.25	-0.066**	-2.56**	-5.47**	-0.58**	-36.51**
30	CAK 23A x DHY 286-1R	1.95**	6.54*	-0.42*	1.38*	0.070**	-1.34	2.66	-0.15	-19.04**
31	CAK 23B x R 42-8	-2.16**	-7.57**	0.29	-1.31*	-0.036**	-2.83**	-5.44**	0.17	-43.23**
32	CAK 23B x R 2000-23	0.22	10.61**	-0.03	1.15*	-0.029*	2.15*	10.92**	0.04	15.88**
33	CAK 23B x R 2000-17-2	0.78	4.49	0.22	1.51**	-0.067**	-0.26	-7.32**	-0.50*	-3.22
34	CAK 23B x R 2000-26	-1.82**	4.36	-0.15	-0.73	-0.019	-2.09*	-5.80**	-0.50*	-26.68**
35	CAK 23B x R 1044-13	0.95	9.76**	-0.14	-1.67**	0.004	-0.89	0.69	-0.03	18.86**
36	CAK 23B x R 2000-21	-2.07**	2.18	-0.16	-2.23**	0.010	0.41	-1.68	0.008	-11.89**
37	CAK 23B x R 23	1.14*	-10.97**	0.02	0.96	0.030*	-0.01	-1.83	0.18	-1.74
38	CAK 23B x R 53	1.25*	-9.06**	-0.16	1.32*	0.021	-0.45	-5.00*	0.06	-1.16
39	CAK 23B x AKH 07R	0.33	-5.42	-0.12	-1.15*	-0.001	1.92*	5.83**	0.52*	5.22
40	CAK 23B x DHY 286-1R	1.36*	1.62	0.24	2.15**	0.086**	2.06*	9.65**	0.04	47.99**

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Table 1. Contd....

41	SRT 1A x R 42-8	4.23**	-12.52**	-0.01	3.40**	-0.019	-0.84	-4.87*	-0.20	18.69**
42	SRT 1A x R 2000-23	3.96**	-13.22**	-0.06	2.87**	0.012	-1.05	-11.61**	0.19	-27.36**
43	SRT 1A x R 2000-17-2	3.68**	-6.51*	0.02	0.90	0.020	0.46	-0.25	0.06	-15.39**
44	SRT 1A x R 2000-26	0.90	-1.35	0.17	1.31*	-0.021	2.80**	9.14**	0.54**	42.89**
45	SRT 1A x R 1044-13	-5.65**	-4.57	-0.01	-3.79**	0.069**	0.31	-0.83	0.12	5.01
46	SRT 1A x R 2000-21	-4.17**	3.47	0.36	-3.51**	-0.002	0.35	2.48	0.02	14.99**
47	SRT 1A x R 23	-4.78**	10.30**	-0.08	-0.15	-0.005	0.67	2.44	-0.47*	-23.41**
48	SRT 1A x R 53	-1.01	8.84**	-0.29	0.70	-0.019	0.27	5.33*	-0.29	-18.69**
49	SRT 1A x AKH 07R	-0.42	9.70**	-0.21	0.90	0.026*	-1.68	-3.32	-0.07	10.64*
50	SRT 1A x DHY 286-1R	3.26**	5.86*	0.12	-2.62**	-0.061**	-1.31	1.50	0.08	-7.36*
51	SRT 1B x R 42-8	-2.61**	16.75**	-0.13	-1.28*	-0.018	-0.14	1.60	0.08	6.51*
52	SRT 1B x R 2000-23	-2.22**	8.05**	0.19	-2.81**	-0.027*	-0.40	4.20*	0.07	0.009
53	SRT 1B x R 2000-17-2	-0.66	-2.41	0.04	0.55	0.066**	0.15	1.55	0.25	7.47*
54	SRT 1B x R 2000-26	2.88**	4.80	0.30	1.96**	-0.007	-1.98*	-2.87	-0.13	-3.17
55	SRT 1B x R 1044-13	0.33	-7.12*	-0.10	2.02**	0.008	-0.30	6.437**	0.20	-24.19**
56	SRT 1B x R 2000-21	0.97	1.60	-0.05	2.46**	-0.041**	-1.78	-3.79	0.00	3.04
57	SRT 1B x R 23	1.86**	0.26	0.02	0.66	0.032*	0.90	2.48	0.07	12.41**
58	SRT 1B x R 53	1.47**	-6.51*	0.25	-1.14*	-0.003	2.38*	4.51*	-0.19	18.81**
59	SRT 1B x AKH 07R	-1.44**	-10.70**	-0.13	0.38	0.012	0.36	-12.36**	-0.15	-7.83*
60	SRT 1B x DHY 286-1R	-0.58	-4.73	-0.38*	-2.81**	-0.022	0.85	-1.76	-0.20	-13.05**
	S.E. +									
	Lines	0.17	0.88	0.06	0.18	0.004	0.31	0.65	0.06	1.00
	Tester	0.22	1.14	0.08	0.23	0.005	0.39	0.84	0.08	1.29
	Crosses	0.55	2.78	0.18	0.56	0.013	0.97	2.06	0.20	3.17

Table 2. Pooled estimates of GCA effects of parents and SCA effects of crosses studied over three environments

Sr. No.	Genotype	Seed index (g)	Lint index (g)	Harvest index (%)	Seed cotton yield/ ha (kg)	Ginning percentage	Upper half mean length (mm)	Uniformity index (%)	Micron-aire value (ug/in)	Fibre strength (g/tex)
	GCA Lines									
1	CAK 53A	-0.33**	-0.07	-1.55**	-148.06**	-0.07	0.40**	-0.06	-0.30**	-0.31**
2	CAK 53B	0.01	-0.09	-0.46*	-4.45	-0.12	0.89**	0.69**	-0.14**	0.63**
3	CAK 23A	0.12	-0.16*	-1.00**	-160.81**	-0.57**	-0.47**	-0.64**	0.18**	0.03
4	CAK 23B	0.008	0.16*	4.52**	231.32**	0.45**	0.52**	0.39**	-0.18**	1.12**
5	SRT 1A	0.04	0.03	-1.16**	-85.16**	-0.07	-1.08**	-0.15	0.15**	-1.26**
6	SRT 1B	0.14	0.12	-0.33	167.18**	0.38*	-0.27**	-0.22*	0.27**	-0.21*
	GCA Testers									
1	R 42-8	-0.15	-0.04	-0.52	-37.20	0.62**	-0.47**	-0.96**	0.40**	-1.13**
2	R 2000-23	-0.02	0.02	1.75**	269.78**	0.81**	1.12**	1.16**	-0.16**	1.68**
3	R 2000-17-2	0.04	-0.14	-0.81**	-172.19**	-0.75**	0.84**	0.67**	-0.26**	-0.09
4	R 2000-26	0.18	0.37**	1.87**	74.16**	0.81**	0.17*	0.23	-0.19**	-1.00**
5	R 1044-13	0.01	-0.22*	-0.75**	32.83	-1.03**	0.80**	0.08	-0.28**	0.75**
6	R 2000-21	-0.20*	-0.07	-0.69*	-200.314**	0.66**	-0.97**	-1.18**	-0.09*	-0.40**
7	R 23	-0.03	-0.16	-3.49**	-269.09**	-0.67**	-1.03**	0.37**	0.20**	-0.71**
8	R 53	-0.18	-0.13	0.08	17.34	-0.48*	-0.73**	0.30*	-0.05	0.43**
9	AKH-07R	0.11	0.21*	3.79**	547.42**	-0.55**	-0.86**	-0.60**	0.05	-0.52**
10	DHY-286-1R	0.24**	0.16	-1.21**	-262.74**	0.58**	1.13**	-0.08	0.40**	1.00**
	SCA Crosses									
1	CAK 53A x R 42-8	-0.77**	-0.48*	1.57*	-300.93**	0.50	-2.07**	-1.82**	0.12	-1.09**
2	CAK 53A x R 2000-23	0.54*	-0.02	-6.58**	-527.64**	0.19	0.04	-0.63*	0.12	-0.45
3	CAK 53A x R 2000-17-2	-0.62**	-0.30	2.12**	-126.00*	-1.89**	0.16	0.22	0.30**	-0.68*
4	CAK 53A x R 2000-26	0.47*	0.14	0.25	414.12**	-0.37	-0.69**	-1.16**	-0.43**	0.10
5	CAK 53A x R 1044-13	0.26	-0.003	-6.97**	260.05**	-0.80	-0.78**	0.82**	0.09	-0.92**
6	CAK 53A x R 2000-21	-0.05	-0.03	4.03**	-86.56	0.06	0.44*	1.16**	-0.18	0.56*
7	CAK 53A x R 23	0.50*	-0.18	-1.67*	91.22	0.39	3.02**	0.63*	0.47**	1.01**
8	CAK 53A x R 53	0.28	0.066	2.55**	-131.69*	-1.14*	0.77**	0.53	0.02	1.18**
9	CAK 53A x AKH-07R	0.005	0.96**	9.66**	624.54**	2.72**	1.00**	1.51**	0.02	0.05
10	CAK 53A x DHY-286-1R	-0.61**	-0.13	-4.97**	-217.09**	0.31	-1.91**	-1.27**	-0.54**	0.23
11	CAK 53B x R 42-8	-0.78**	-0.12	-1.32*	-214.99**	1.19*	0.92**	1.17**	0.19*	0.36

Contd...

Table 2. Contd....

12	CAK 53B x R 2000-23	-0.99**	-0.45*	-0.28	222.87**	-1.66**	0.26	-0.07	-0.16	3.39**
13	CAK 53B x R 2000-17-2	0.48*	0.23	3.47**	10.24	-0.22	-0.33	-1.13**	0.11	0.50
14	CAK 53B x R 2000-26	-0.11	0.03	-2.73**	113.00	0.05	-1.46**	-1.06**	-0.01	-2.36**
15	CAK 53B x R 1044-13	0.16	-0.15	-3.03**	-548.94**	-1.93**	-0.16	2.14**	-0.01	0.29
16	CAK 53B x R 2000-21	0.87**	0.46*	-4.02**	-185.52**	0.55	0.07	0.64*	0.10	-0.84**
17	CAK 53B x R 23	-0.69**	-0.20	0.35	437.53**	1.33**	0.54**	0.57	-0.14	-0.18
18	CAK 53B x R 53	0.56*	0.45*	6.90**	203.79**	1.08*	0.46**	-0.63*	-0.18*	-1.08**
19	CAK 53B x AKH-07R	0.23	-0.33	-0.80	-97.11	0.92	0.20	0.01	-0.04	-0.07
20	CAK 53B x DHY-286-1R	0.26	0.09	1.47*	59.12	-1.31**	-0.49**	-1.64**	0.16	-0.008
21	CAK 23A x R 42-8	0.58*	0.24	0.93	849.83**	-0.40	-1.64**	1.32**	-0.08	-2.96**
22	CAK 23A x R 2000-23	-0.24	-0.05	-3.51**	517.17**	0.83	-0.10	0.52	-0.27**	-2.00**
23	CAK 23A x R 2000-17-2	-0.03	0.19	1.62*	322.22**	-1.12*	1.04**	1.72**	-0.26**	1.85**
24	CAK 23A x R 2000-26	0.06	0.22	1.41*	-768.46**	1.42**	-0.58**	-0.65*	0.28**	0.42
25	CAK 23A x R 1044-13	0.12	0.03	2.06**	294.87**	-0.49	-0.318	-0.52	0.59**	-2.88**
26	CAK 23A x R 2000-21	-0.39	-0.13	0.98	158.46**	0.11	2.41**	-0.03	-0.20*	2.26**
27	CAK 23A x R 23	-0.28	-0.03	1.15	-292.65**	-0.07	-1.37**	0.31	-0.34**	1.06**
28	CAK 23A x R 53	0.19	-0.41	-1.97**	-52.68	-1.22*	0.20	-0.77*	-0.11	2.10**
29	CAK 23A x AKH-07R	-0.01	-0.16	-6.12**	-676.15**	-0.41	-1.04**	-1.93**	0.28**	-0.69*
30	CAK 23A x DHY-286-1R	0.01	0.11	3.43**	-352.61**	1.35**	1.41**	0.03	0.12	0.83**
31	CAK 23B x R 42-8	0.49*	0.21	-1.83**	-800.69**	-0.29	-0.78**	-1.42**	-0.44**	0.97**
32	CAK 23B x R 2000-23	0.46*	0.36	2.39**	294.16**	0.46	-0.91**	-1.42**	0.04	-3.10**
33	CAK 23B x R 2000-17-2	0.14	-0.37	-3.04**	-59.76	-1.25*	1.31**	0.88**	0.18*	-0.80**
34	CAK 23B x R 2000-26	-0.45*	-0.60**	-3.82**	-494.14**	-1.40**	1.41**	1.16**	0.31**	0.98**
35	CAK 23B x R 1044-13	0.49*	0.14	-1.53*	349.26**	0.76	0.94**	-0.61*	-0.55**	2.16**
36	CAK 23B x R 2000-21	-0.53*	-0.37	0.67	-220.34**	0.36	-1.34**	-0.61*	0.40**	-0.21
37	CAK 23B x R 23	0.02	0.05	1.45*	-32.37	0.96*	-0.92**	-0.56	-0.06	0.10
38	CAK 23B x R 53	-0.56*	-0.40	-1.73**	-21.62	1.23*	-0.30	0.05	-0.15	0.87**
39	CAK 23B x AKH-07R	-0.68**	0.47*	1.44*	96.82	-1.07*	0.98**	1.86**	-0.07	1.38**
40	CAK 23B x DHY-286-1R	0.60**	0.49*	5.99**	888.69**	0.22	-0.39*	0.67*	0.33**	-2.36**

Contd...

Table 2. Contd....

41	SRT 1A x R 42-8	0.03	0.01	-0.05	346.17**	0.47	1.05**	-0.34	0.07	1.31**
42	SRT 1A x R 2000-23	-0.03	-0.04	2.39**	-506.72**	-0.32	2.45**	1.65*	-0.04	3.59**
43	SRT 1A x R 2000-17-2	0.10	0.22	-1.84**	-285.11**	2.35**	-0.19	-0.50	0.07	-0.95**
44	SRT 1A x R 2000-26	0.02	0.38	7.88**	794.35**	1.02*	-0.54**	0.86**	-0.07	-0.66*
45	SRT 1A x R 1044-13	-0.71**	-0.17	5.37**	92.80	0.95	-0.59**	-1.87**	0.09	-1.03**
46	SRT 1A x R 2000-21	0.07	0.009	-0.33	277.58**	-1.39**	0.66**	0.27	-0.29**	-0.47
47	SRT 1A x R 23	0.17	0.14	-3.66**	-433.58**	-1.49**	-0.93**	0.21	0.06	-0.82**
48	SRT 1A x R 53	-0.03	0.19	-4.70**	-346.16**	-1.53**	-0.89**	0.78*	-0.03	-1.61**
49	SRT 1A x AKH-07R	0.33	-0.49*	-0.97	197.05**	-0.44	-1.65**	-2.17**	0.12	-0.38
50	SRT 1A x DHY-286-1R	0.03	-0.24	-4.07**	-136.37*	0.37	0.65**	1.11**	0.01	1.03**
51	SRT 1B x R 42-8	0.44	0.13	0.70	120.61*	-1.47**	2.52**	1.09**	0.13	1.40**
52	SRT 1B x R 2000-23	0.26	0.22	5.59**	0.16	0.49	-1.73**	-0.05	0.31**	-1.43**
53	SRT 1B x R 2000-17-2	-0.08	0.01	-2.34**	138.41*	2.13**	-1.99**	-1.18**	-0.40**	0.08
54	SRT 1B x R 2000-26	0.01	-0.16	-2.99**	-58.87	-0.72	1.87**	0.85**	-0.07	1.50**
55	SRT 1B x R 1044-13	-0.34	0.15	4.10**	-448.04**	1.51**	0.92**	0.04	-0.21*	2.37**
56	SRT 1B x R 2000-21	0.04	0.08	-1.34*	56.38	0.29	-2.25**	-1.42**	0.16	-1.29**
57	SRT 1B x R 23	0.27	0.24	2.38**	229.84**	-1.12*	-0.32	-1.18**	0.01	-1.18**
58	SRT 1B x R 53	-0.44	0.10	-1.05	348.37**	1.58**	-0.24	0.03	0.46**	-1.46**
59	SRT 1B x AKH-07R	0.12	-0.45*	-3.20**	-145.14*	-1.71**	0.51**	0.72*	-0.32**	-0.27
60	SRT 1B x DHY-286-1R	-0.30	-0.31	-1.84**	-241.73**	-0.96*	0.72**	1.09**	-0.08	0.26
	S.E. +									
	Lines	0.07	0.07	0.21	18.56	0.15	0.06	0.10	0.03	0.09
	Tester	0.09	0.09	0.27	23.96	0.20	0.07	0.13	0.04	0.11
	Crosses	0.23	0.22	0.66	58.68	0.49	0.18	0.31	0.09	0.28

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