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Research Note

Heterosis for seed cotton yield and quality traits in cotton (*Gossypium hirsutum* L.)

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Abstract

Forty five intra-hirsutum hybrids from a 10 × 10 diallel crossing excluding reciprocals along with their parents and check were tested in three environments at Regional Agricultural Research Station, Lam Farm, Guntur, Agricultural Research Station, Jangamaheswarapuram and Agricultural Research Station, Darsi during *kharif*, 2013-14. Observations were recorded on seed cotton yield and fibre quality traits to estimate the extent of heterosis over mid, better parent and check. Heterosis for seed cotton yield plant^{-1} over mid parent, better parent and standard check ranged from -10.25 (NDLH 1938 × MCU 5) to 33.83 (NDLH 1938 × L 604), -14.3 (NDLH 1938 × MCU 5) to 23.37 (L 770 × RAH 1004) and -10.17 (L 604 × G COT 16) to 39.47 (NDLH 1938 × L 604); respectively. The hybrids NDLH 1938 × L 604 and NDLH 1938 × RAH 1004 recorded maximum significant positive heterosis over mid, better parent and check for most of the fibre quality characters. The cross combination involving NDLH 1938 parent recorded significant positive heterosis for most of the characters. Hence, the parent NDLH 1938 can be used for exploitation of heterosis.

Keywords

Fibre quality traits, Gossypium hirsutum, heterosis, seed cotton yield.

Cotton (*Gossypium* spp.) popularly called “White Gold” and “King of Fibre Crops” is the most important renewable natural fibre crop of global importance. In India, cotton is being grown over an area of 115.53 lakh ha with an annual production of 375 lakh bales (1 bale=170 kgs of lint) with a productivity of 552 kg lint / ha (Anonymous, 2014). Cock (1909) first suggested the possibility of commercial exploitation of heterosis in cotton. For developing potential hybrids in cotton, it is necessary to exploit the hybrid vigour available in cotton. Hybridisation is the most potent technique for breaking yield barriers and evolving genotypes with higher yield potential. Selection of appropriate parents for hybridisation is the single most important factor determining both the extent and magnitude of success of any plant breeding programme. There are several techniques for the evaluation of the genetic makeup of genotypes and diallel analysis is the one which is commonly being used. The present experiment was carried out with the objective of finding out the extent of heterosis over mid parent, best parent and check for seed cotton yield and fibre quality traits in three environments.

The present investigation was carried out by selecting the ten parents *viz.*, NDLH 1938, L 788, L 770, NA 1325, L604, SURABHI, RAH 1004, HYPS 152, MCU 5 and G COT 16 based on their performance in genetic divergence study carried out with 63 genotypes during *kharif*, 2012-13 and forty five intra-specific cross combinations were made in diallel fashion without reciprocals during off season (2013) at Regional Agricultural Research Station, Lam Farm, Guntur, Andhra Pradesh. The evaluation of hybrids along with parents and standard check (NCS-145) was done at three locations i.e., Regional Agricultural Research Station, Lam Farm, Guntur, Agricultural Research Station, Jangamaheswarapuram and Agricultural Research Station, Darsi during *kharif*, 2013-14. Each entry was represented by following 120 x 60 cm spacing with 3 rows for each entry with a row length of 6m. Recommended doses of fertilizers 120 N, 60 P_2O_5 and 40 K_2O kg/ha were applied in split doses. Observations were recorded on five randomly selected plants from each genotype per replication for seed cotton yield plant^{-1}(g). The data on 2.5% span length (mm), micronaire value (10^{-6}g/inch), bundle strength (g/tex), uniformity ratio and elongation (%) were recorded on plot basis. The fibre quality parameters were studied at Central Institute for Research on Cotton Technology (CIRCOT), RARS, Lam, Guntur, Andhra Pradesh.

The pooled analysis of variance for fifty six genotypes (parents, F_1s and check) for seed cotton yield plant^{-1}, 2.5% span length, micronaire value, bundle strength, uniformity ratio and elongation % showed that variances were significant for the characters studied and were presented in the Table 1. The portioning of total variance into various components revealed that a large portion of the variance for all the characters studied was attributed to genotypes and environments, when they were tested against G × E component. Environmental variances were found to be significant for most of the characters. Significant variability also existed among the genotypes for all the characters.The magnitude of variance for G × E interaction was also found to be significant for most of the characters.

The heterosis observed over the mid parent, best parent and check for seed cotton yield and quality traits in three environments (pooled) by the forty five crosses has been presented in the Tables 2 & 3. The results indicated that the phenomenon of heterosis was observed for all the characters, however, its magnitude varied with the characters.

Heterosis for seed cotton yield plant^{-1} over mid parent, better parent and standard check ranged from -10.25 (NDLH 1938 × MCU 5) to 33.83 (NDLH 1938 × L 604), -14.3 (NDLH 1938 × MCU 5) to 23.37 (L 770 × RAH 1004) and -10.17 (L 604 × G COT 16) to 39.47 (NDLH 1938 × L 604); respectively. Ten crosses over mid parent, one cross over better parent and eight crosses over standard check exhibited significant positive heterosis. These results are in accordance with the findings of Rajamani *et al.* (2009), Punitha *et al.* (2012) and Sandip Patil *et al.* (2012) over both mid and better parents and Tuteja *et al.* (2013), Nirania *et al.* (2014) and Tuteja (2014) over standard check.

Heterosis for 2.5% span length over mid parent ranged from -9.58 (RAH 1004 × MCU 5) to 9.57 (NDLH 1938 × L 604), over better parent it ranged from -16.28 (RAH 1004 × MCU 5) to 3.27 (NDLH 1938 × NA 1325) and over standard check ranged from -8.08 (RAH 1004 × MCU 5) to 9.75 (SURABHI × G COT 16). Significant positive heterosis was exhibited by only one cross (NDLH 1938 × L 604) over mid parent and four crosses over standard check.

These results are in conformity with the reports of Rajamani *et al.* (2009), Punitha *et al.* (2012) and Sandip Patil *et al.* (2012) for heterosis over mid parent and better parent; where as heterosis over standard check was reported by Rajamani *et al.* (2009), Sandip Patil *et al.* (2012), Tuteja *et al.* (2013) and Tuteja (2014).

Heterosis for micronaire value (10^{-6} g/inch) in pooled analysis over mid parent, better parent and standard check ranged from -21.36 (SURABHI × HYPS 152) to 16.21 (L 604 × RAH 1004); -22.77 (SURABHI × HYPS 152) to 12.14 (L 604 × RAH 1004) and -14.0 (SURABHI × HYPS 152) to 29.98 (NDLH 1938 ×RAH1004),respectively.

Significant positive heterosis was exhibited by ten crosses over mid parent, five crosses over better parent and thirty one crosses over standard check. Similar type of results were reported by Rajamani *et al.* (2009) and Sandip Patil *et al.* (2012) for heterosis over mid parent; Sandip Patil *et al.* (2012) and Deshmukh *et al.* (2014) for heterosis over better parent and Rajamani *et al.* (2009), Tuteja *et al.* (2013) and Tuteja (2014) over standard check.

For bundle strength, heterosis over mid parent ranged from -7.78 (HYPS 152 × G COT 16) to 10.81 (NDLH 1938 × L 604); over better parent -11.0 (RAH 1004 × MCU 5) to 8.73 (NDLH 1938 × L 604) and over standard check -8.38 (NA 1325 × RAH 1004) to 6.91 (SURABHI × G COT 16). Significant positive heterosis was exhibited by four crosses over mid parent, one cross over better parent and one cross over standard check. Earlier workers Rajamani *et al.* (2009), Punitha *et al.* (2012) and Sandip Patil *et al.* (2012) for heterosis over mid parent; Rajamani *et al.* (2009), Wankhade *et al.* (2009), Punitha *et al.* (2012), Sandip Patil *et al.* (2012) and Deshmukh *et al.* (2014) over better parent and Rajamani *et al.* (2009), Wankhade *et al.* (2009), Sandip Patil *et al.* (2012), Tuteja *et al.* (2013) and Tuteja (2014) over standard check also reported similar results.

Heterosis for uniformity ratio over mid parent, better parent and standard check ranged from -6.94 (NDLH 1938 × G COT 16) to 2.93 (L 604 × SURABHI), -9.08 (NDLH 1938 × G COT 16) to 1.37 (L 788 × G COT 16) and -3.38 (L 770 × MCU 5) to 7.08 (NDLH 1938 × RAH 1004), respectively. Significant positive heterosis was exhibited by five crosses over standard check. Similar type of results was earlier reported by Neelima (2002), Rajamani *et al.* (2009) and Sandip Patil *et al.* (2012).

For elongation (%), heterosis over mid parent, better parent and standard check ranged from -4.79 (L 770 × RAH 1004) to 4.63 (L 604 × HYPS 152); -7.04 (L 770 × RAH 1004) to 2.42 (L 604 × HYPS 152) and -2.26 (L 604 × MCU 5) to 6.59 (NDLH 1938 × RAH 1004), respectively. Significant positive heterosis exhibited by only one cross (L 604× HYPS 152) over mid parent and four crosses over standard check.

These results are in conformity with the reports of Sandip Patil *et al.* (2012) for heterosis over mid parent; Sandip Patil *et al.* (2012) and Deshmukh *et al.* (2014) for heterosis over better parent and

Sandip Patil *et al.* (2012) for heterosis over standard check.

Based on overall performance (*per se* performance, *sca* effects and standard heterosis) the hybrids *viz*., NDLH 1938 × L 604 (33.83**, 15.26 and 39.47**), NDLH 1938 × RAH 1004 (27.43**, 12.87 and 36.57**) and NDLH 1938 × L 770 (24.49**, 11.47 and 34.48**) were identified as the best specific cross combinations for seed cotton yield and quality traits.

The cross combination involving NDLH 1938 parent recorded significant positive heterosis for most of the characters. Hence, the parent NDLH 1938 can be used for exploitation of heterosis.

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Table 1. Analysis of variance of combining ability for different characters in cotton over three environments (pooled) during *kharif*, 2013-14.

Source of variation	df	Seed cotton yield plant^{-1} (g)	2.5% span length (mm)	Micronaire value (10^{-6} g/inch)	Bundle strength (g/tex)	Uniformity ratio	Elongation (%)
Environments	2.00	348887.50**	62.47**	6.26**	0.19	119.09**	0.04
Blocks within Environments	6.00	179.06	2.30	0.04	2.03*	2.79	0.05
Treatments	54.00	2510.85**	18.45**	0.93**	7.84**	14.35**	0.11**
Parents	9.00	1845.91**	36.81**	0.45**	11.41**	16.68**	0.22**
Hybrids	44.00	2451.83**	15.11**	1.05**	7.29**	13.18**	0.08**
Parents vs. Hybrids	1.00	11092.01**	0.26	0.03	0.31	45.18**	0.10*
Treatment × Environments	108.00	1503.05**	10.52**	0.74**	4.45**	7.63**	0.05**
Parent × Environments	18.00	974.56**	11.21**	0.50**	3.90**	10.69**	0.07**
Hybrids × Environments	88.00	1570.03**	10.25**	0.78**	4.45**	6.68**	0.04**
Parent vs. Hybrids × Env.	2.00	3312.68**	16.29**	0.80**	9.18**	22.12**	0.03
Error	324.00	341.59	1.95	0.02	0.79	1.54	0.02

**Significant at 1% level * Significant at 5% level

Table 2. Percentage heterosis over mid parent, better parent and check for seed cotton yield plant^{-1}, 2.5 % span length and micronaire value of cotton hybrids in three environments and pooled during *kharif* , 2013-14.

Hybrid	Seed cotton yield plant^{-1} (g)			2.5 % span length (mm)			Micronaire value (10^{-6} g/inch)		
	Mid	Better	NCS-145	Mid	Better	NCS-145	Mid	Better	NCS-145
NDLH 1938 × L 788	10.73	3.79	25.58*	6.48	2.46	3.3	1.98	0.18	25.22**
NDLH 1938 × L 770	24.49**	11.47	34.88**	5.84	0.72	3.92	-5.41*	-11.33**	10.80**
NDLH 1938 × NA 1325	8.21	-4.49	15.57	3.64	3.27	-3.06	-0.39	-5.2	18.45**
NDLH 1938 × L 604	33.83**	15.26	39.47**	9.57**	3.07	8.99*	-4.71	-13.39**	8.22*
NDLH 1938 × SURABHI	13.98	6.83	29.26**	3.66	-1.61	2.06	8.57**	0.92	26.11**
NDLH 1938 × RAH 1004	27.43**	12.87	36.57**	0.31	0.14	-6.35	10.70**	4.02	29.98**
NDLH 1938 × HYPS 152	3.62	-4.24	15.87	3.09	-3.99	3.73	-3.63	-8.88**	13.87**
NDLH 1938 × MCU 5	-10.25	-14.3	3.69	1.47	-6.2	2.99	4.09	-3.14	21.03**
NDLH 1938 × G COT 16	-2.62	-9.14	9.93	3.25	-5.15	5.57	-10.37**	-15.72**	5.32
L 788 × L 770	8.79	3.6	9.62	-2	-3.12	-0.04	4.44	-0.44	20.04**
L 788 × NA 1325	8.58	1.81	7.72	-0.83	-4.25	-3.47	-1.46	-4.6	15.02**
L 788 × L 604	15.93	5.85	12	-0.65	-2.97	2.61	-0.96	-8.52**	10.30**
L 788 × SURABHI	-7.36	-7.36	-1.98	4.21	2.74	6.57	-2.35	-7.69*	11.29**
L 788 × RAH 1004	7.87	1.53	7.42	3.52	-0.23	0.58	8.08**	3.29	24.53**
L 788 × HYPS 152	4.89	3.32	9.32	-4.11	-7.32*	0.13	-10.52**	-13.94**	3.76
L 788 × MCU 5	-5.09	-6.92	2.44	-0.94	-5	4.31	-5.14	-10.24**	8.22*
L 788 × G COT 16	8.93	8.4	14.7	-2.01	-6.62	3.93	-17.25**	-20.87**	-4.59
L 770 × NA 1325	0.14	-1.49	-5.72	-0.77	-5.24	-2.23	3.51	1.87	14.99**
L 770 × L 604	18.02	12.91	8.06	3.04	1.78	7.63*	-1.81	-5.01	3.83
L 770 × SURABHI	2.01	-2.86	2.78	-0.93	-1.2	2.49	-1.94	-2.81	6.24
L 770 × RAH 1004	24.90**	23.37*	18.06	2.88	-1.94	1.18	-8.03**	-8.26*	0.79
L 770 × HYPS 152	7.77	4.12	6.87	-0.51	-2.75	5.07	0.96	0.03	11.39**

**Significant at 1% level * Significant at 5% level

Table 2. (cont…)

Hybrid	Seed cotton yield plant^{-1} (g)			2.5 % span length (mm)			Micronaire value (10^{-6} g/inch)		
	Mid	Better	NCS-145	Mid	Better	NCS-145	Mid	Better	NCS-145
L 770 × MCU 5	1.6	-5.03	4.52	-1.12	-4.1	5.3	3.44	2.63	12.18**
L 770 × G COT 16	22.32*	17.02	22.62*	-3.62	-7.14*	3.36	-7.38*	-7.68*	1.58
NA 1325 × L 604	8.37	5.34	-2.46	-0.23	-5.84	-0.43	10.84**	5.59	19.18**
NA 1325 × SURABHI	3.91	-2.58	3.08	4	-0.94	2.75	2.47	-0.03	12.84**
NA 1325 × RAH 1004	15.62	15.15	7.5	1.72	1.53	-4.7	10.51**	9.04**	23.08**
NA 1325 × HYPS 152	18.05	12.28	15.25	1.86	-4.82	2.83	1	0.32	13.24**
NA 1325 × MCU 5	20.80*	11.22	22.41*	0.61	-6.69	2.46	2.34	-0.06	12.81**
NA 1325 × G COT 16	20.78*	13.76	19.2	-0.83	-8.60*	1.73	5.45	4.12	17.53**
L 604 × SURABHI	6.1	-3.12	2.51	1.33	0.36	6.13	6.25*	3.69	11.32**
L 604 × RAH 1004	19.70*	15.9	8.19	-6.32	-11.73**	-6.66	16.21**	12.14**	23.21**
L 604 × HYPS 152	19.53*	10.67	13.6	-0.65	-1.71	6.2	2.41	-1.81	9.34*
L 604 × MCU 5	-1.39	-11.54	-2.64	-2.3	-4.11	5.29	-7.33*	-9.67**	-2.81
L 604 × G COT 16	-6.52	-14.27	-10.17	-1.08	-3.55	7.35	5.16	1.41	11.59**
SURABHI × RAH 1004	-4.52	-10.14	-4.92	3.41	-1.68	1.98	-7.99**	-9.04**	-0.07
SURABHI × HYPS 152	18.53*	16.76	23.54*	1.3	-0.72	7.26	-21.36**	-22.77**	-14.00**
SURABHI × MCU 5	1.44	-0.52	9.49	0.33	-2.45	7.12	-8.16**	-8.25*	-1.29
SURABHI × G COT 16	-5.96	-6.42	-0.98	2.08	-1.39	9.75*	-19.21**	-20.19**	-12.18**
RAH 1004 × HYPS 152	6.94	2.1	4.8	-3.31	-9.81**	-2.56	13.21**	12.45**	25.19**
RAH 1004 × MCU 5	10.37	2	12.26	-9.58**	-16.28**	-8.08*	12.74**	11.57**	22.58**
RAH 1004 × G COT 16	10.01	4.01	8.99	-4.28	-11.93**	-1.98	7.61**	7.53*	18.32**
HYPS 152 × MCU 5	-3.9	-7.14	2.2	0.65	-0.16	9.62*	-9.62**	-11.15**	-1.06
HYPS 152 × G COT 16	-9.26	-10.19	-5.89	-7.76*	-9.11**	1.16	-8.11**	-8.66**	1.72
MCU 5 × G COT 16	4.34	1.84	12.08	-2.79	-3.45	7.46	-0.94	-2.04	7.79*

**Significant at 1% level * Significant at 5% level

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Table 3. Percentage heterosis over mid parent, better parent and check for bundle strength, uniformity ratio and elongation per cent of cotton hybrids in three environments and pooled during *kharif*, 2013-14.

Hybrid	Bundle strength (g/tex)			Uniformity ratio			Elongation %		
	Mid	Better	NCS-145	Mid	Better	NCS-145	Mid	Better	NCS-145
NDLH 1938 × L 788	7.52*	5.13	2.72	-6.06**	-8.22**	-1.16	0.09	-2.34	1.75
NDLH 1938 × L 770	6.99*	5.01	1.8	-2.94	-6.95**	0.21	-0.57	-1.32	2.82
NDLH 1938 × NA 1325	-0.36	-0.59	-6.75*	-3.29	-5.17*	2.13	-1.05	-3.3	0.75
NDLH 1938 × L 604	10.81**	8.73**	5.78	-2.09	-6.54**	0.65	0.87	-2.36	1.73
NDLH 1938 × SURABHI	4.72	0.67	1.87	-2.03	-4.52*	2.83	1.24	1.17	5.41*
NDLH 1938 × RAH 1004	-1.01	-4.4	-4.18	0	-0.57	7.08**	0.6	-1.05	6.59**
NDLH 1938 × HYPS 152	4.39	0.39	1.5	-3.5	-6.08**	1.15	0.12	-1.02	3.13
NDLH 1938 × MCU 5	0.29	-6.82*	1.37	-3.89*	-6.69**	0.49	-1.52	-1.53	2.62
NDLH 1938 × G COT 16	5.35	-1.07	5.17	-6.94**	-9.08**	-2.08	-2.06	-2.37	2.37
L 788 × L 770	-0.04	-0.43	-2.71	2.14	0.19	2.92	0.74	-0.97	1.62
L 788 × NA 1325	-3.35	-5.28	-7.44*	-2.15	-2.52	0.91	0.87	0.71	0.16
L 788 × L 604	2.93	2.56	0.21	-0.33	-2.67	-0.01	2.97	2.13	1.24
L 788 × SURABHI	4.58	2.78	4.01	-4.80*	-5.04*	-2.44	-1.38	-3.71	0.2
L 788 × RAH 1004	2.91	1.62	1.85	-2.75	-4.46*	1.72	0.35	-3.64	3.79
L 788 × HYPS 152	-2.87	-4.5	-3.45	0.5	0.11	2.85	1.09	-0.24	1.57
L 788 × MCU 5	-1.43	-6.44*	1.78	-3.93*	-4.54*	-1.93	-0.4	-2.83	1.26
L 788 × G COT 16	1.76	-2.35	3.81	1.38	1.37	4.16	-0.72	-3.43	1.26
L 770 × NA 1325	-0.18	-1.79	-4.79	0.02	-2.26	1.17	-0.43	-1.97	0.6
L 770 × L 604	4.1	4.07	0.95	0.2	-0.24	-1.44	1.6	-0.93	1.66
L 770 × SURABHI	-4.19	-6.2	-5.08	0.46	-1.23	0.97	-4.47*	-5.14*	-1.29
L 770 × RAH 1004	-1.43	-3.04	-2.83	-5.23**	-8.64**	-2.73	-4.79*	-7.04**	0.13
L 770 × HYPS 152	0.56	-1.51	-0.42	-1.04	-2.57	-0.67	0.76	0.37	2.99

**Significant at 1% level * Significant at 5% level

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Table 3 (cont…)

Hybrid	Bundle strength (g/tex)			Uniformity ratio			Elongation %		
	Mid	Better	NCS-145	Mid	Better	NCS-145	Mid	Better	NCS-145
L 770 × MCU 5	-2.34	-7.66**	0.46	-3.49	-4.74*	-3.38	-1.14	-1.89	2.24
L 770 × G COT 16	4.08	-0.5	5.46	0.34	-1.59	1.12	-1.44	-2.5	2.24
NA 1325 × L 604	-0.59	-2.22	-5.16	-0.73	-3.41	-0.02	1.2	0.22	-0.33
NA 1325 × SURABHI	4.4	0.59	1.79	-1.13	-1.74	1.71	0.63	-1.6	2.4
NA 1325 × RAH 1004	-5.56	-8.58**	-8.38**	0.14	-1.25	5.13*	-2.79	-6.53**	0.69
NA 1325 × HYPS 152	1.15	-2.5	-1.42	-2.21	-2.95	0.46	0.41	-0.76	1.04
NA 1325 × MCU 5	-3.18	-9.84**	-1.92	-2.89	-3.86	-0.49	-2.23	-4.47	-0.44
NA 1325 × G COT 16	-0.17	-6.04*	-0.11	-1.12	-1.48	1.98	0.33	-2.26	2.48
L 604 × SURABHI	6.67*	4.46	5.71	2.93	0.76	3	2.08	-1.13	2.88
L 604 × RAH 1004	-4.21	-5.76	-5.54	2.78	-1.35	5.03*	-0.41	-5.13*	2.2
L 604 × HYPS 152	4.86	2.73	3.86	0.31	-1.67	0.24	4.63*	2.42	4.28
L 604 × MCU 5	-2.31	-7.61*	0.51	0.14	-1.6	-0.19	-3.1	-6.21**	-2.26
L 604 × G COT 16	1.04	-3.39	2.71	-1.9	-4.2	-1.56	1.7	-1.86	2.91
SURABHI × RAH 1004	-0.15	-0.63	0.56	-1.97	-3.92	2.29	-1.31	-2.99	4.5
SURABHI × HYPS 152	5.1	5.05	6.31	-4.99**	-5.12*	-3.01	-2.17	-3.22	0.71
SURABHI × MCU 5	-5.39*	-8.69**	-0.66	-3.22	-3.59	-1.45	-3.18	-3.26	0.82
SURABHI × G COT 16	3.04	0.56	6.91*	-5.42**	-5.67**	-3.07	-4.54*	-4.91*	-0.29
RAH 1004 × HYPS 152	-4.77	-5.18	-4.14	2.08	-0.09	6.37**	1.44	-1.34	6.28**
RAH 1004 × MCU 5	-7.36**	-11.00**	-3.18	-1.12	-3.46	2.78	-1.09	-2.7	4.81*
RAH 1004 × G COT 16	-6.51*	-9.18**	-3.45	2.11	0.33	6.82**	-3.79	-5.06*	2.26
HYPS 152 × MCU 5	-3.54	-6.95*	1.23	-3.65	-3.89	-2.02	-3.04	-4.15	-0.11
HYPS 152 × G COT 16	-7.78**	-10.04**	-4.36	-3.67	-4.05	-1.41	-4.52*	-5.90*	-1.33
MCU 5 × G COT 16	-2.74	-3.85	4.6	-1.74	-2.37	0.32	-2.39	-2.69	2.04

**Significant at 1% level * Significant at 5% level