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Combining Ability Analysis for Yield and Fibre Quality Traits in American Cotton (*Gossypium hirsutum* L.) Genotypes

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ABSTRACT

The present study was conducted with the aim of determining combining ability and variances for different traits and to identify the best combiners with respect to seed cotton yield and fiber quality. Forty eight F_1 hybrids along with parents were grown in randomized block design with three replications and the data were recorded for 14 characters namely, days to 1st flower, plant height, number of monopodial branch per plant, number of sympodial branch per plant, number of bolls/plant, boll weight, seed index, ginning out turn lint index, seed cotton yield per plant, uniformity index, fibre strength, upper half mean length and micronaire value. The variance gca/sca ratio depicted predominance of non-additive gene action for days to first flowering, number of bolls per plant, boll weight, seed index, seed cotton yield per plant, fibres strength, uniformity index, upper half mean length and micronaire value. The characters lint index and number of monopods per plant revealed non-additive and additive gene action while plant height, number of sympods per plant and ginning out turn were predominantly controlled by additive gene action. The lines H1471, H 1472, H 1522 and H 1098i and the tester C 201 were found best combiners to be considered for future breeding programme. The cross combination H 1480 × C 201 recorded highest significant SCA effects for seed cotton yield per plant followed by H1098i × C 211 and H 1522 × C210.

Keywords**:** Combining ability, American cotton genotypes, Line x tester, *Gossypium hirsutum*

Introduction

Cotton is the leading natural fiber and grown in more than 50 countries in the world. It is one of the commodities with global importance and high commercial value providing income to millions of farmers worldwide. India is at rank number one in terms of area under cotton cultivation and raw cotton production in the world. Per hectare productivity in India still much lower compared to many leading cotton growing countries. (ICAR-AICRP (Cotton), Annual Report 2020-21). Development of new varieties/ hybrids of different cultivated cotton species with high lint yield and lint quality is the primary objective of all cotton breeders. For registration of a new variety, it is required to test for DUS traits. In the cotton crop, a plethora of studies has been conducted for the classification of genotypes on the basis of DUS traits (Sagar et al. 2019; Kumar et al. 2021a). The yield contributing traits and fibre quality parameters are the important character in cotton improvement programme. Heterosis breeding is an important breeding technique to facilitate yield enhancement and help to enrich many other desirable quantitative and qualitative traits in crops. Generally, the development of cotton hybrids/ varieties for higher lint yield with desirable fibre quality parameters is the most important objective of the cotton improvement programs. Cotton fiber quality is expressible by a multitude of measurements (Hake et al. 1996). Fiber length, fiber fineness, fiber strength, short fiber index and the spinning consistency index

are the most important fiber quality traits (Ekinci and Basbag 2018). However, further increase in raw cotton productivity is a challenging mission for breeders due to extensive use of local available germplasm (Tyagi et al. 2014; Zhang et al. 2020 and Kumar et al. 2021b) and the high impact of environmental fluctuations on the yield and yield contributing traits.

To achieve higher lint yield with good fibre quality in cotton, it is essential to select appropriate parents for a successful breeding programme. Line x Tester analysis provides a systematic approach for finding of suitable parents and F_1 hybrids for various investigated traits. Combining ability describes the breeding value of parental lines in hybrid production. Sprague and Tatum (1942) reported that GCA effects were due to additive type of gene action however SCA effects were due to genes which are non-additive (dominant and epistatic) type of gene action.

The present investigation was conducted to estimate GCA effects of Parents as well as the SCA effects of the crosses for yield and fibre quality traits in American cotton and to determine appropriate parents and hybrids for the tested characters.

Materials and Methods

The materials used in present investigation were selected based on their genetic diversity. The parental materials were selected from different experiment sown during *Kharif* 2016 at Cotton section, Department of Genetics and Plant Breeding, research area (Table 1). The selected material comprising of sixteen parents (12 lines + 4 testers) were grown in crossing block during *Kharif* 2017 and crossing were made by Line x Tester mating design which results into development of forty eight F_1 hybrids.

The 48 F_1 hybrids and their parents (16) i.e. twelve lines and four testers along with the check hybrid HHH 223 were grown during *Kharif* 2018. Each entry was sown in two rows of 3.0 meter length adopting a spacing of 67.5 cm between rows and 60 cm between the plants in randomized block design with three replications. All the recommended packages of practices were followed from sowing to picking. Five competitive plants were randomly selected and observations were recorded from them from each entry i.e. parents, hybrids and check for days 1st flowering, plant height (cm), number of monopods per plant, number of sympods per plant, number of bolls per plant, boll weight (g), seed index (g), seed cotton yield per plant (g), ginning outturn (%) and lint index (g). Lint samples were sent to CIRCOT Lab Sirsa for analysis of four fibre quality traits, uniformity index (%), fibre strength (g/tex), upper half mean length (mm) and micronaire value (µg /inch).

The analysis of variance was carried out as per the standard statistical method to test the significance of differences among the tested materials. Evaluation of hybrids and parents involved in line x tester analysis was taken up separately by conducting a relevant RBD analysis first and later the variation among the crosses and parents was partitioned through combining ability analysis. The genetic variation among the F_1 hybrids was further partitioned into genetic components attributable to general combining ability (GCA) and specific combining ability (SCA) following the method as reported by Kempthorne (1957).

Results and Discussion

The analysis of variance for Line x Tester for different characters of American cotton genotypes as depicted in the table 2 indicated that significant variations were present among the genotypes for the characters i.e. days to 1st flower, plant height, number of monopods per plant, number of bolls per plant, boll weight, seed index, seed cotton yield per plant, ginning outturn, lint index, uniformity index, fibre strength, upper half mean length and micronaire value except for number of sympodial branches per plant revealing sufficient amount of wide genetic diversity as indicated by the significance of the mean squares.

The forty eight cross combinations obtained by crossing twelve lines and four testers were subjected into line x tester (L x T) analysis. The analysis revealed significant differences among lines for all parameters under investigation except number of monopods per plant, number of sympods/plant and all fiber quality parameters (Table 2). The significant differences were also observed among the testers for all traits except for number of sympods/plant and for all fiber quality parameters. Line x tester interactions was significant for number of bolls per plant, seed cotton yield, seed index, ginning out turn, lint index and fibre strength.

The study revealed greater magnitude of SCA variance than GCA in all the characters except for plant height, number of monopods per plant, number of sympods per plant and ginning out turn depicting the role of non- additive gene action for the said character. Therefore, heterosis breeding may be rewarding for the improvement of the said characters in cotton. The estimate of GCA and SCA variances was presented in Table 3. The ratio of σ^2GCA/ σ^2SCA was less than unity for the characters *viz.* Days to 1st flower, number of bolls per plant, boll weight, seed index, seed cotton yield and lint index indicating preponderance of non additive gene action (dominance and epistasis), which is an important in exploitation of heterosis through hybrid breeding. Several authors Vekariya et al. (2017),

Shinde et al. (2018) Swetha et al. (2018), Chinchane et al. (2018) and Premlatha et al. (2020) have reported the predominance of SCA variance in cotton for morphological, yield and its component characters. Similar results were observed for fibre quality traits *viz*., upper half mean length, fibre strength and micronaire value i.e. the ratio of σ^2GCA / σ^2SCA was less than unity. Variance of GCA effects were higher than variance of SCA effects (σ^2GCA / σ^2SCA)>1 for the characters plant height, number of sympods per plant and ginning outturn which indicated that these traits are controlled by additive gene action. The number of monopods per plant and lint index observed the ratio of σ^2GCA / σ^2SCA near to unity which indicated that additive gene is prevailing with non-additive gene actions for the expression of these traits. The results are in agreement with earlier reported the findings of Lukonge et al. 2008; Bolek et al. 2010 and Ekinci and Basbag 2018.

The GCA effects of parents presented in table 4 revealed that among female parents the genotype H 1471, H 1472, H 1522 and H 1098i were best combiners for seed cotton yield. The genotypes observed good general combiner for days to first flower *i.e.* earliness (H 1471), plant height (H 1480), no. of sympods per plant (H 1518), no. of bolls per plant (H 1480), boll weight (H 1522) seed index (H 1519), ginning out turn (H 1518) and lint index (H 1518). For fibre characters i.e. uniformity index, UHML, fiber strength and micronnaire value good general combiners are H 1519, H 1523, H 1471 and H 1522 respectively. Among testers C 201 was the best combiner for earliness and good general combiner for seed cotton yield/plant, boll weight, number of monopods/plant, seed index, ginning out turn and lint index. Thus, high gca effect in desirable indicates the presence of additive genes for that character in the parent therefore, selection is effective for improvement of the characters. Bayyapu Reddy et al. (2017), Bilwal et al. (2018) also reported different parents with good general combining ability for seed cotton yield and yield attributing characters.

The specific combining ability effects are usually used to make out the best cross combinations for hybrid production. The SCA effects of the crosses for various characters were presented in table 5. Among forty eight hybrids, the following nine hybrids, H 1472 × C 202, H 1480 × C 201, H 1488 × C 210, H 1508 × C 210, H 1518 × C 201, H 1518 x C 202, H 1522 × C 210, H 1523 × C 211 and H 1098i × C 211 registered positive and significant specific combining ability for seed cotton yield/plant. Similar findings were reported by Bayyapu Reddy (2017) and Premalatha et al. (2020). The crosses H 1471 × C 201, H 1523× C 202, H 1471 × C 211, H 1471 × C 211, H 1523 × C 202, H 1489 × C 210, H 1098i × C 202, H 1508 × C 211, H 1472 × C 201, H 1520 × C 211, H 1508 × C 211, H 1520 × C 211 and H 1520 × C 201 recorded the highest SCA effects for days to 1st flowering, plant height, number of monopods/plant, number of sympods/plant, number of bolls/plant, boll weight, seed index, ginning outturn, lint index, Uniformity index, upper half mean length, fiber strength and micronaire value, respectively. The SCA effects may not only be the appropriate choice for exploitation of heterosis, because the hybrids with low mean value may also depict high sca effect. Hence, the cross having significant sca effects should be evaluated under different locations over the years prior to suggest for commercial cultivation.

Conclusions

The characters, days to 1st flowering, number of bolls per plant, boll weight, seed index, seed cotton yield per plant, uniformity index, upper half mean length, fibre strength and micronaire value revealed predominance of non-additive gene action. Additive gene action was depicted by the characters, plant height and number of sympods per plant and ginning out turn. The characters, number of monopods per plant and lint index were governed by both additive and non-additive gene action. It may be concluded that H1471, H1472, H 1522, H1098i and C 201 were the best parents on the basis of their gca effects for yield and yield contributing traits as well as fiber quality traits. The crosses involving these parents would bring about superior hybrids. The cross combinations H 1480 × C 201, H 1098i × C 211 and H 1522 × C 210 were the best based on their high sca effects for seed cotton yield per plant. Therefore, these cross combination may be utilized as hybrid cultivar after thorough evaluation over time and space.

Table 1. Details of experimental genotypes with yield performance.

No.	Females (Lines)	Seed Cotton Yield (kg/ha)		
		2016	2017	Mean
1	H1471	3534	1914	2724
2	H1472	3179	2083	2631
3	H1480	3272	2454	2863
4	H1488	3441	2222	2832
5	H1489	3595	2917	3256
6	H1508	3503	2346	2925
7	H1518	3025	2145	2585
8	H1519	2819	3302	3061
9	H1520	2767	2978	2873
10	H1522	3354	1960	2657
11	H1523	3519	3256	3388
12	H1098i	2932	2500	2716
	Males (Testers)			
1	C-201	2787	-	2787
2	C-202	2316	-	2316
3	C-210	2187	-	2187
4	C-211	1952	-	1952

Table 2. Analysis of variance for Line x Tester for different characters in American cotton (*G. hirsutum* L.).

Source of Variation	Df	Days to 1st Flower	Plant Height	Number of Monopods Per Plant	Number of Sympods Per Plant	Number of Bolls Per Plant	Boll Weight	Seed Index	Seed Cotton Yield	Ginning Out Turn	Lint Index	UI	Fibre Strength	Micronaire Value	UHML
Replication	2	6.05	500.69	2.30	446.02	72.44	0.32	0.05	131.58	15.44	0.88	0.002	0.30	0.14	0.03
Crosses	47	16.79**	203.43	0.39	10.07	42.91**	0.42	0.92**	1319.48**	20.09**	1.09**	0.62*	3.86**	0.19**	1.92
Line	11	19.54**	471.36**	0.41	19.93	88.76**	0.50*	1.85**	1175.59**	47.01*	1.39**	0.82	5.75	0.41	2.76
Tester	3	60.92**	607.94**	2.00**	11.41	26.62*	0.93**	1.04**	6376.16**	69.97*	5.66**	0.11	1.06	0.03	0.60
Line×tester	33	11.87	77.35	0.24	6.67	30.77**	0.34	0.60**	907.74**	6.58**	0.57*	0.60	3.48*	0.13	1.75
Error	94	4.06	87.99	0.31	6.83	6.78	0.16	0.09	167.55	2.75	0.15	0.39	1.65	0.13	1.39

* Significant 5 at p=0.05, ** Significant at=0.01, UI= Uniformity Index, UHML=Upper Half Mean Length

Table 3. Estimates of genetic components of variance for different characters in American cotton (*G. hirsutum* L.).

Variance	Days to 1st Flower	Plant Height	Number of Monopods Per Plant	Number of Sympods Per Plant	Number of Bolls Per Plant	Boll Weight	Seed Index	Seed Cotton Yield	Ginning Out Turn	Lint Index	UI	Fibre Strength	Micronaire Value	UHML
COV(HS)	1.18	19.26	0.05	0.38	1.02	0.02	0.04	119.51	2.16	0.12	0.06	0.13	0.14	0.00
COV FS	4.97	34.98	0.15	0.70	10.03	0.09	0.24	485.74	5.60	0.38	0.37	1.32	1.77	0.10
σ^2GCA	1.18	19.26	0.05	0.38	1.02	0.02	0.04	119.51	2.16	0.12	0.06	0.13	0.14	0.00
σ^2SCA	2.60	-3.55	0.05	-0.05	8.00	0.06	0.17	246.73	1.28	0.14	0.25	1.07	1.48	0.11
σ^2GCA/ σ^2SCA	0.45	-5.43	1.04	-6.94	0.13	0.25	0.20	0.48	1.69	0.91	0.26	0.12	0.10	-0.02

* Significant 5 at p=0.05, ** Significant at=0.01, UI= Uniformity Index, UHML=Upper Half Mean Length

Table 4. Estimation of general combining ability effects of parents for different characters in American cotton (*G. hirsutum* L.).

No.	Parents	Days to 1st Flower	Plant Height	Number of Monopods/ Plant	Number of Sympods/ Plant	Number of Bolls/Plant	Boll Weight	Seed Index	Seed Cotton Yield/Plant	Ginning Out Turn	Lint Index	UI	UHML	Fibre Strength	Micronaire Value
A. Females															
1	H1471	-2.76**	-2.57	-0.11	-1.35	-1.85*	-0.04	-0.05	12.42**	-0.19	-0.07	0.19	0.56	1.08**	-0.20*
2	H1472	-2.26	0.35	0.06	0.81	2.32**	0.14	0.34**	13.00**	-1.01**	0.08	-0.14	-0.19	-0.27	0.02
3	H1480	-0.01	9.76*	0.22	0.98	5.15**	0.06	0.56**	5.00	-3.17**	-0.28*	0.02	0.20	-0.20	-0.18
4	H1488	0.74	5.51	-0.19	0.56	2.15**	-0.06	0.18*	3.17	-2.56**	-0.43**	-0.23	-0.38	-0.27	0.06
5	H1489	-0.01	4.10	0.06	0.98	1.99**	0.09	-0.57**	0.17	-0.89	-0.62**	-0.31	-0.65	-0.98	-0.03
6	H1508	1.57**	-14.65**	-0.28	-0.85	-4.35**	-0.36**	-0.01	-13.58**	-0.77	-0.19	-0.07	-0.02	0.29	-0.14
7	H1518	0.49	3.82	0.06	2.31**	-0.18	0.26*	-0.25**	-8.42*	3.63**	0.62**	0.17	0.23	0.42	0.28**
8	H1519	-0.01	3.26	-0.03	0.65	-0.43	0.04	0.65**	-8.67*	-0.90	0.26*	0.47**	0.47	0.57	0.12
9	H1520	0.10	0.68	-0.19	-0.02	-2.18**	-0.01	0.11	-13.75**	1.14*	0.33*	0.37*	0.60	0.15	0.14
10	H1522	0.74	-4.15	0.31	-0.52	1.24	0.33**	-0.10	8.92**	0.73	0.09	-0.06	-0.52	-0.40	0.27**
11	H1523	0.90	-4.82	-0.11	-2.27*	-1.93**	-0.24*	-0.54**	-6.83*	2.37**	0.12	-0.39*	-0.71*	-1.22*	-0.01
12	H1098i	0.74	-1.32	0.22	-1.27	-1.93**	-0.24*	-0.33**	8.58**	1.62**	0.07	-0.01	0.40	0.83	-0.31*
SE (d)		0.59	3.30	0.17	0.88	0.74	0.12	0.08	3.43	0.51	0.11	0.18	0.34	0.38	0.09
CD	5%	1.07	6.46	0.33	1.73	1.46	0.24	0.15	6.72	0.99	0.22	0.36	0.68	0.75	0.18
CD	1%	1.41	7.44	0.44	2.28	1.92	0.31	0.20	8.85	1.31	0.29	0.47	0.89	1.00	0.24
B. Males															
1	C 201	-1.54**	-.4.86	-0.22*	-0.83	-1.18**	0.21**	0.13**	12.08**	2.02**	0.57**	-0.01	0.02	-0.10	-0.16
2	C 202	-0.60	-5.63**	-0.06	0.12	-0.07	-0.15*	-0.05	-19.00**	-0.18	-0.09	0.07	0.12	0.15	0.04
3	C 210	1.24**	3.29	0.33**	0.40	0.49	-0.09	0.14**	3.00	-0.88*	-0.11	-0.07	-0.18	0.14	-0.00
4	C 211	0.90*	2.82	-0.06	0.31	0.76	0.03	-0.22**	3.92*	-0.96*	-0.36**	0.02	0.05	-0.19	-0.02
SE (d)		0.32	1.09	0.10	0.62	0.43	0.07	0.04	1.98	0.29	0.06	0.10	0.20	0.22	0.053
CD	5%	0.62	3.73	0.19	1.00	0.84	0.14	0.09	3.90	0.57	0.13	0.21	0.39	0.44	0.11
CD	1%	0.81	4.91	0.26	1.32	1.11	0.18	0.11	5.11	0.75	0.17	0.27	0.52	1.00	0.14

* Significant 5 at p=0.05, ** Significant at=0.01, UI= Uniformity Index, UHML = Upper Half Mean Length

Table 5. Estimation of specific combining ability effects of crosses for different characters in American cotton (*G. hirsutum* L.).

No.	Hybrids	Days to First Flower	Plant Height	Number of Monopods Per Plant	Number of Sympods Per Plant	Number of Bolls Per Plant	Boll Weight	Seed Index	Seed Cotton Yield	Ginning Out Turn	Lint Index	UI	UHML	Fibre Strength	Micronaire Value
1	H1471× C201	-4.79**	1.82	-0.03	-0.92	-1.90	-0.13	0.41**	8.33	-0.45	0.22	-0.65	-1.10	-1.35	0.03
2	H1471× C202	1.93	-9.71	-0.53	-0.20	-1.35	-0.23	-0.37*	4.25	2.89**	0.31	0.26	0.73	0.60	-0.25
3	H1471× C210	1.43	-0.63	-0.08	-1.81	0.76	0.24	-0.10	-21.75**	-0.84	-0.24	0.39	0.63	0.54	-0.01
4	H1471× C211	1.43	8.51	0.47	2.94	2.49	0.12	0.06	8.67	-1.60	-0.29	-0.01	-0.26	0.21	0.23
5	H1472× C201	4.04**	-4.76	-0.19	-1.76	-5.74**	0.36	0.79**	9.92	1.94	1.07**	-0.32	-0.18	-0.14	0.08
6	H1472× C202	-3.57**	6.38	0.31	1.63	2.82	0.18	0.11	16.00*	-0.43	-0.04	-0.40	-0.81	-0.85	0.10
7	H1472× C210	1.60	-3.54	-0.42	0.02	0.93	-0.94**	-0.00	1.00	0.54	-0.02	0.07	0.16	-0.31	0.07
8	H1472× C211	-2.07	1.93	0.31	0.10	1.99	0.40	-0.84**	-26.92**	-2.05*	-1.00**	0.65	0.83	1.29	-0.25
9	H1480× C201	-1.21	2.82	-0.03	0.08	0.43	-0.23	-0.13	26.25**	0.59	-0.01	0.18	-0.07	0.66	0.11
10	H1480× C202	0.51	-1.38	0.14	-0.20	-0.35	0.27	0.12	-5.33	0.13	0.12	-0.23	0.67	0.02	0.02
11	H1480× C210	-0.32	-0.96	0.08	-0.15	0.43	0.011	-0.01	-6.33	-0.30	-0.07	0.23	-0.60	0.19	-0.21
12	H1480× C211	1.01	-0.49	-0.19	0.27	-0.51	-0.05	0.02	-14.58*	-0.42	-0.05	-0.18	0.14	-0.87	0.08
13	H1488× C201	1.71	2.74	0.06	0.16	-0.90	0.09	-0.45**	-16.58*	-1.95	-0.76*	-0.24	-0.02	-1.01	0.31
14	H1488× C202	-2.24*	-5.13	-0.11	-0.45	-1.35	-0.28	-0.10	-9.17	0.12	0.00	0.69	1.22	1.89*	-0.31
15	H1488× C210	0.60	-1.04	0.17	-0.73	-0.57	-0.07	0.31*	21.50**	0.96	0.42	0.15	-0.12	0.23	-0.01
16	H1488× C211	-0.07	3.43	-0.11	1.02	2.82	0.27	0.23	4.25	0.87	0.34	-0.60	-1.08	-1.11	0.01
17	H1489× C201	-0.21	-4.18	0.47	0.08	-1.07	0.07	0.13	2.08	-0.76	-0.13	0.51	0.58	1.01	0.10
18	H1489× C202	0.85	5.63	-0.03	-0.20	-1.51	-0.37	-0.18	10.17	1.04	0.06	0.44	0.85	1.07	-0.09
19	H1489× C210	-1.99	4.04	-0.42	1.52	3.93**	0.51*	0.03	-20.17**	0.35	0.14	-0.43	-0.58	-0.76	0.09
20	H1489× C211	1.35	-5.49	-0.03	-1.40	1.35	-0.22	0.02	7.92	-0.64	-0.07	-0.52	-0.85	-1.32	-0.10
21	H1508× C201	1.54	3.90	-0.19	0.58	0.26	0.26	-0.20	-11.83	-0.94	-0.37	-0.39	-0.49	-0.63	0.00
22	H1508× C202	0.26	-6.63	-0.03	-3.04	-5.18**	-0.12	0.05	-5.42	-1.07	-0.14	-0.34	-1.13	-1.22	-0.03
23	H1508× C210	-1.57	0.79	0.25	1.69	3.60*	-0.11	0.33*	17.58*	-1.10	-0.02	-0.08	0.08	-0.19	0.14
24	H1508× C211	-0.24	1.93	-0.03	-0.77	1.32	-0.03	-0.18	-0.33	3.11**	0.53*	0.81	1.54*	2.04**	-0.11
25	H1518× C201	-0.04	3.07	-0.19	1.41	2.76	0.04	0.35*	16.33*	-1.67	-0.07	0.57	0.47	1.14	-0.11
26	H1518× C202	-0.32	0.88	-0.36	-1.20	-1.68	0.40	0.03	19.75*	0.79	0.16	0.13	0.60	0.51	-0.00

Continuing Table 5

No.	Hybrids	Days to First Flower	Plant Height	Number of Monopods Per Plant	Number of Sympods Per Plant	Number of Bolls Per Plant	Boll Weight	Seed Index	Seed Cotton Yield	Ginning Out Turn	Lint Index	UI	UHML	Fibre Strength	Micronaire Value
27	H1518× C210	0.51	0.29	0.25	-0.48	1.76	-0.52*	-0.42*	-7.58	0.17	-0.29	-0.28	-0.25	-0.26	-0.06
28	H1518× C211	-0.15	-4.24	0.31	0.27	-2.85*	0.08	0.10	-28.50**	0.71	0.20	-0.42	-0.89	-1.40	0.17
29	H1519× C201	-0.21	-4.01	0.22	1.41	1.01	-0.21	-0.75**	-5.42	-0.47	-0.67**	0.06	0.45	0.16	0.07
30	H1519× C202	-2.15*	2.46	-0.28	-0.20	1.57	0.22	0.20	9.00	-0.47	0.05	0.32	0.31	0.29	0.10
31	H1519× C210	1.35	6.54	0.00	-0.48	-1.99	0.29	0.58**	-4.83	-0.30	0.37	-0.28	-0.72	-0.48	-0.06
32	H1519× C211	1.01	-4.99	0.06	-0.73	-0.60	-0.30	-0.03	0.75	1.25	0.25	-0.10	-0.04	0.03	-0.11
33	H1520× C201	-3.13**	-0.10	-0.28	0.41	-0.57	0.24	0.28	-5.33	-0.12	0.22	0.21	0.50	-0.04	-0.39*
34	H1520× C202	1.26	7.04	0.22	2.47	1.32	0.07	0.24	-8.25	-1.12	-0.06	-0.64	-0.76	-1.74*	0.23
35	H1520× C210	0.43	-4.88	0.17	-2.15	-2.90*	0.21	-0.46**	11.42	0.86	-0.14	-0.34	-0.79	-0.46	0.11
36	H1520× C211	1.43	-2.07	-0.11	-0.73	2.15*	-0.52**	-0.07	2.17	0.37	-0.02	0.78*	1.05	2.24**	0.04
37	H1522× C201	1.04	2.74	-0.11	-0.42	1.68	-0.03	0.17	10.00	1.49	0.49*	-0.17	-0.50	0.10	0.06
38	H1522× C202	1.10	-5.13	0.39	-0.70	-1.76	-0.13	-0.85**	-32.25**	0.23	-0.62**	-0.05	-0.31	-0.46	-0.04
39	H1522× C210	0.60	-2.04	-0.00	0.35	-2.99	0.08	0.40**	23.08**	0.13	0.34	0.12	0.49	0.29	-0.04
40	H1522× C211	-2.74*	4.43	-0.28	0.77	3.07**	0.08	0.28	-0.83	-1.85	-0.21	0.10	0.32	0.07	0.016
41	H1523× C201	0.21	6.60	-0.03	-1.34	1.51	-0.13	0.17	-17.25*	0.66	0.29	0.17	0.01	-0.53	-0.04
42	H1523× C202	1.60	8.21	0.14	1.72	5.07**	-0.30	0.01	1.83	0.99	0.19	-0.15	-0.02	-0.01	0.48*
43	H1523× C210	-1.90	0.63	0.08	2.10	1.85	0.11	-0.54**	-5.83	-1.43	-0.70**	0.18	0.22	0.43	-0.06
44	H1523× C211	0.10	-2.24	-0.19	-2.43	-8.43**	0.32	0.38*	21.25**	-0.22	0.22	-0.20	-0.22	0.11	-0.39*
45	H1098i×C201	1.04	2.57	0.31	0.33	2.51	-0.33	-0.77**	-17.00*	1.67	-0.29	0.07	0.35	0.62	-0.26
46	H1098i×C202	0.76	2.63	0.14	-.0.38	2.40	0.30	0.81**	-0.58	-3.10**	-0.03	-0.03	-0.08	-0.09	-0.20
47	H1098i×C210	-0.74	0.79	-0.25	0.10	-4.82**	0.18	-0.05	-8.58	0.97	0.22	0.27	0.27	0.79	0.04
48	H1098i×C211	-1.07	0.74	-0.19	-0.81	-0.10	-0.15	-0.01	26.17**	0.46	0.10	-0.31	-0.55	-1.29	0.39*
	SE_d	**1.10**	**6.60**	**0.34**	**1.77**	**1.48**	**0.24**	**0.15**	**6.86**	**1.01**	**0.23**	**0.36**	**0.68**	**0.76**	**0.18**
	CD 5%	**2.14**	**12.93**	**0.67**	**3.47**	**2.91**	**0.47**	**0.30**	**13.44**	**1.98**	**0.44**	**0.71**	**1.35**	**1.51**	**0.37**
	CD 1%	**2.82**	**17.01**	**0.89**	**5.24**	**3.83**	**0.62**	**0.39**	**17.70**	**2.61**	**0.58**	**0.95**	**1.79**	**2.00**	**0.48**

* Significant 5 at p=0.05, ** Significant at=0.01, UI= Uniformity Index, UHML = Upper Half Mean Length

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