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Heterosis and combining ability in gobi sarson *(Brassica napus* L.)

M.N. Khan*, Shafiq A. Wani and Sartaj A. Shah
Division of Plant Breeding and Genetics, S.K. Univ. of Agricultural Sciences & Tech. of Kashmir, Shalimar SRINAGAR(J&K) INDIA

ABSTRACT
Eight gobi sarson (*B. napus* L) genotypes namely NRCG-58-, NRCG-32, NRCG-29, ISN-602, ISN-223, ISN-530, NRCG-57 and SGS-16 were crossed in all the possible combination without reciprocals to study heterosis and combining ability. Estimates of heterosis over mid and better parents exhibited a wide range for seed yield, oil content as well as morphological and yield component traits. The high manifestation of heterobeltiosis was observed for seed yield ranging from 40.86 to 191.49 per cent. The crosses NRCG-58 x SGS-16 and NRCG-29 x ISN-530 were observed to have fairly high heterosis for seed yield, besides plant height, primary branches plant^{-1}, siliquae on main raceme, siliquae plant^{-1} and 1000-seed weight. Estimated variance due to gca and sca were significant indicating involvement of both additive and non-additive gene effects in controlling the expression of all the traits. The magnitude of dominance variance was higher than the corresponding value of additive variance for all the traits. None of the parents/crosses was found to be good general/specific combiner for all the traits. NRCG-57,-NRCG-58 and SGS-16 were found to be good general combiners for seed yield and some of its component traits and could be a source of elite gene pool for future breeding programmes. Four crosses viz. ISN-530 x NRCG-57,-NRCG-58 x SGS-16, NRCG-58 x NRCG32 and NRCG-32 x ISN-530 exhibited superior per se performance as well as superior sca for seed yield and some of the yield component. The crosses were mostly the result of high x low general combiners, which can be exploited for realizing transgressive segregants in advanced generations for seed yield and other important traits.

Key words : HSeterosis, Gobi sarson.

INTRODUCTION

Gobi sarson (*Brassica napus* L.) is a potential oilseed crop for Kashmir valley provided the genotypes that fit in the paddy, sarson rotation. In order to achieve a varietal improvement to develop early maturing cultivars having better yielding ability with resilience to biotic and abiotic stress conditions is of prime importance. To follow such objectives it is essential to generate information on the genetic architecture of breeding materials in rape seed crops. The analysis of combining ability is used to assess the nicking ability of genotypes and thus, helps in identifying parents which are likely to be useful to get desirable segregants in a hybridization programme. The effective exploitation of heterosis for seed yield, and its component traits have been reported in gobhi sarson. Thus, the present study was therefore, under taken to estimate heterosis and combining ability of selected gobhi sarson cultivars.

MATERIALS AND METHODS

The experimental materials consisted of eight diverse genotypes viz. NRCG-58, NRCG-32, NRCG-29, ISN-602, ISN-223, ISN-530, NRCG-57 and SGS-16 and their 28 F_1's (excluding reciprocals) obtained through diallel cross. The trial with parents and 28 crosses was laid out in a randomized block design with three replications during rabi, 2002.04. The material was planted in three rows of 5 m length with row to row distance of 30 cm and plant to plant distance 10 cm. Data for 11 characters viz. plant height (cm), primary branches plant^{-1}, secondary branches plant^{-1}, siliquae on main raceme, siliquae plant^{-1}, seed siliqua^{-1}, days to maturity, 1000-seed weight (g), seed yield plant^{-1} (g) and oil content (%) were recorded on ten random selected plants from each treatment. Heterosis was estimated as per [Hayes *et al*. 1965] and combining ability as per model-I and method-II of [Griffing, 1956].

RESULTS AND DISCUSSIONS

The findings of the present investigation revealed that considerable heterosis over mid as well better parent exhibited in most of the hybrids for seed yield, oil content, morphological, maturity and yield component traits (Table 1). However, heterosis over better was comparatively lower for days to 50% flowering and days to maturity. The maximum economic heterosis (191.4%) was expressed by crossed NRCG-58 x SGS-16 and minimum (40.86%) expressed by crossed ISN-223 x ISN-530. For morphological characters viz. Plant height, primary branches plant^{-1} and secondary branches plant^{-1}, the significant positive heterobeltiosis was observed in NRCG-58 x ISN-530, NRCG-29 x ISN-530 and NRCG-29 x NRCG-57 crosses. These components were essential for production of high dry matter for realizing high yield. The cross combination NRCG-58 x NRCG-57, NRCG-229 x ISN-530, NRCG-32 x ISN-530 and NRCG-58 x SGS-16 exhibited significant positive heterobeltiosis for the yield component traits viz. siliquae on main raceme, siliquae plant^{-1}, seed siliqua^{-1} and 1000-seed weight. Similarly, high heterobeltiosis was observed in days to 50% flowering and maturity trait by ISN-530 x NRCG-57 cross and oil content by SGS-16 x NRCG-57 cross. This is in agreement with the findings of [Prasad and Singh 1985; Yadav *et al*., 1997 and Ghosh *et al*., 2002.]. The high heterotic values of crosses in most of the traits might be due to the presence of different gene or gene groups, separately in the both the parents and when they were brought together, they nicked well for that particular character or might be due to non-allelic interaction (dominance or epistatic or both).

Hybrids, NRCG-58 x SGS-16 followed by NRCG-29 x ISN-530 and NRCG-58 x ISN0-602 recorded high heterotic, besides some yield component traits viz. Siliquae on main raceme, siliquae plant^{-1} and 1000-seed weight indicating the additive or synergistic effect of the component characters on seed yield the same as also reported by [Thakur and Sagwal, 1997 ; Singh *et al*., 1995 and Tyagi *et al*., 2000].

Analysis of variance for combining ability (Table 2) revealed that general combining ability and specific combining ability variance were highly significant for all the traits indicating that both additive and non-additive gene action were important for the characters studied. However, the magnitude of dominance variance was higher than corresponding value of additive variance for all the traits suggesting that biparental or selective mating or any other forms of recurrent selection in early generations were more useful to exploit non-additive gene action in improvement of these characters. These results are in agreement with [Laban and Jindal 1982 ; Thakral *et al*., 2000 and Kant and Gulati, 2001]. A perusal of gca effects (Table 3) revealed that the parent NRCG-58 was a good general combiner for morphological traits viz. plant height, primary branches plant^{-1}, secondary branches plant^{-1}. NRCG-32 was the good general combiner for some yield

***Author for correspondence**

Table 1 : Heterosis (percent) over mid and better parent for eleven quantitative characters in gobhi sarson (*Brassica napus* L.)

Crosses		Days to 50% flowering	Plant height (cm)	Primary branches plant $^{-1}$	Secondary branches plant^{-1}	Siliquae on main raceme	Siliquae plant^{-1}	Seed Siliqua^{-1}	Days to maturity	1,000-seed weight (g)	Seed yield plant^{-1} (g)	Oil content (%)
1		2	3	4	5	6	7	8	9	10	11	12
NRCG-58 X NRCG-32	M.P.	0.97*	22.08*	49.26**	18.63**	70.33**	90.98**	3.86**	1.74**	37.05**	160.20**	3.15**
	B.P.	1.24**	14.38**	39.04**	8.33**	44.83**	71.29**	-8.12**	2.29**	19.74**	142.90**	2.26**
NRCG-58 X NRCG-29	M.P.	0.09	21.48**	59.66**	0.88**	67.34**	30.43**	22.49**	1.35**	52.06**	124.05**	5.11**
	B.P.	0.35	9.24**	47.62**	-1.04**	44.86**	29.89**	11.43**	1.49**	35.61**	102.05**	1.33**
NRCG-58 X ISN-602	M.P.	1.41**	21.94**	40.00**	21.20**	10.29**	40.39**	17.94**	1.54**	40.13**	167.14**	11.01**
	B.P.	1.59**	17.06**	35.82**	19.10**	2.26**	26.48**	-3.39**	1.89**	24.73**	156.83**	10.08**
NRCG-58 X SGS-16	M.P.	1.96**	19.16**	48.25**	-7.51**	34.03**	24.02**	-0.08	-1.00**	98.34**	201.88**	17.88**
	B.P.	3.06**	13.51**	34.13**	-10.93**	9.76**	14.90**	-2.13**	0.54	96.23**	191.49**	11.06**
NRCG-58 X ISN-223	M.P.	2.95**	18.65**	40.60**	11.99**	5.93**	20.59**	-7.01**	1.96**	46.56**	92.03**	1.33**
	B.P.	4.74**	15.02**	33.57**	8.68**	-3.09**	10.54**	-8.98**	2.31**	43.13**	85.89**	-3.30**
NRCG-58 X ISN-530	M.P.	0.35	31.89**	52.63**	19.10**	14.09**	34.00**	20.08**	-0.80**	89.69**	166.61**	16.76**
	B.P.	0.70	28.15**	38.10**	10.42**	-4.82**	33.66**	5.11**	0.54	87.45**	135.45**	11.26**
NRCG-58 X NRCG-57	M.P.	-0.26	4.48**	37.18**	22.14**	22.44**	6.15**	18.38**	0.20	52.00**	86.35**	0.25**
	B.P.	0.00	-0.56	25.83**	14.93**	-40.58**	-7.00**	0.25**	1.08**	33.22**	69.78**	-5.61**
NRCG-32 X NRCG-29	M.P.	1.23**	11.91**	23.32**	12.23**	37.63**	9.39**	18.22**	3.22**	43.41**	98.55**	4.84**
	B.P.	1.77**	7.08**	6.85**	4.33**	34.74**	-2.25**	14.60**	3.92**	13.70**	68.44**	0.23**
NRCG-32 X ISN-602	M.P.	-0.62	13.70**	20.00**	8.53**	-4.53**	-2.74**	27.09**	-0.87**	0.31**	56.54**	-0.08
	B.P.	-0.53	10.85**	15.07**	0.72**	-13.12**	-3.22**	16.28**	-0.67	-1.81**	40.89**	-1.76**
NRCG-32 X SGS-16	M.P.	1.16**	13.98**	20.97**	0.55**	22.65**	-6.77**	1.65**	0.20	35.21**	79.19**	5.62**
	B.P.	1.98**	12.02**	2.74**	-11.25**	17.15**	-10.01**	-11.68**	1.20**	19.23**	61.93**	-1.29**
NRCG-32 X ISN-223	M.P.	1.97**	9.78**	-12.59**	10.02**	43.91**	-7.48**	11.69**	1.55**	73.65**	129.03**	7.21**
	B.P.	3.46**	5.98**	-14.38**	3.32**	32.72**	-9.67**	0.70**	2.44**	54.90**	120.58**	3.17**
NRCG-32 X NRCG-57	M.P.	-0.35	26.76**	-9.09**	25.61**	-30.21**	-17.85**	17.63**	-1.13**	34.69**	46.54**	0.05
	B.P.	0.18	24.69**	-10.60**	21.65**	-38.59**	-20.00**	11.85**	-0.80*	34.18**	42.75**	-5.02**
NRCG-29 X ISN-602	M.P.	0.62	8.55**	10.37**	2.34**	53.55**	19.66**	5.88**	3.43**	90.19**	139.61**	15.91**
	B.P.	1.06*	1.38**	-0.75**	2.16**	42.49**	7.40**	-5.82**	3.92**	53.25**	124.13**	12.66**
NRCG-29 X SGS-16	M.P.	-1.69*	-0.12	43.54**	14.63**	17.63**	2.23**	25.19**	-0.60*	105.78**	162.67**	20.30**
	B.P.	-0.36	-6.01**	40.19**	8.36**	10.11**	-5.65**	11.79**	1.08**	81.81**	144.67**	17.47**
NRCG-29 X ISN-223	M.P.	1.61**	3.16**	40.08**	17.88**	41.76**	15.21**	13.01**	0.74*	81.08**	119.19**	-1.29**
	B.P.	3.64**	-4.55**	23.57**	16.61**	33.36**	5.20**	4.86**	0.95**	58.18**	92.04**	-9.02**
NRCG-29 X ISN-530	M.P.	-0.61	15.30**	83.73**	20.08**	31.99**	74.21**	3.67**	-0.80**	93.64**	174.00**	18.54**
	B.P.	-0.53	1.07**	79.44**	13.36**	26.32**	73.05**	-0.68**	0.68*	74.54**	167.65**	17.12**
NRCG-29 X NRCG-57	M.P.	-2.45**	5.48**	41.09**	38.23**	-2.37**	39.62**	-4.59**	-0.87**	82.75**	137.81**	8.27**
	B.P.	-2.45	-0.65*	20.53**	32.49**	-15.65**	21.87**	-11.92**	0.14	45.30**	97.45**	-1.50**
ISN-602 X SGS-16	M.P.	-1.43**	24.69**	6.78**	-4.92**	12.49**	-20.38**	12.73**	-1.06**	72.15**	115.18**	18.05**
	B.P.	-0.54	23.68**	-5.97**	-9.97**	-1.76**	-22.76**	-9.13**	0.13	54.70**	114.21**	12.12**
ISN-602 X ISN-223	M.P.	-0.81*	5.13**	38.69**	-12.57**	56.04**	75.36**	-5.09**	1.48**	34.29**	154.66**	-2.03**
	B.P.	0.73	4.08**	35.71**	-13.67**	53.78**	72.04**	-20.91**	2.17**	22.11**	137.32**	-7.24**
ISN-602 X ISN-530	M.P.	-0.70	11.57**	1.69**	-1.91**	2.57**	-7.21**	22.54**	-0.46	13.13**	72.95**	1.67**
	B.P.	-0.18	4.20**	-10.45**	-7.55**	-8.59**	16.22**	13.36**	0.54	-0.34**	58.28**	-2.33**
ISN-602 X NRCG-57	M.P.	-2.90**	3.70**	-5.96**	6.77**	8.74**	0.31*	12.43**	-0.53	58.47**	102.41**	6.44**
	B.P.	-2.47**	2.77	-11.26**	2.16**	-11.76**	-2.80**	7.95**	0.00	55.69**	77.98**	-0.57**
SGS-16 X ISN-223	M.P.	-0.45	8.47**	23.97**	6.87**	30.30**	6.88**	-3.27**	-1.20**	83.25**	145.23**	10.25**
	B.P.	0.18	6.52**	7.14**	0.00	15.24**	5.65**	-7.22**	0.68*	80.86**	129.50**	-0.57**
SGS-16 X ISN-530	M.P.	2.13**	-9.83**	91.18**	23.52**	-23.67**	20.99**	-5.11**	0.59*	103.36**	164.79**	23.72**
	B.P.	3.60**	-16.43**	91.18**	10.61**	-25.42**	12.35**	-18.40**	0.79*	98.84**	141.34**	22.26**
SGS-16 X NRCG-57	M.P.	0.98**	-0.47	19.37**	22.12**	-21.49**	13.48**	27.51**	-0.79**	56.89**	136.54**	5.77**
	B.P.	2.34**	-0.56	0.00	10.93**	-27.99**	6.77**	6.17**	-0.13	38.79**	108.81**	-5.81**
ISN-223 X ISN-530	M.P.	-1.52**	5.87**	23.14**	13.35**	12.00**	-1.09**	-5.37**	-0.07	62.99**	64.04**	3.79**
	B.P.	0.55	-0.18	6.43**	8.12**	1.12**	-9.13**	-15.59**	1.63**	57.35**	40.86**	-5.39**
ISN-223 X NRCG-57	M.P.	-1.07**	6.90**	27.15**	20.76**	9.54**	-1.30**	8.82**	1.74**	35.53**	70.07**	-3.70**
	B.P.	0.91*	4.89**	22.52**	16.97**	-10.10**	-6.11**	-6.18**	2.99**	21.29**	59.72**	-5.06**
ISN-530 X NRCG-57	M.P.	-3.76**	17.55**	55.73**	41.20**	26.00**	91.93**	21.69**	-2.44**	46.33**	202.52**	7.02**
	B.P.	-3.68**	8.86**	30.46**	38.98**	13.16**	68.50**	17.06**	-1.99**	26.95**	146.55**	-3.68**
±S.E. (diff.)	M.P.	0.37	0.26	0.05	0.03	0.14	0.12	0.06	0.29	0.04	0.10	0.06
	B.P.	0.43	0.30	0.06	0.04	0.16	0.14	0.07	0.34	0.05	0.12	0.07

*, ** significant at 5.0 and 1.0 percent level, respectively

Table 2 : Analysis of variance for combining ability (mean squares) and estimates of variance components for eleven quantitative characters in gobhi sarson (*Brassica napus* L.)

Source	d.f.	Days to 50% flowering	Plant height (cm)	Primary branches plant^{-1}	Secondary branches plant^{-1}	Siliquae on main raceme	Siliquae plant^{-1}	Seeds siliqua^{-1}	Days to maturity	1,000-seed weight (g)	Seed yield plant^{-1} (g)
Treatments	35	27.01**	416.90**	2.77**	3.57**	241.23**	2291.71**	19.16**	28.31**	10.26**	47.47**
Parents	7	22.26**	269.51**	1.33**	1.89**	171.16**	406.56**	20.23**	35.02**	3.40**	3.05**
Crosses	27	29.23**	347.89**	2.07**	3.22**	235*33**	2570.63**	17.41**	27.16**	4.77**	19.06**
Parents vs. Crosses	1	0.07	3311.78**	31.89**	24.56**	890*86**	7957.13**	58.85**	12.23**	206.66**	1125.77**
Gca	7	18.93**	242.42**	0.71**	1.67**	70.08**	253.96**	11.83**	8.51**	1.50**	3.19**
Sca	28	6.52**	113.10**	0.98**	1.07**	82.99**	891.39**	5.03**	9.67**	3.90**	18.98**
Error	70	0.0900	0.0460	0.0020	0.0007	0.0134	0.0104	0.0026	0.0580	0.0012	0.0073
σ^2_g		1.88	24.24	0.07	0.17	7.01	25.39	1.18	0.84	0.15	0.32
σ^2_S		6.43	113.06	0.98	1.07	82.98	891.38	5.02	9.61	3.90	18.98
σ^2_A		3.77**	48.47**	0.14**	0.33**	14.01**	50.79**	2.36**	1.69**	0.30**	0.64**
		±0.74	±9.52	±0.03	±0.07	±2.75	±9.98	±0.46	±0.33	±0.06	±0.13
σ^2_D		6.43**	113.06**	0.98**	1.07**	82.98**	891.38**	5.02**	9.61**	3.90**	18.98**
		±0.07	±1.22	±0.01	±0.01	±0.89	±9.59	±0.05	±0.10	±0.04	±0.20
$2\sigma^2_g/2\sigma^2_g + \sigma^2_S$		0.37	0.30	0.13	0.24	0.14	0.05	0.32	0.15	0.07	0.03
$(\sigma^2_D/\sigma^2_A)^{0.5}$		1.31	1.53	2.65	1.80	2.43	4.19	1.46	2.38	3.61	5.45

*, ** significant at 5.0 and 1.0 per cent level, respectively.

component traits viz. siliquae on main raceme, siliquae plant^{-1} and seed siliua^{-1} whereas NRCG-58, NRCG-57 and SGS-16 exhibited good general combiners for seed yield. In case of days to 50% flowering and maturity desirable general combining effects was recorded for ISN-602, ISN-223 and NRCG-57 parents while NRCG-57, ISN-223 and NRCG-58 were the good general combiners for oil content. These parents could be source of elite gene pool for future breeding programme The present results are in partially conformity with those of [Wani and Srivastava 1989 ; Han 1990 and Thakral *et al*., 2001].

The estimates of specific combining effects (table 4) revealed that none of the cross combinations exhibited superior sca effects for all the traits. The significant and desirable sca effects were identified in ISN-530 x NRCG-57, NRCG-58 x SGS-16, NRCG-58 xc NRCG-32 and NRCG-32 x ISN-530 for seed yield and some of the yield components and NRCG-32 x ISN-223 and NRCG-58 x ISN-530 for oil content. Besides desirable sca effects were observed in 12 crosses for days to flowering, 18 plant height, 17 primary branches plant^{-1}, 18 secondary branches plant^{-1}, 16 siliquae on main raceme, 12 siliquae plant^{-1}, 15 seed siliqua^{-1}, 14 days to maturity and 22 cross 1000 seed weight. The results are in partial agreement with the findings of [Kaur *et al*., 1998 ; Mondal and Khajuria, 2000 and Ghosh *et al*., 2002]. The crosses were mostly the result of high x low general combiners, could be exploited for realizing transgressive segregants in advanced generations for seed yield and other important traits.

Table 3 : General combining ability effects of parents for eleven quantitative characters in gobhi sarson (*Brassica napus* L.)

Parents	Days to 50% flowering	Plant height (cm)	Primary branches plant^{-1}	Secondary branches plant^{-1}	Siliquae on main raceme	Siliquae plant^{-1}	Seeds siliqua^{-1}	Days to maturity	1,000-seed weight (g)	Seed yield plant^{-1} (g)
NRCG-58	1.90**	1.10**	0.45**	0.27**	-4.36**	2.35**	1.33**	-0.63**	-0.27**	0.83**
NRCG-32	1.23**	6.57**	-0.02	-0.60**	2.27**	1.21**	0.29**	1.18**	-0.15**	-0.02
NRCG-29	0.77**	6.79**	-0.08**	0.26**	3.80**	-3.80**	-0.09**	-0.59**	-0.35**	-0.56**
ISN-602	-0.67**	0.50**	-0.29**	-0.50**	-3.05**	0.51**	-1.75**	-0.16*	0.06**	-0.73**
SGS-16	-1.00**	-2.18**	-0.38**	0.39**	0.13**	-9.72**	1.47**	1.01**	0.56**	0.47**
ISN-223	-2.17**	-4.17**	0.10**	-0.18**	-0.24**	-1.20**	0.01	-1.16**	-0.09**	-0.16**
ISN-530	0.80**	-7.45**	-0.01	-0.10**	0.91**	4.01**	-0.20**	1.01**	-0.37**	-0.38**
NRCG-57	-0.87**	-1.16**	0.23**	0.47**	0.54**	6.63**	-1.07**	-0.66**	0.61**	0.55**
± S.E.(g_i)	0.09	0.06	0.01	0.01	0.03	0.03	0.02	0.07	0.01	0.03
± S.E. (g_i-g_j)	0.13	0.10	0.02	0.01	0.05	0.05	0.02	0.11	0.02	0.04

*, ** significant at 5.0 and 1.0 per cent level, respectively.

Table 4 : Specific combining ability effects for eleven quantitative characters in F_1 generation in gobhi sarson (*Brassica napus* L.)

Crosses	Days to 50% flowering	Plant height (cm)	Primary branches plant^{-1}	Secondary branches plant^{-1}	Siliquae on main raceme	Siliquae plant^{-1}	Seeds siliqua^{-1}	Days to maturity	1,000-seed weight (g)	Seed yield plant^{-1} (g)	Oil content (%)
1	2	3	4	5	6	7	8	9	10	11	12
NRCG-58 X NRCG-32	-0.76**	4.57**	1.12**	0.83**	15.54**	68.00**	-1.53**	1.90**	0.54**	4.69**	-0.16**
NRCG-58 X NRCG-29	-0.96**	10.42**	0.61**	-0.94**	11.62**	-1.72**	2.26**	1.00**	-0.57**	0.29**	-1.16**
NRCG-58 X ISN-602	2.14**	6.90**	0.69**	1.76**	-3.30**	18.20**	1.34**	2.24**	0.31**	3.93**	2.24**
NRCG-58 X SGS-16	1.80**	7.71**	0.35**	-1.33**	8.07**	8.41**	-0.94**	-2.26**	2.00**	4.92**	2.83**
NRCG-58 X ISN-223	3.64**	6.74**	0.47**	0.44**	-6.92**	-1.91**	-1.40**	2.57**	-0.06	-0.34**	-0.44**
NRCG-58 X ISN-530	-0.33	15.79**	0.15**	0.53**	-0.96**	-5.66**	1.27**	-2.26**	2.22**	2.22**	3.41**
NRCG-58 X NRCG-57	0.004	-9.00**	0.44**	0.39**	-9.13**	-17.58**	1.29**	0.74**	0.68**	-0.55**	-1.32**
NRCG-32 X NRCG-29	1.37**	2.18**	0.08	0.07**	3.39**	-6.45**	0.24**	5.20**	0.19**	0.63**	-0.10*
NRCG-32 X ISN-602	-1.53**	1.03**	0.69**	0.53**	-8.73**	-11.83**	1.13**	-4.23**	-1.34**	-1.22**	-1.38**
NRCG-32 X SGS-16	0.47	5.08**	0.18**	-0.50**	4.66**	-9.02**	-1.63**	0.27**	-0.32**	-0.88**	-1.00**
NRCG-32 X ISN-223	1.97**	0.001	-1.13**	0.21**	6.62**	-17.18**	0.59**	1.10**	2.88**	4.05**	3.44**
NRCG-32 X ISN-530	3.34**	3.72**	0.614**	-0.13**	10.94**	25.94**	7.52**	4.60**	-0.65**	4.37**	0.21**
NRCG-32 X NRCG-57	0.004	18.90**	-0.92**	0.53**	-14.72**	-31.48**	-0.14**	-3.06**	0.70**	-1.80**	-0.25**
NRCG-29 X ISN-602	2.27**	0.95**	-0.42**	-0.20**	9.41**	3.65**	-0.63**	6.54**	2.35**	2.14**	3.49**
NRCG-29 X SGS-16	-3.40**	-5.84**	0.24**	0.67**	0.07	-6.41**	3.01**	-1.63**	1.29**	2.27**	2.90**
NRCG-29 X ISN-223	2.77**	-1.99**	0.52**	0.78**	3.13**	-1.33**	1.66**	-0.80**	0.87**	1.47**	-2.22**
NRCG-29 X ISN-530	-0.53	8.50**	1.27**	0.40**	3.82**	34.92**	-1.45**	-2.63**	1.38**	2.32**	3.25**
NRCG-29 X NRCG-57	-2.53**	0.01	0.70**	1.60**	-4.28**	21.96**	-2.18**	-2.30**	1.62**	2.98**	1.66**
ISN-602 X SGS-16	-2.30**	19.81**	-0.35**	-0.46**	1.75**	-23.16**	0.88**	-2.06**	1.54**	0.64**	3.02**
ISN-602 X ISN-223	-1.13**	-2.27**	-1.31**	-1.22**	10.81**	71.19**	-0.97**	1.77**	-0.05	4.70**	-1.77**
ISN-602 X ISN-530	-0.10	1.15**	-0.91**	-0.73**	-3.84**	-29.79**	0.86**	-1.06**	-1.32**	-1.90**	-2.66**
ISN-602 X NRCG-57	-2.76**	-4.64**	-0.68**	-0.40**	4.60**	-10.88**	-0.04	-0.73**	1.94**	1.64**	1.71**
SGS-16 X ISN-223	-1.80**	5.08**	0.06	0.25**	6.33**	5.06**	-0.54**	-3.06**	1.23**	2.97**	1.59
SGS-16 X ISN-530	3.90**	17.57**	1.67**	1.27**	-12.51**	4.14**	-2.36**	3.44**	2.23**	1.89**	3.91
SGS-16 X NRCG-57	3.24**	-5.72**	-0.03	0.74**	-7.04**	10.42**	2.97**	0.44*	0.25**	2.82**	-0.70**
ISN-223 X ISN-530	-2.93**	-1.28**	-0.34**	0.15**	-2.62**	-24.11**	-1.64**	-0.73**	0.83**	-2.18**	-0.23**
ISN-223 X NRCG-57	-0.60*	2.44**	0.62**	0.38**	2.65**	-13.00**	0.80**	4.27**	-0.36**	-0.34**	-1.58**
ISN-530 X NRCG-57	-4.90**	10.22**	1.14**	1.5**	13.64**	68.09**	0.67**	-4.23**	0.32**	6.58**	0.84**
± S.E. (S_{ij})	0.27	0.19	0.04	0.02	0.11	0.09	0.05	0.22	0.03	0.08	0.04
± S.E. ($S_{ij} – S_{kl}$)	0.38	0.27	0.05	0.03	0.15	0.13	0.06	0.30	0.04	0.11	0.06

*, ** significant at 5.0 and 1.0 per cent level, respectively.

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