INHERITANCE STUDIES IN BRASSICA JUNCEA, COSS

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SUMMARY

A 5 x 5 diallel involving Laha 101, RT-11, E1/43, Rai 62 and 5405 genotypes of Brassica juncea, Coss. was made to study inheritance through Griffing and Hayman's approaches. The 20 F-1s (including reciprocals) along with 5 parents were tested in randomized block design with four replications in four 4-metre rows at 40 x 15 cm spacings. Nineteen characters were studied on 5 competitive plants selected at random. All the components were significant for majority of characters. Predominant role of additive gene action was indicated by flowering and maturity days, plant height, siliqua/main raceme, siliqua length with and without beak, threshing percentage, 250 seed weight and seed yield. However, in the case of Griffing's approach days of flowering to maturity, length of main raceme and seeds/siliqua along with above mentioned characters also showed predominant role of additive gene action. The seed yield showed overdominance in Griffing's approach. Rank correlation between per se performance and sca effects of the crosses as well as the parental values and gca effects indicated the preference for per se performance and parental values respectively.

The seed yield/plant showed positive and significant gca effects for the cross 5405 x Laha 101. On the other hand, RT-11 gave negative and significant gca effects. The best cross combination was Laha 101 x 5405. Thus, good x good general combiner produced the best specific combiner, indicating thereby that this character is mainly governed by additive type gene action. The experimental results have been discussed in the light of improving Brassica juncea for seed yield.

Mustard, Brassica juncea (L) Czern & Coss, an edible oil yielding crop of rabi (October to March/April), is gaining importance in tropical dry land areas of India because it is relatively more tolerant to moisture stress, frost and aphids than the rapeseed group. The necessity of studying inheritance of seed yield and its components in genetically diverse material in formulating productive projects needs no further emphasis. Few studies of this nature have been made in B. campestris (L) (Zuberi et al., 1972; Singh et al. 1970, 1971; Devarathinam et al., 1976 and Yadava et al., 1977) and B. juncea (Singh et al., 1970, Tiwari and Singh, 1975, Yadava et al., 1974 and Asthana and Pandey, 1977). The evidence for reciprocal effects (Mehrotra, 1964 and Mehrotra et al., 1974) for yield and several yield-contributing components exists in mustard. The inheritance studies in full diallel system of mating have not been made in B. juncea. Therefore, the present project aimed to estimate types of gene action, reciprocal effects and combining ability in yield and its components. The inferences drawn have been used for suggesting breeding procedure.

MATERIALS AND METHODS

A full diallel of five parents namely, (1) Laha 101, (2) RT-11, (3) E1/43, (4) Rai-62 and (5) 5405 was prepared. Twenty F-1s along with parents were sown in randomized block design with four replications. Each treatment was accommodated in four 4-metre rows in 40 x 15 cms. spacings. Data were recorded on 5 competitive plants selected at random from each plot on following characters:

1. Days to flowering
2. Days to maturity
3. Days from flowering to maturity
4. Plant height
5. Stem diameter
6. Length of first raceme
7. Primary branches
8. Secondary branches
9. Siliquas/first raceme
10. Silqua per plant
11. Siliqua length with beak
12. Siliqua length without beak
13. Seeds per siliqua
14. Weight of 25 siliquas with seeds
15. Weight of seeds from 25 siliquas
16. Threshing percentage
17. Weight of 250 seeds
18. Weight of seeds from first raceme
19. Seed yield per plant

These characters and parents numbered from 1 to 19 and 1 to 5 respectively are referred to in Tables 1 to 4.

The mean data were analysed following Griffing (1956) and Hayman's (1954) approaches for estimating combining ability and gene action respectively.

RESULTS AND DISCUSSION

The genotypic effects were significant for all characters considered in this study. The reciprocal mean squares were non-significant for all characters except days to flowering, stem diameter, length of first raceme and primary branches. Mean squares due to general combining ability (gca) and specific combining ability (sca) were found to be significant for all characters except primary branches, siliquas/plant, weight of 250 seeds, weight of seeds/first raceme and seed yield/plant (Table 1). The above unity ratio of mean squares (sca/gca) indicated over-dominance for stem diameter, primary branches, siliquas/plant, weight of 250 seeds and yield. The mean squares for traits under study were translated into gca and sca variances. The variance ratio σ^2sca/ σ^2gca) suggested over-dominance for days from flowering to maturity, stem diameter, primary and secondary branches, siliquas/plant, seeds/siliqua, weight of 25 siliquas with seed, weight of seeds from 25 siliquas, weight of seeds/first raceme and seed yield. These variances were further translated to genetical components. The ratio of σ^2D/ σ^2A indicated over-dominance for characters stem diameter, primary and secondary branches, siliquas/plant, weight of 25 siliquas, weight of seeds from 25 siliquas, weight of seeds/first raceme and seed yield/plant. These three ratios have given different results. The ratio of mean square is a crude estimate of degree of dominance, whereas, in variance ratio the error component is accounted for. It is therefore more reliable than the estimates from the ratio of mean squares. Further translation of statistical components to respective genetical estimates refines the estimates because of the consideration of mating behaviour. Similar expressions have been advocated by Chaudhary *et al.* (1974, 1977).

TABLE 1

COMBINING ABILITY VARIANCES AND DEGREE OF DOMINANCE

Source	d.f.	1	2	3	4	5	6	7	8	9	10
gca	4	41.24	37.05	18.16	513.34	0.0130	72.41	0.3382*	26.27	80.91	6456.06*
sca	10	3.19	5.23	5.42	75.51	0.0152	12.25	0.5216*	20.01	8.51	8131.09*
reciprocal	10	2.66	1.39*	2.37*	16.86*	0.0053	6.01	0.7900	12.16*	1.82*	6298.01*
error	72	0.58	1.35	1.57	13.55	0.0036	2.78	0.2996	7.12	3.07	4382.02
sca/gca		0.08	0.14	0.30	0.15	1.1692	0.17	1.5423	0.76	0.11	1.26
$o^2_{sca} = o^2_D$		1.55	2.31	2.29	36.88	0.0069	5.64	0.1321	7.67	3.24	2231.59
$o^2_{gca} = \frac{1}{2}\, o^2_A$		3.82	3.21	1.30	44.14	-0.0002	6.07	-0.0159	0.72	7.28	-128.78
$o^2_{sca} = o^2_{gca}$		0.41	0.72	1.76	0.84	-34.50	0.93	-8.3082	10.64	0.44	-17.33
$o^2_D = o^2_A$		0.20	0.36	0.88	0.42	-17.25	0.46	-4.1541	5.32	0.22	-8.66

Source	d.f.	11	12	13	14	15	16	17	18	19
gca	4	32.58	0.4124	5.41	0.1130	0.0401	46.12	0.0075*	0.6565*	16.36*
sca	10	3.05	0.0541	1.48	0.0464	0.0167	4.27	0.0082*	0.6518*	17.82*
reciprocal	10	0.66*	0.0100*	0.33*	0.0060*	0.0014*	2.05*	0.0120*	0.5592*	19.26*
error	72	0.50	0.0044	0.20	0.0052	0.0027	1.84	0.0086	0.3787	18.65
sca/gca		0.09	0.1312	0.27	0.4106	0.4165	0.09	1.0933	0.9928	1.09
$o^2_{sca} = o^2_D$		1.52	0.0296	0.76	0.0245	0.0083	1.45	-0.0002	0.1626	-0.49
$o^2_{gca} = \frac{1}{2}\, o^2_A$		2.97	0.0362	0.40	0.0005	0.0034	4.21	-0.0003	0.0036	-0.001
$o^2_{sca} = o^2_{gca}$		0.51	0.8177	1.90	49.000	2.4412	0.34	0.6667	45.1667	823.33
$o^2_D = o^2_A$		0.26	0.4088	0.95	24.500	1.2206	0.17	0.3333	22.5833	411.667

*Non-significant

TABLE 2

GENERAL COMBINING ABILITY EFFECTS AND RANK CORRELATIONS

Parents	1	2	3	4	5	6	7	8	9	10
1	2.319	3.067	0.834	8.683	-0.0172	0.591	0.237	0.616	-4.458	18.61
2	-1.929	-1.519	0.283	2.592	0.0088	2.179	-0.239	-1.821	1.294	-6.58
3	1.627	0.629	-0.944	2.693	0.0538	2.534	-0.004	-1.214	-1.032	-25.68
4	-2.173	-0.679	1.584	-10.020	-0.0012	-3.953	0.108	2.308	1.414	33.65
5	0.156	-1.500	-1.757	-3.946	-0.0442	1.349	-0.104	0.111	2.784	-20.00
C.D.5 %	0.669	1.018	1.097	3.226	0.0529	1.461	0.480	2.339	1.537	58.02
rs	1.000	1.000	0.700	1.000	0.900	0.400	0.400	0.700	0.900	0.60

Parents	11	12	13	14	15	16	17	18	19
1	1.765	0.158	0.137	0.0696	0.0088	-1.353	0.0356	0.0784	1.045
2	0.972	0.055	0.346	0.0486	0.0328	0.549	-0.0214	-0.0646	-1.345
3	0.453	0.184	-0.119	0.0786	0.0078	-1.476	-0.0204	-0.2346	-1.114
4	-2.951	-0.308	-1.167	-0.1774	-0.1072	-1.262	-0.0174	-0.1836	-0.130
5	-0.238	-0.090	0.805	-0.0194	0.0578	3.542	0.0236	0.4044	1.545
C.D.5 %	0.622	0.058	0.396	0.0635	0.0461	1.190	0.0815	0.5394	3.786
rs	1.000	1.000	1.000	0.9000	0.7500	0.700	0.900	0.400	0.800

TABLE 3

SPECIFIC COMBINING ABILITY EFFECTS AND RANK CORRELATIONS

Crosses	1	2	3	4	5	6	7	8	9	10
1 x 2	-0.499	1.990	2.569	4.349	-0.034	-1.295	-0.222	-4.232	-0.287	59.192
3	-0.081	1.352	1.456	-5.481	0.005	0.199	-0.326	-0.194	0.313	-20.936
4	0.379	-1.679	-1.947	1.621	0.070	-1.288	0.836	4.924	0.167	36.726
5	-2.224	-0.793	1.354	4.932	-0.091	1.432	-0.241	1.896	-0.367	-34.818
2 x 3	-1.148	-2.836	-1.578	3.274	0.064	2.811	0.508	1.958	2.411	36.720
4	-0.412	0.556	1.044	7.402	0.099	4.333	-0.178	2.161	2.705	49.962
5	0.638	-0.582	-0.955	-2.336	-0.027	-1.255	-0.241	-1.717	-0.829	-51.422
3 x 4	-1.204	-1.136	-0.044	-2.938	-0.105	-1.966	-0.422	-2.971	-0.368	-42.641
5	1.156	0.144	-0.928	6.087	0.117	2.039	0.724	2.491	0.771	81.885
4 x 5	-0.142	0.067	0.259	1.800	0.057	0.201	0.372	1.144	1.935	66.157
C.D.5 %	1.158	1.764	1.900	5.588	0.092	2.531	0.831	4.051	2.662	100.501
rs	0.382	0.503	0.750	0.321	0.891	0.539	0.861	0.830	0.382	0.846

Crosses	11	12	13	14	15	16	17	18	19
1 x 2	-1.531	-0.059	-0.953	-0.135	-0.096	-0.992	-0.034	-0.305	-1.684
3	0.292	-0.113	0.036	0.064	0.053	1.118	-0.020	-0.275	-0.265
4	1.066	0.138	1.309	0.070	0.078	1.369	-0.038	-0.091	1.965
5	0.468	0.046	-0.062	-0.047	-0.061	-1.945	0.165	1.440	4.950
2 x 3	0.870	-0.065	0.737	0.105	0.044	-0.244	0.016	0.317	2.184
4	1.274	0.141	0.525	0.221	0.119	0.632	0.043	0.271	2.565
5	0.776	0.079	0.168	-0.081	0.014	2.638	-0.037	-0.231	-2.009
3 x 4	-1.046	-0.262	-0.824	-0.248	-0.125	-0.843	0.012	0.016	-1.715
5	1.405	-0.044	1.118	0.218	0.119	0.373	-0.018	-0.116	1.244
4 x 5	-0.330	0.032	-0.008	0.024	0.019	0.524	-0.031	-0.152	1.200
C.D.5 %	1.078	0.101	0.686	0.110	0.080	2.062	0.141	0.934	6.557
rs	0.224	-0.248	0.774	0.814	0.624	0.333	0.479	0.345	0.830

TABLE 4

GENETIC COMPONENTS AND THEIR PROPORTIONS

	1	2	3	4	5	6	7	8	9	10
t^2	0.627	-4.549	-0.302	-0.503	-0.557	0.487	-0.812	-99.397	-0.177	-0.835
b	0.949*	0.624*	0.205	1.093*	0.316	0.401	0.499*	-0.067	0.499	0.690*
D	18.404*	9.552*	5.481*	250.510*	0.003*	21.567*	0.088*	5.152	19.716*	2142.81*
F	2.231*	-3.788	1.274	63.293*	0.001	-3.634	-0.164	-9.816	-9.636*	-4759.46*
H_1	5.306*	8.701*	10.140*	136.615*	0.025*	21.594*	0.444	28.770*	12.652*	7498.15*
H_2	5.217*	7.762*	7.712*	123.916*	0.023*	18.944*	0.383*	25.775*	10.869*	5711.10*
h_2	7.657*	4.578*	-0.034	215.395*	0.013*	15.600*	0.230*	14.522*	24.667*	18122.02*
E	0.582*	1.350*	1.566*	13.548*	0.004*	2.780*	0.300*	7.121*	3.074*	4382.0*
$\sqrt{H_1/D}$	0.537	0.954	1.360	0.738	3.156	1.001	2.087	2.363	0.801	1.633
$H_2/4H_1$	0.246	0.223	0.190	0.227	0.227	0.219	0.216	0.224	0.215	0.190
$\frac{\sqrt{4DH + F}}{\sqrt{4DH - F}}$	1.255	0.656	1.187	1.413	1.152	0.845	0.383	0.425	0.532	0.190
h^2/H_2	1.468	0.590	0.004	1.738	0.548	0.823	0.519	0.563	2.269	2.417
H_1-H_2	0.088	0.939	2.428	12.699	0.002	2.650	0.061	2.995	1.783	1787.05
r	0.776	0.761	0.789	0.608	0.098	0.710	0.612	0.902	0.896	0.86
r^2	0.602	0.580	0.622	0.370	0.010	0.505	0.374	0.814	0.803	0.74

Contd......

TABLE 4 (CONTD.)

	11	12	13	14	15	16	17	18	19
t^2	-0.039	0.473	0.639	-0.671	0.174	0.601	-1.076	-22.616	-29.260
b	1.061*	1.034*	1.012*	0.662	0.911	0.817	0.045	0.025	0.030
D	13.916*	0.332*	2.219*	0.047	0.017	13.048	0.009	0.341	18.041
F	1.340*	0.229*	0.168	0.006	0.003	-4.688	0.011	-0.461	-24.299
H_1	5.351*	0.160*	2.576*	0.085	0.029	4.857	0.004	0.546	8.850
H_2	5.099*	0.099*	2.546*	0.082	0.028	4.832	0.001	0.537	1.676
h_2	6.408*	0.004	2.549*	0.020	0.017	3.247	0.004	0.246	33.575
E	0.504*	-0.004	0.204*	0.005	0.003	1.844	0.009	0.379	18.655
$\sqrt{H_1/D}$	0.620	0.694	1.077	1.346	1.314	0.609	0.659	1.255	0.700
$H_2/4H_1$	0.238	0.156	0.247	0.243	0.244	0.249	0.052	0.246	0.047
$\frac{\sqrt{4DH} + F}{\sqrt{4DH} - F}$	1.168	2.975	1.073	1.100	1.111	0.544	0.011	0.299	0.020
h^2/H_2	1.257	0.044	1.001	0.242	0.622	0.668	4.584	0.451	20.032
H_1-H_2	0.252	0.061	0.030	0.003	0.001	0.025	0.003	0.009	7.674
r	0.857	0.897	0.703	0.837	0.668	0.902	0.659	0.558	0.907
r^2	0.735	0.804	0.495	0.701	0.446	0.813	0.434	0.312	0.822

* Significant 5 % level

The *gca* and *sca* effects for 19 characters have been presented in Tables 2 and 3 respectively. Parents 5405 and Laha 101 were the best general combiners for seed yield and the cross Laha 101 x 5405 was the best specific combiner. The best specific combiners had both the best general combiners. This expression indicated the predominant role of additive gene action. Contrary to this, parameters used in Table 1 indicated over-dominance for this character. The next best specific combiners namely RT-11 x Rai 62 and RT-11 x E1/43 had parents with poor *gca*. This clearly demonstrated over-dominance for seed yield as is given in Table 1.

For threshing percentage, the best combiner RT-11 x 5405 with parents having the best *gca* indicated predominance of additive gene action. With regard to length of siliqua (including beak) the best combiner was E1/43 x 5405. Both these parents had poor *gca*. Similarly, Laha 101 and RT 11 with good *gca* were poor in cross combination. This suggested additive gene action. This inference was also strengthened by the degree of dominance (σ^2 D/σ^2 A). In 250 seed weight, the best cross Laha 101 x 5405 with parents having good *gca* effects suggested additive gene action.

On the average, *gca* effects and average parental value were similar as indicated by high and significant rank correlations (Snedecor, 1956) except for some characters, such as length of first raceme, primary branches and weight of seeds/first raceme. This expression suggests that there is no necessity to estimate *gca* effects. Secondly, average parental values are actual observations, whereas *gca* effects are estimated. On the contrary, rank correlations between *sca* effects and *per se* performance of the crosses being non-significant indicated inconsistent trend between these parameters. Therefore, *sca* effects can be preferred to *per se* performance. However, *per se* performance is actual observation, whereas *sca* effect is an estimate. Similar inferences have been drawn by Singh *et al.* (1974), Chaudhary and Singh (1977) and Chaudhary *et al.* (1977).

Genetic components and their proportions (Table 4) were estimated following Hayman (1954). Nine characters namely, days to flowering and maturity, plant height, siliqua/first raceme, siliqua length with and without beak, threshing percentage, 250 seed weight and seed yield showed predominant role of additive type gene action. Seed yield is a complex character and is governed by a number of attributes. It shows additive (Tables 2, 3 and 4) as well as non-additive (Table 1) type of gene actions. In Table 1, estimates of *gca* and *sca* variance being negative could have changed the degree of dominance. Apart from this, Hayman's (1954) approach is considered better than Griffing's (1956) for estimating the degree of dominance (Kearsey, 1965; Chaudhary, 1973 and Chaudhary *et al.*, 1977).

Singh *et al.* (1970) found additive effects for plant height, flowering days, siliquas/main raceme and siliqua length in *B. juncea*. Yadava *et al.* (1974) in Indian mustard reported significant effects due to reciprocals, *gca* and *sca*. They indicated equal importance of additive and non-additive variances for seed yield, siliquas/main raceme, siliqua length, seed/siliqua, length of main raceme and secondary branches, whereas, additive gene action was predominant in case of plant height and primary branches. Yadava *et al.*(1977) in *toria* (*B. campestris* var. *toria*) reported additive type gene action for flowering days, where as for maturity it was non-additive.

In the present investigation, seed yield and its components are under the control of additive and non-additive type of gene action (Tables 2, 3 and 4). Therefore, in order to improve seed yield, reciprocal recurrent selection may be adopted to use both types of gene actions. The material so produced could be handled by pure line method. Since crossed seed production is relatively easy in B. juncea (Mehrotra, 1964), the adoption of this approach would not pose limitations. Further, path coefficient analysis with formulation of selection indices for simultaneous improvement of yield and yield component characters would be useful.

Mustard yields are generally low (6-8 Q/ha) in tropical dryland regions because of low productive plant populations/unit area. The poor germination is due to acute soil moisture stress caused by the stoppage of erratically distributed rains in late August or early September. Obviously, mustard is sown (middle of October) in a gradually receding conserved (30% efficiency) moisture in kharif (July to September) fallow rabi (October to March) mustard cropping system. The deep placement of seed leads to uneven germination and early sowing favours serious disease and pest attacks and poor development of yield component characters because of thermo- and photo- sensitivity of mustard genotypes. It is therefore desirable to isolate phenotypically stable genotypes for germination percentage in chemically simulated moisture (Mehrotra, 1973 and 1977) and temperature stresses in germinator. Another course could be conducting experiments with genotypically diverse population of mustard in space and time to isolate photo- and thermo- nonsensitive yield-stable genotypes to be used either as a variety or in hybridisation programmes.

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SESSION D / SESSION D / SITZUNG D

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