ANALYSIS OF YIELD AND ITS COMPONENTS IN A DIALLEL CROSS OF RAPESEED

A.M. Olivieri and P. Parrini

Rapeseed has been always cultivated in Northern Italy but in the last ten years, because of the erucic acid and the competition with other crops its acreage has dropped.

All the varieties sown in Italy such as Leonessa, Olimplade Precoce, Torrazzo and Matador have not been replaced even if some foreign zero erucic varieties have demonstrated to be promising (Mosca, 1979; 1981).

At the Institute of Agronomy of the University of Padova a repeseed breeding program began in 1977 with the aim to develop zero-erucic varieties well adapted to Northern Italy environments. The ways to pursue this program were envisaged to be two: 1) to develop new high-yielding varieties starting from germplasm of different origin; 2) to transfer zero-erucic genes into the well adapted old varieties by a backcross program.

Yield components, namely number of siliquas per plant, number of seeds per siliqua and unitary seed weight were examined in a diallel cross set in order to obtain a right evaluation of the parents to be chosen for maximize grain yield.

Becouse of the relatively mild winter climate occurring in Northern Italy all the rapeseed varieties are sown in autumn . So it is possible to compare and utilize for breeding pourposes the so called "winter" as well as "summer" varieties.

The present paper reports the first results concerning combining ability in seed yield and its components and indicates the criterion used for starting a breeding program.

MATERIAL AND METHODS

Twenty rapeseed varieties, namely Midas, Esora, Kosa, Dolora, Oro, Zephir, Vanda, Cresor, Eurora, Primor, Lesira, Gira, Kara I, Eragi, Status, Brink, Sano, Girita, Sinera, Ramses "o" and the line 51/74 (named Sedo) supplied by prof. W. Schuster of the University of Giessen, were crossed by hand in an insect-proof greenhouse in the spring of 1977. For each combination 3 to 5 flowers of 1-2 plant per variety were pollinated and after 50-60 days siliquas were collected. In the next September seeds were sown in Jiffy pots and on October 10, 420 F_1 progenies were transplanted together with parental material in open field according to a randomized block design with two replications. Each progeny was represented by 30-40 plants placed 25x70 cm apart.

Data concerning number of siliquas per plant, number of seeds per siliqua and 1000 seed weight were collected on ten plants sampled in each plot. Yield per plant was obtained by multiplying the yield components for each plant.

The analysis of data was carried out according to Hayman (1954) keeping in mind the issues in diallel analysis by Baker (1978).

RESULTS

Table I shows the risults of analysis of variance for seed yield and its components. For all traits general combining ability (a) accounted for most of the variation, whereas specific combining ability (b) and maternal effects (c and d) were small. Putting the sum of a,b,c,d and error as 100 general combining ability gives about 60% of variation for grain yield and 47,67 and 86% for respectively siliquas per plant, number of seeds per siliqua and 1000 seed weight and therefore heritability is relatively higher for the last two components in respect to the first one. The b_1 effect, which expresses the variation between means of parents and progenies, is significant only for grain yield and number of siliquas per plant suggesting heterosis for these traits.

Table 2 reports yield performances of each parent and its progeny along with the range of variation obtained in reciprocal crosses. Minimum values occur in the parents themselves in Kosa, Dolora, Oro, Primor, Lesira, 51/74, Brink, Ramses "o", whereas the highest yields were obtained in combinations involving mainly a winther with a summer variety. Brink, Vanda, Cresor, Sano and Primor showed the highest g.c.a. effects and in general winter varieties were better than the spring ones. The combinations Primor x Sinera, Ramses "o" x Esora, Status x Midas, Ramses "o" x Gira exhibited heterosis of the order of 100%.

The number of siliquas per plant and the number of seeds per siliqua were correlated with grain yield (r = 0.80 and 0.63) indicating that they represent the main components of yield per plant. When analysis in carried out on progeny means the three components are generally scarcely correlated.

For number of siliquas per plant (table 3) g.c.a. effects were high in Brink, Eragi and Vanda. Their mean contributes were + 235, + 235 and + 206 respectively. Fifteen out of the 21 best combinations come from a summer x winter cross and high heterotic effects (over 100%) were found in crosses Midas x Brink, Lesira x Dolora, Status x Midas.

As far as number of seeds per siliqua is concerned (table 3) French varieties Cresor, Primor and Ramses "o" showed the highest g.c.a. effects increasing of 2.5, 2.2 and 1.7 such a trait when they enter a combination. In general, spring varieties were worse than the winter ones.Brink and Kara I were better than their respective progenies. The weight of 1000 seeds ranged from 3.1 to 5.3. In terms of g.c.a. high performances were obtained by Ramses "o", Sinera, Kara I, Eurora and Brink. These winter varieties increased this trait by 6-8%.

In the average values of yield and its components in winter, summer and winter x summer types are shown in table 4. Winter x summer crosses exhibited a certain heterosis for number of siliquas per plant, whereas were intermediate in respect to their parental types for number of seeds per siliqua and 1000 seed weight. Since the number of pods per plant expresses mainly the capacity of assimilation during the vegetative growth, whereas no. of seeds/siliqua and 1000 seed weight the capacity in nutrient mobilitation, it seems that winter x summer hybrids have a greater capacity to supply nutrients rather than transfer them into the seeds.

Moreover it is to point out that summer types when sown in autumn result earlier in flowering and ripening than winther types and earliness is dominant or partially dominant on lateness. Therefore it seems that winter x summer types have a great potentiality for breeding pourposes.

DISCUSSION AND CONCLUSIONS

Although according to a geometrical model (Grafius, 1964) all three components contribute in increasing seed yield, the larger variation in number of siliquas per plant in respect to the number of seeds per siliqua and 1000 seed weight indicates that it is convenient to select for the former trait. However its low heritability suggests to choice inside the material with good standards for 1000 seed weight and number of seeds per siliqua. This criterion was applied in 1979 when the selection was performed on F_2s from crosses involving Primor, Ramses "o", Brink, Esora and Status. In doing so we selected for yield (or number of siliquas per plant) within progenies which would maintain their performances for the other two components of yield.

Becouse of the high plasticity in the number of siliquas per plant (Hühn and Schuster, 1975) and some indication that variation is not given only by genes with additive and dominant effects (Mather and Jinks, 1971), it was not possible to predict the response of selection when the material was evaluated at a right density.

REFERENCES

Baker R.J. 1978. Issues in diallel analysis. Crop Sci. 18, 533-6.
Grafius J.E. 1964. A. geometry of plant breading. Crop Sci. 4, 241-6.
Hayman B.I. 1954. The analysis of variance of diallel table. Biometrics, 10, 235-244.
Hühn H. and Schuster W. 1975. Untersuchungen zur quantitativen Einschätzung von Konkurrenzeffekten in Winterrapsbeständen. Z. Pflanzenzüchtg, 75, 217-236.
Mosca G. 1979. Comportamento agronomico e qualità del seme in varietà di colza di recente costituzione. Rivista di Agronomia, XIII, 423-430.
Mosca G. 1981. Varietà di colza: prove di confronto. Agric. Ricerca. IV, 6, 9-14.
Mather K. and Jinks J.L. 1971. Biometrical genetics. Chapman and Hall London.

Table I : Results of the Hayman analysis

Effects	d.f.	Yield per plant	No. siliquas per plant (x 1000)	No. seeds per siliqua	1000 seed weight
a (g.c.a.)	20	28630**	1602**	136.6**	4.21**
b (s.c.a.)	210	4780**	398**	20.9**	0.22**
b_1	1	67930**	6012**	13.3 n.s.	0.11 n.s.
b_2	20	2020 n.s.	289 n.s.	18.7 n.s.	0.22**
b_3	189	4740**	380**	21.2**	0.22**
c	20	7560**	815**	13.1n.s.	0.29**
d	190	4380**	342**	17.5 n.s.	0.13**
Enor	440	2987	230	15.5	0.07

TABLE 4. Relationships between types and yield components.

Yield and Components	Winter x Winter	Winter x Summer	Summer x Summer
No. Siliquas/Plant	1613 a	1688 a	1494 b
No. Seeds/Siliqua	22.1	21.5	21.0
1000 Seed Weight	4.4	4.2	4.2
Yield/Plant	158 a	154 a	134 b

Numbers with the same letter are not different at P = 0.05

TABLE 2 : Yield per plant (g) in parental material and its progeny and g.c.a. effects.

Parental Material	Type (I)	Country of origin	Parental yield per plant	Progeny Mean	Progeny Max values	Progeny Min. values	G.C.A. effects
Midas	S	Canada	98	158	227	108	5.6
Esora	S	W. Germany	87	139	193	78	− 14.2
Kosa	S	"	72	118	175	72	− 35.0
Dolora	S	"	71	131	253	82	− 22.2
Oro	S	"	73	149	218	78	− 3.9
Zephir	S	Canada	100	127	195	63	− 26.2
Vanda	S	"	200	176	227	82	23.1
Cresor	S	France	209	175	253	92	22.5
Eurora	W	W. Germany	149	163	251	112	9.9
Primor	W	France	86	167	209	113	14.4
Lesira	W	W. Germany	82	163	237	111	10.6
Gira	W	"	118	158	251	57	5.5
Kara I	W	"	139	158	262	64	5.6
51/74	S	"	73	121	190	73	− 32.2
Eragi	W	"	146	167	235	98	13.8
Status	W	Sweden	79	138	205	57	− 14.7
Brink	W	Sweden	132	180	236	138	26.8
Sano	W	W. Germany	162	171	219	119	17.8
Glrita	W	"	125	150	227	79	− 2.5
Sinera	W	"	94	142	200	73	− 11.2
Ramses "O"	W	France	92	160	242	101	6.7
Mean			114	153			0

(I) S = Summer; W = winter

TABLE 3 : Performance in parental material and its progeny yield components

Parental material	No. of siliquas per plant			No. of seeds per siliqua			1000 seed weight		
	Parental value	Progeny mean	Best progeny	Parent	Progeny mean	Best progeny	Parent	Progeny mean	Best progeny
Midas	994	1663	2493	20	21	26	4.4	4.4	5.1
Esora	918	1521	2023	22	21	25	4.4	4.4	5.0
Kosa	843	1377	2631	18	20	28	4.8	4.3	4.8
Dolora	1095	1663	2452	18	21	27	3.4	3.6	4.2
Oro	1002	1665	2363	19	21	25	4.4	4.3	5.0
Zephir	1578	1538	2424	15	20	24	4.3	4.1	4.8
Vanda	1778	1837	2421	26	22	29	4.4	4.3	4.8
Cresar	2027	1646	2452	23	24	29	4.8	4.4	4.8
Eurora	1483	1644	2725	24	22	27	4.3	4.5	4.9
Primor	741	1661	2197	26	24	29	4.1	4.3	5.0
Lesira	761	1694	2240	25	23	28	4.3	4.3	4.9
Gira	1316	1724	2421	18	21	27	4.2	4.3	4.8
Kara I	1267	1622	2267	26	21	26	4.2	4.6	5.3
51/74	1087	1462	2260	20	21	26	3.1	3.8	4.5
Eragi	1826	1866	2631	17	21	26	4.7	4.3	4.8
Status	804	1447	2013	23	22	25	4.4	4.4	5.1
Brink	1230	1866	2493	27	22	26	4.1	4.6	5.3
Sano	1825	1777	2232	22	22	27	4.1	4.3	4.7
Girita	1596	1511	1967	18	23	28	4.2	4.3	4.8
Sinera	1373	1600	2424	15	19	25	4.5	4.6	5.3
Ramses "O"	955	1467	2009	22	24	27	4.5	4.6	5.2
Mean	1262	1631		21	22		4.3	4.3	