J. Agric. Sci. Mansoura Univ., 30 (11): 6603 - 6620, 2005

PERFORMANCES AND CORRELATIONS OF PARENTAL LINES AND THEIR HYBRIDS FOR ECONOMICAL TRAITS OF CANOLA, *Brassica napus* L.

El-Adl, A.M.*; A.H. Abd El-Hadi*; M.M. Keshta and E.F. El-Azzony****
*** Dept. of Genetics, Faculty of Agriculture, Mansoura University, Egypt.**
**** Oil Crops Res. Sec. Field Crops Res. Inst., A.R.C., Giza, Egypt.**

ABSTRACT

This investigation was conducted to study the mean performances of 10 parental lines of canola and the F_1 hybrids among them. Complete diallel crosses mating design were used to obtain 45 F_1 hybrids and 45 F_1 reciprocal hybrids at three environments. These environments were: El-Gamalia 2002/2003 (E_1), El-Serw 2002/2003 (E_2) and El-Serw 2003/2004 (E_3). Different vegetative, yield traits and oil percent were studied. In the same time, the nature of association among pairs of studied traits were evaluated.

The presence of significant variation which noticed among all studied traits makes it possible and necessary to compare the means of all genotypes to evaluate their performances. However, the inbred line $_{325}$ (P_8) appeared to be the earliest, while the parental line Serw $_6$ (P_2) was the tallest and the best parent for N.se./sil. The line Serw $_{37}$ (P_3) had the larger N.pr.br./pl., while the line Serw $_4$ (P_1) started its flowering branches lower than the earlier parents and it was the largest for S.Y./pl.. The Line $_{164}$ (P_{10}) was the best parent for 1000 S.W.gms. and oil %. The Line Serw $_{98}$ (P_5) was the best for N.sil./pl.. The combined data showed that the hybrid between P_4 x P_7 produced more oil % of 46.7 %, while the hybrid between P_1 x P_8 produced the less oil of 36.7 %. The results also showed that the N.se./sil. and N.sil./pl. were very effective in the determination of S.Y./pl. in grams, while 1000 S.W.gms. trait was less effective. Therefore, selection for more N.sil./pl. and more N.se./sil. could increase the yield.

The most desirable r_{ph} and r_g correlations were obtained among S.Y./pl. gms. and N.sil./pl. which showed positive and significant values. Therefore, these two traits showed a desirable association. This finding indicated that selection program to increase one trait would, indeed, increase the other. It could be also mention that all negative r_{ph} and r_g correlations were insignificant. This result indicated that this type of association was not important, where the values of r_{ph} and r_g correlations were small. The negative r_{ph} and r_g correlations between 1000 S.W. gms. and N.sil./pl. indicated that when plant had more siliqua, the size and weight of seeds become less.

INTRODUCTION

Kandil *et al.* (1996) evaluated four parents of canola and six F_1 hybrids among them. They found significant differences among the parents and their F_1 hybrids for N.pr.br./pl., N.sil./pl., S.Y./pl. and S.Y./m^2 traits, while 1000 S.W. and Oil % were not significantly different. In this respect, Hammad (1998) evaluated 15 F_1 hybrids and their parents. He noticed the presence of significant variations between these genotypes for N.pr.br./pl., P.H.cms., N.se./pl., 1000 S.W. and S.Y./pl.gms traits. Similarly, Riaz *et al.* (2001) found that the magnitudes of variances among inbred lines and their F_1 hybrids over two locations were significant for P.H. and D.M. traits. In the same way, Teilep (2003) and Kassab (2004) studied different F_1 hybrids of canloa and their parents. They illustrated the presence of variation among these genotypes for D.50%f., D.M., P.H., N.pr.br./pl., N.se./sil., N.sil./pl., 1000 S.W. and Oil % traits.

Many authors studied the mean performances of F_1 hybrids of canola among them, Kandil *et al.* (1996), Halaka (2000), Teilep (2003) and Kassab (2004). They obtained high performances F_1 hybrids of canola, although the exhibited mean values differed among them.

Concerning phenotypic and genotypic correlations in canola, Hamed (1993) found that pod yield trait was significantly correlated with oil % (0.98) and protein yield (0.97) traits. He also added that seed yield trait showed highly significant correlations with pod yield (0.94), biological yield (.80) and strew yield (0.72). In this respect, Ozer *et al.* (1999) obtained positive values of correlations among S.Y./pl. gms and each of: D.50% f., P.H., N.pr.br./pl., N.sil./pl., N.se./sil., 1000S.W. and oil % traits. On the other hand, El-Baz and El-Shakhess (2001) reported negative and significant phenotypic and genotypic correlations among P.H. and oil % which were: -0.33 and -0.37, respectively.

In another study by Sharief and Keshta (2002) and Maria *et al.* (2003), they found positive and significant correlation coefficients between P.H. and each of: oil %, S.Y./fe. and S.Y./pl.. On the other hand, Marinkovic *et al.* (2003) observed negative and significant correlation coefficients between S.Y./pl. and each of: P.H. (-0.303), H.f.br. (-0.27) and N.pr.br./pl. (-0.06). In addition, Teilep (2003) and Kassab (2004) reported that positive and significant correlation between 1000 S.W. and days to first flower, while it was negatively and significantly correlated with N.pr.br./pl..

MATERIALS AND METHODS

The genetic materials used in the present investigation included 10 inbred lines of canola, *Brassica napus*, L.. The seeds of all inbred lines were obtained from Oil Crops Research section, El-Serw Agricultural Research station, Agric. Res. Center, Egypt. These inbred lines were: Serw4, Serw6, Serw37, Serw64, Serw98, Serw101, Serw103, Line325, Line163 and Line164. In the growing season of 2002, all inbred lines were crossed to obtain 45 F_1 and their 45 F_{1r} hybrids through a complete diallel crosses mating design including reciprocal hybrids. In addition, the parental lines were selfed to obtain additional amounts of seeds for further investigation.

All (100) genotypes were evaluated at the three environments: El-Gamalia 2002/2003 (E_1), El-Serw 2002/2003 (E_2) and El-Serw 2003/2004 (E_3). The experimental design was a randomized complete blocks design with three replications. Each block consisted of 100 plots. The plot was a single row 4.2 m. long and 0.6 m. wide. The agricultural practices were carried out as recommended for canola plantation.

The data were recorded on the following traits:

Days to 50 % flowering (D.50%F.); plant height in centimeters (P.H.cms.); number of primary branches per plant (N.pr.br. /pl.); height of the first branch (H.f.br.cms.); weight of 1000 seeds in grams(1000 S.W.gms);

number of seeds per siliqua(N.Se./sil.); number of siliqua per plant(N.sil./pl.); seed yield per plant in grams (S.Y./pl.gms) and oil percent (oil %).

The analyses of variance for each environment and the combined analysis over environments were made according to Steel and Torrie (1960) and Cockerham and Cox (1963), respectively.

Estimation of phenotypic and genotypic correlations between all pairs of studied traits required, a covariance analyses between all pairs of traits at each environment and from the combined data over the three environments according to the procedures as outlined by Singh and Chaudhary (1985).

RESULTS AND DISCUSSION

There are very few studies on canola have done in Egypt. However the Ministry of Agriculture has introduced and selected several cultivars. Now, it is the time to start a serious studies on this crop to evaluate the possibility of cultivating it in newly reclaimed lands. Indeed, the investigation will threw a light about the nature of variation among these lines, the mean performances and correlations among studied traits.

The genetic materials used in this investigation included 10 inbred lines which were involved in a complete diallel crosses mating design to produce 45 F_1 hybrids and 45 F_{1r} reciprocal hybrids. All genotypes which included the 10 parental lines and the 90 F_1 hybrids were evaluated at three environments: El-Gamalia 2002 / 2003, El-Serw 2002 / 2003 and El-Serw 2003 / 2004. The vegetative, yield, yield component traits and oil percent were studied. Therefore, form the economical point of view, the evaluation of the parental lines and the F_1 hybrids among them is of paramount importance specially under several environments.

The mean performances of parental lines:

The means of all parental lines for all studied traits at three different environments and from the combined data over the three environments were calculated and the results are presented in Table 1.

In general, all parental lines showed high performances for all studied traits at environment E_1 (El-Gamalia 2002/2003), while the lowest performances for most traits were obtained at environment E_2 (El-Serw 2002/2003). This finding was expected because the soil at E_1 is more fertile and irrigated by river Nile water , while the soil at E_2 is poor in fertility, has a higher level of salinity and irrigated by drainage water.

The means of the 10 parents for D.50%F. ranged from 76 days to 110 days for parent P_8 at E_2 and parent P_6 at E_1, respectively. The combined data over the three environments for this trait ranged from 83 days to 107 days for parent P_8 and parent P_6, respectively. These results indicated that the parent P_8 was earlier in flowering data than the parent P_6 and all other parents.

Table 1: The mean performances of parents for all studied traits at the three environments and from the combined data over the thre environments.

	Evirs.	D.50%F.	P.H. cms.	N. pri. br./pl.	H. f. bra.	1000 S.W.	N.se./sil.	N.sil./pl.	Se.Y./pl.	Oil%
P_1	E_1	93	152	10.8	7.1	3.3	29.4	557	53.2	42.1
	E_2	85	91	9.5	5.6	3.6	25.0	374	33.1	39.2
	E_3	87	121	11.2	6.5	3.5	25.6	486	44.9	41.1
	Comb.	88	121	10.5	6.4	3.5	26.7	472	43.7	40.8
P_2	E_1	108	212	9.9	45.2	3.2	31.3	464	46.2	40.3
	E_2	100	120	8.9	32.1	3.1	26.8	306	26.5	37.2
	E_3	101	173	10.2	39.7	3.2	26.5	430	37.1	39.2
	Comb.	103	168	9.7	39.0	3.1	28.2	400	36.6	38.9
P_3	E_1	106	134	11.9	10.5	4.0	26.4	357	39.6	41.3
	E_2	97	95	11.4	15.8	2.2	24.4	323	17.8	37.4
	E_3	99	120	14.2	19.6	2.6	24.9	426	28.5	37.9
	Comb.	101	123	12.5	15.3	2.9	25.3	369	28.6	38.9
P_4	E_1	95	208	8.5	22.7	3.3	31.5	455	48.3	43.1
	E_2	96	99	7.5	28.5	3.0	25.6	293	23.6	38.2
	E_3	90	147	8.6	31.0	3.0	26.1	489	38.4	41.2
	Comb.	94	151	8.2	27.4	3.1	27.7	412	36.8	40.8
P_5	E_1	98	181	8.5	8.7	3.5	22.5	647	50.7	40.3
	E_2	99	101	7.8	9.2	3.6	23.9	354	30.5	37.0
	E_3	92	139	8.8	8.6	3.6	22.3	515	42.3	39.1
	Comb.	94	140	8.4	8.8	3.5	23.0	505	41.2	38.8
P_6	E_1	110	164	7.8	15.6	3.4	27.5	489	47.6	43.1
	E_2	104	99	5.9	11.3	2.8	29.7	300	25.3	39.8
	E_3	107	129	7.2	18.4	2.5	30.2	475	37.7	40.8
	Comb.	107	131	7.0	15.0	2.9	29.1	421	36.9	41.2
P_7	E_1	103	210	11.3	54.1	3.6	28.8	466	48.4	39.5
	E_2	91	112	10.6	35.3	3.3	25.1	354	29.7	37.5
	E_3	96	159	13.8	43.8	3.2	26.6	479	41.6	38.2
	Comb.	98	160	11.9	44.4	3.4	26.8	433	39.9	38.4
P_8	E_1	89	153	9.2	8.3	3.8	29.1	430	48.7	40.1
	E_2	76	85	9.2	6.6	3.5	25.9	307	28.3	37.1
	E_3	83	116	10.8	7.9	3.7	28.1	382	40.5	39.1
	Comb.	83	118	9.7	7.6	3.7	27.7	373	39.2	38.7
P_9	E_1	98	171	8.1	12.7	2.6	28.8	437	36.1	38.3
	E_2	90	101	7.3	15.6	2.4	26.3	257	17.8	36.8
	E_3	91	132	7.8	21.2	2.9	28.8	305	25.9	36.4
	Comb.	93	135	7.7	16.5	2.6	28.0	333	26.6	37.2
P_{10}	E_1	101	192	8.9	9.2	3.1	27.5	528	46.7	43.1
	E_2	93	108	8.1	9.7	4.2	25.8	210	22.5	40.1
	E_3	93	126	9.3	10.8	4.0	25.6	325	34.2	41.2
	Comb.	96	112	8.7	9.9	3.8	26.3	355	34.4	41.5

The results also cleared that P.H. cms. ranged from 212 cms. to 85 cms. for P_2 at E_1 and P_8 at E_2, respectively. The combined data over the three environments for this trait ranged from 168 cms. to 118 cms. for P_2 and P_8, respectively. These results indicated that the P_2 was taller than P_8 and all other parents.

In the same time, the results indicated that N.pr.bra/pl. ranged from 14.2 branches to 5.9 branches for P_3 at E_3 and P_6 at E_2, respectively. The combined data over the three environments for this trait ranged from 12.5 branches to 7.0 branches for P_3 and P_6, respectively. These results indicated that P_3 was the highest for N.pr.bra./pl. than P_6 and all other parents.

The means of the 10 parents for H.f.bra. ranged from 5.6 cms. to 54.1 cms. for P_1 at E_2 and P_7 at E_1, respectively. The combined data over the three environments for this trait ranged from 6.4 cms to 44.4 cms for P_1 and P_7, respectively. These results indicated that P_1 started to have flowering branches near the surface from of soil than P_7 and all other parents.

The means of the parental lines for 1000 s.w.gms. ranged from 4.2 gms to 2.2 gms. For parent P_{10} at E_2 and parent P_3 at E_2, respectively. The combined data over the three environments for this trait ranged from 3.8 gms. to 2.6 gms. for parents P_{10} and P_9,respectively. Thus, these findings indicated that P_{10} was higher in 1000 s.w.gms. than parent P_9 and all other parents. Similarly, N.se./sil. ranged from 31.5 seeds to 22.5 seeds for P_4 at E_1 and P_5 at E_1 and E_3, respectively. The combined data over the three environments for this trait ranged from 29.1 seeds to 23.0 seeds for P_6 and P_5, respectively. These results indicated that P_6 had more N.se./sil. than P_5 and all other parents.

The results indicated that N.sil./pl. ranged from 647 siliqua to 210 siliqua for P_5 at E_1 and P_{10} at E_2, respectively. The means from the combined data over the three environments for this trait ranged from 505 siliqua to 333 siliqua for P_5 and P_9, respectively. Thus, these results indicated that P_5 was the highest for N.sil./pl. than P_9 and all other parents.

The means of the 10 parents for S.Y./pl. gms. ranged from 53.2 gms to 17.8 gms for P_1 at E_1 and P_3 and P_9 at E_2, respectively. The combined data over the three environments for this trait ranged from 43.7 gms. to 26.6 gms for P_1 and P_9, respectively. These results indicated that P_1 was the highest for S.Y./pl. gms. than P_9 and all other parents.

The means of the 10 parental lines for oil % ranged from 43.1 % to 36.4 % for P_4, P_6 and P_{10} at E_1 and P_9 at E_3, respectively. The combined data over the three environments for this trait ranged from 41.5 % to 37.2 % for P_{10} and P_9, respectively. These results indicated that P_{10} was the highest parent for oil % than P_9 and all other parents.

In general, the means of the 10 parental lines for all studied traits did not show the superiority of certain parent for all traits. However, the line $_{325}$ (P_8) appeared to be the earliest, while the line $Serw_6$ (P_2) was the tallest and the best parent for N.se./sil. The line $Serw_{37}$ (P_3) had the larger N.pr.br./pl. While the line $Serw_4$ (P_1) started its flowering branches lower than the earlier parents and the largest S.Y./pl.. While, the $Line_{164}$ (P_{10}) was the best parent for 1000 S.W.gms. and oil %. The Line Serw $_{98}$ (P_5) was the best for N.sil./pl..

The F_1 hybrids and their reciprocals:

According to the complete diallel crosses mating design of the 10 parental lines, the resulted 45 F_1 hybrids and their 45 F_{1r} reciprocal hybrids at the three environments and from the combined data over environments were evaluated for all studied traits and their mean performances are presented in Table 2. The means of all F_1 and F_{1r} hybrids were arranged so that the first parent was the female parent, while the second parent was the male parent.

In general, the means of all F_1 hybrids varied not only from one F_1 hybrids to another but also, for the same F_1 hybrid at the different environments. These results indicated that environments exerted important effects on the same genotypes. The results also showed the presence of significant differences among all the F_1 hybrids and their F_{1r} reciprocals hybrids which were true at the three environments and certainly from the combined data. These differences between the hybrids and their reciprocals ranged from insignificant up to highly significant.

For number of days to 50 % flowering (D.50%f.) all F_1 hybrids and their reciprocals appeared to have larger means indicating that they flowered later than their parents. These results indicated that F_1 hybrids had a longer period of vegetative growth which would be noticed when the plant height trait would be studied. It is a common fact that plants which have longer period of vegetative growth have also more yield. The earliest plants were also shorter and had their in H.f.br. near the surface of the soil.

The results also cleared that the earliest F_1 hybrid was the F_1 hybrid between P_8 x P_4 which flowered after 80 days from planting at E_2, while the latest F_1 hybrid in flowering was the cross between P_6 x P_7 which flowered after 124 days from planting at E_1. The means obtained from the combined data showed similar trend where the earlier F_1 hybrid over the three environments was also the same hybrid between P_8 x P_4 which gave 50 % flowering rate after 85 days from planting and the latest F_1 hybrid was also the F_1 hybrid between P_6 x P_7 which gave 50 % flowering rate after 115 days from planting. Therefore, the range of 50 % flowering rate of the F_1 hybrids significantly varied when compared with the range of the parents for the same trait which showed a range of 83 days to 107 days.

The results also, indicated that the reciprocal hybrids were close to each other with few differences ranged from not significant up to highly significant. It was also noticed that all F_1 hybrids and their reciprocals were later at E_1 than the other two environments. These results indicated that the rich soil which irrigated by river Nile water gave more and stronger vegetative growth causing the hybrids to flower later than the same F_1 hybrids at the other two environments which were poorer in their fertility.

For plant height in centimeters (P.H.cms.) all F_1 hybrids and their reciprocals appeared to have larger means indicating that they were taller than their parents. These findings indicated that F_1 hybrids had a taller plants which in turn caused an increase in N.pr.br./pl..

The obtained means showed that the tallest F_1 hybrid was the F_1 hybrid between P_3 x P_4 which had a height of 232 cms. at E_1, while the shortest F_1 hybrids was the hybrid between P_6 x P_9 which was 95 cms. in height at E_2. The means obtained from the combined data over the three environments showed that the tallest F_1 hybrid was the F_1 hybrid P_4 x P_{10} which had 198 cms. in length and the shortest F_1 hybrid was the F_1 hybrid P_8 x P_1 which showed 128 cms. in length. Therefore, P.H. cms. significantly varied and had a wider range than their parents which showed a range of 118 cms. to 168 cms. for the same trait.

The results also, indicated that the reciprocal hybrids were not close to each other with differences ranged from not significant up to highly significant. It was an important observation to noticed that all F_1 hybrids and their reciprocals were taller at E_1 than at the other two environments.

The results indicated that E_1 yielded plants with more vegetative growth than the same F_1 hybrid at the other two environments which were poor in soil and irrigation water with high degree of salinity.

The number of primary branches per plant (N.pr.br./pl.) for the F_1 hybrids and their reciprocals tended to have larger means than their parents. The reported means in Table 2 showed that the highest F_1 hybrid for this trait was the F_1 hybrid between P_1 x P_6 at E_1 and P_2 x P_7 at E_3 which had 14.8 branches per plant, while the lowest F_1 hybrid for this trait was the cross between P_5 x P_4 which had 6.5 branches at E_2. The means obtained from the combined data over the three environments showed that the highest F_1 hybrids were the F_1 hybrids between P_2 x P_7; P_3 x P_6; P_6 x P_8 and P_{10} x P_7 which showed 13.5 branches per plant, while the lowest F_1 hybrid was the F_1 hybrid between P_5 x P_4 which gave 8.3 branches per plant. Therefore, N.pr.br./pl significantly varied in the F_1 hybrids than the range of the parents for the same trait which showed a range of for 7.0 to 12.5 branches per plant.

The results also indicated that the F_1 hybrids and their reciprocals were not close to each other with differences ranged from not significant up to highly significant. It was very important observation to notice that all F_1 hybrids and their reciprocals were higher at E_1 than the other two environments.

The means of height of first branch in centimeters (H.f.br.cms.) for all F_1 hybrids and their reciprocals appeared to have smaller means indicating that they started to produce their flowering branches near the soil surface. The reported means showed that the F_1 hybrid P_3 x P_6 at E_3 started to have flowering branches at 2.5 cms. from soil surface, while the F_1 hybrid P_6 x P_2 at E_1 started to produce the first flowering branches at 38.9 cms. from soil surface. The obtained means from the combined data over the three environments showed that the F_1 hybrid P_4 x P_8 started to have its flowering branch at 3.4 cms. from soil surface, while the F_1 hybrid between P_6 x P_2 started at 28.5 cms from soil surface. Therefore, H.f.br.cms. significantly varied in the F_1 hybrids and had a wider range than the range of the parents which showed a range of 6.4 cms. to 44.4 cms. from the soil surface. The results also, indicated that the F_1 hybrids were not close to their reciprocals with differences ranged from not significant up to highly significant.

In general, it was apparent that variations within parental lines were present but in different magnitudes for each trait. Accordingly, the two traits D.50 % f. and N.pr.br./pl. showed less variations than the two traits P.H.cms. and H.f.br.cms. which showed larger amounts of variation.

Table 2: The mean performances of F_1 hybrids (F_1) and their F_1 reciprocal hybrids (F_{1r}) for all studied traits at the three environments and from the combined data over the three environments.

	D.50%F.				P.H..cms.				N.pr.br./pl.				H. f. bra.cms.			
	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.
p_1xp_2	112	95	97	101	219	138	180	179	14.4	10.8	11.9	12.3	22.3	21.5	25.9	23.2
P_2xp_1	103	94	96	98	215	152	195	187	12.9	11.3	14.1	12.8	17.3	18.3	17.3	17.6
p_1xp_3	112	98	99	103	166	109	131	135	11.4	8.4	10.3	10.0	13.2	13.0	19.3	15.2
P_3xp_1	104	94	93	97	167	111	142	140	10.9	8.8	10.2	10.0	11.9	7.5	9.9	9.8
p_1xp_4	114	99	102	105	214	120	153	162	10.7	9.5	9.8	10.0	12.7	7.8	10.1	10.2
P_4xp_1	102	94	97	98	206	119	166	164	12.2	8.5	11.7	10.8	11.0	5.6	8.9	8.5
p_1xp_5	116	103	106	108	183	125	161	156	12.4	9.9	10.4	10.9	13.5	14.1	15.9	14.5
P_5xp_1	101	91	95	96	180	109	142	144	10.0	7.6	10.8	9.5	9.7	15.0	15.6	13.4
p_1xp_6	117	103	107	109	187	127	169	161	14.8	11.1	12.3	12.7	3.8	4.5	7.1	5.1
P_6xp_1	101	98	101	100	198	126	178	168	10.6	8.3	11.2	10.0	15.8	17.1	18.5	17.1
p_1xp_7	119	107	110	112	191	116	150	152	9.2	9.0	9.1	9.1	23.5	18.0	23.0	21.5
P_7xp_1	109	97	102	103	213	107	143	154	10.1	9.5	10.4	10.0	4.8	9.2	6.5	6.8
p_1xp_8	102	92	94	96	159	113	144	139	13.1	8.5	10.8	10.8	10.3	13.0	17.1	13.5
P_8xp_1	96	86	93	92	177	97	111	128	9.9	7.6	9.6	9.0	9.5	5.7	9.1	8.1
p_1xp_9	101	92	93	95	179	135	174	163	14.0	7.3	10.8	10.7	11.5	8.0	10.4	10.0
P_9xp_1	98	89	91	93	175	120	167	154	11.6	7.8	10.2	9.9	23.7	18.9	20.8	21.1
p_1xp_{10}	104	93	96	98	201	103	133	148	9.6	8.8	9.4	9.3	12.9	10.3	11.2	11.5
$P_{10}xp_1$	101	99	103	101	187	125	161	158	9.7	8.2	10.9	9.6	19.3	9.7	18.9	16.0
p_2xp_3	113	100	102	105	219	158	199	192	12.6	11.5	14.1	12.7	21.8	12.8	20.9	18.5
P_3xp_2	111	101	103	105	226	120	168	171	12.4	7.5	10.0	10.0	23.1	23.9	27.6	24.9
p_2xp_4	109	99	100	103	227	146	195	190	14.1	7.5	13.5	11.7	20.2	18.7	19.0	19.3
P_4xp_2	104	89	93	96	219	144	169	184	14.3	11.4	14.6	13.4	17.3	13.5	16.5	15.7
P_2xp_5	116	100	105	107	204	118	152	158	13.2	9.4	12.3	11.6	12.3	5.5	9.7	9.2
p_5xp_2	107	98	100	102	218	123	160	167	11.3	7.7	10.7	9.9	10.8	12.2	11.8	11.6
P_2xp_6	118	104	107	110	196	107	148	151	11.0	9.0	11.2	10.4	15.9	25.6	13.9	18.5
p_6xp_2	111	92	94	99	214	107	152	157	9.5	9.5	8.3	9.1	38.9	21.3	25.4	28.5
P_2xp_7	120	106	108	112	224	137	185	182	14.5	11.2	14.8	13.5	34.0	6.8	6.6	15.8
p_7xp_2	120	105	111	112	229	127	181	179	14.2	10.6	12.8	12.5	30.7	19.7	22.7	24.4
P_2xp_8	101	92	92	95	197	118	188	168	12.6	9.2	12.8	11.5	17.5	4.5	29.0	17.0
p_8xp_2	101	91	95	96	216	147	182	182	10.6	7.8	9.0	9.1	5.4	4.0	8.1	5.9

Table 2 continued:

	D.50%F.				P.H..cms.				N.pr.br./pl.				H. f. bra.cms.			
	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.
P_2xp_9	108	95	95	99	203	132	180	172	9.7	8.9	10.3	9.6	19.4	10.8	16.0	15.4
p_9xp_2	111	94	96	101	212	141	181	178	9.8	9.3	9.5	9.5	4.6	5.0	9.7	6.5
P_2xp_{10}	113	96	97	102	211	126	169	169	10.2	7.4	9.3	8.9	16.3	8.6	11.3	12.1
$p_{10}xp_2$	110	101	97	103	214	151	194	186	13.0	9.5	10.0	10.8	18.6	18.0	21.8	19.5
P_3xp_4	101	91	92	95	232	155	190	192	13.9	10.9	14.3	13.0	8.2	9.5	12.0	9.9
p_4xp_3	108	96	102	102	214	121	172	169	11.2	7.6	10.2	9.7	14.2	11.2	13.4	12.9
P_3xp_5	108	95	98	100	176	142	149	156	10.8	7.6	10.8	9.7	13.8	9.5	9.5	10.9
p_5xp_3	97	89	91	93	192	116	155	155	12.6	10.9	12.9	12.2	13.5	9.3	10.3	11.0
P_3xp_6	109	98	101	102	201	133	175	170	14.4	11.6	14.5	13.5	10.8	3.9	2.5	5.7
p_6xp_3	109	96	98	101	200	138	185	174	12.6	7.9	11.7	10.7	10.0	10.6	12.2	11.0
P_3xp_7	115	102	106	108	218	130	187	178	11.8	8.3	12.6	10.9	13.5	23.2	16.0	17.6
p_7xp_3	112	101	102	105	211	122	171	168	13.0	7.7	9.8	10.2	8.8	5.9	9.3	8.0
P_3xp_8	97	89	91	93	173	122	158	151	9.9	8.7	9.8	9.5	14.7	7.6	9.2	10.5
p_8xp_3	91	82	84	86	186	111	158	152	11.2	8.5	10.3	10.0	15.2	7.9	12.9	12.0
P_3xp_9	103	92	94	96	155	102	138	132	11.8	8.5	12.6	11.0	14.6	15.4	18.7	16.2
p_9xp_3	100	86	89	92	203	148	187	179	10.2	7.2	9.2	8.9	12.0	10.7	10.4	11.0
P_3xp_{10}	106	95	96	99	207	108	151	155	13.3	10.3	13.7	12.4	15.1	17.5	9.8	14.1
$p_{10}xp_3$	103	90	94	96	198	133	181	171	12.0	8.6	10.5	10.4	9.2	7.1	11.8	9.4
P_4xp_5	106	91	97	98	190	116	157	154	10.3	8.2	9.7	9.4	19.1	15.2	19.2	17.8
p_5xp_4	104	95	97	99	213	133	166	171	9.7	6.5	8.7	8.3	16.9	14.9	18.1	16.6
P_4xp_6	110	96	100	102	172	110	147	143	10.5	8.9	9.8	9.7	23.6	18.8	23.7	22.0
p_6xp_4	113	104	107	108	219	98	153	157	13.4	7.9	11.9	11.1	9.7	4.9	7.4	7.3
P_4xp_7	112	98	104	105	225	154	193	191	11.1	10.5	14.3	12.0	9.8	16.1	11.3	12.4
p_7xp_4	109	95	98	101	224	127	174	175	13.6	9.4	11.0	11.3	10.1	11.0	12.8	11.3
P_4xp_8	97	87	93	93	214	128	179	174	13.4	10.6	12.6	12.2	4.0	3.2	3.1	3.4
p_8xp_4	90	80	85	85	207	117	166	164	14.1	11.1	12.0	12.4	5.5	4.8	11.6	7.3
p_4xp_9	106	92	97	99	187	101	137	142	12.3	9.9	10.5	10.9	12.1	11.2	13.1	12.1
p_9xp_4	109	99	102	103	213	129	172	171	11.1	9.9	9.4	10.1	14.5	13.4	12.3	13.4
P_4xp_{10}	108	96	98	101	227	166	199	198	11.8	8.6	10.1	10.2	20.6	27.8	29.0	25.8
$p_{10}xp_4$	109	98	102	103	211	117	141	156	10.2	8.4	10.1	9.6	15.5	5.8	9.3	10.2

Table 2 continued:

	D.50%F.				P.H.cms.				N.pr.br./pl.				H. f. bra.cms.			
	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.
P_5xp_6	111	103	106	107	199	150	184	177	10.2	9.7	10.1	10.0	10.5	5.7	8.6	8.2
p_6xp_5	105	94	96	98	197	134	179	170	14.4	11.5	14.3	13.4	11.6	10.8	11.9	11.4
P_5xp_7	118	106	108	110	213	138	177	176	12.5	10.5	12.2	11.7	5.4	4.5	7.4	5.8
p_7xp_5	109	94	97	100	215	141	182	179	11.8	8.6	10.8	10.4	32.5	23.9	24.0	26.8
P_5xp_8	100	90	94	95	165	98	138	134	9.1	7.5	9.2	8.6	11.9	8.3	11.1	10.5
p_8xp_5	108	96	99	101	183	113	161	152	11.7	7.7	9.6	9.7	10.7	8.3	11.8	10.3
P_5xp_9	103	92	95	96	185	110	150	148	11.1	8.5	10.6	10.1	11.0	18.9	14.0	14.6
p_9xp_5	111	102	102	105	175	115	161	150	11.9	10.1	12.3	11.4	18.8	18.5	16.1	17.8
P_5xp_{10}	105	97	99	100	204	142	182	176	12.0	8.8	10.1	10.3	19.1	19.4	22.3	20.3
$p_{10}xp_5$	117	105	109	110	172	114	140	142	9.2	7.7	9.6	8.8	20.8	13.2	16.4	16.8
P_6xp_7	124	109	112	115	220	118	177	171	10.7	7.6	8.3	8.9	13.9	7.2	8.6	9.9
p_7xp_6	120	106	113	113	197	118	159	158	10.8	9.5	12.5	10.9	13.7	11.1	13.0	12.6
P_6xp_8	96	86	89	90	182	107	171	154	14.5	11.6	14.4	13.5	13.6	8.0	10.5	10.7
p_8xp_6	99	87	92	93	209	141	176	176	12.3	10.1	11.6	11.3	4.0	6.5	4.7	5.1
P_6xp_9	118	103	109	110	170	95	132	132	10.5	8.8	12.1	10.5	13.6	9.4	11.4	11.5
p_9xp_6	112	104	106	108	194	135	178	169	13.0	10.6	12.8	12.1	13.6	15.0	14.0	14.2
P_6xp_{10}	108	93	98	100	191	97	142	143	12.2	10.4	12.4	11.7	17.4	10.8	14.2	14.1
$p_{10}xp_6$	111	98	104	104	208	144	186	180	14.0	11.1	12.2	12.4	3.9	4.6	6.5	5.0
P_7xp_8	101	91	96	96	190	115	155	153	9.9	8.1	11.0	9.7	18.4	10.1	19.4	16.0
p_8xp_7	111	99	105	105	217	113	155	162	14.1	11.0	12.5	12.5	3.5	14.6	2.8	7.0
P_7xp_9	108	96	99	101	195	105	152	150	11.3	9.5	12.2	11.0	16.1	9.7	15.4	13.7
p_9xp_7	109	94	98	101	219	160	190	189	13.8	11.6	13.6	13.0	5.1	11.5	9.4	8.7
P_7xp_{10}	109	97	98	101	219	135	179	178	10.0	9.6	11.7	10.4	17.0	7.0	17.8	13.9
$p_{10}xp_7$	109	97	101	102	220	158	196	191	14.6	11.9	13.9	13.5	26.3	14.4	29.1	23.3
P_8xp_9	97	86	91	91	192	99	122	138	10.5	7.7	10.0	9.4	5.4	5.3	8.7	6.5
p_9xp_8	103	91	99	98	178	116	152	148	11.4	8.0	10.9	10.1	4.4	3.9	6.8	5.0
P_8xp_{10}	108	96	99	101	201	105	128	145	10.7	6.9	9.4	9.0	6.3	5.4	5.9	5.8
$p_{10}xp_8$	98	86	91	92	181	110	130	140	11.2	7.2	8.5	9.0	4.5	3.6	8.0	5.3
P_9xp_{10}	108	95	98	100	203	121	167	163	9.8	9.0	11.2	10.0	12.9	10.4	10.6	11.3
$p_{10}xp_9$	111	101	106	106	163	118	172	151	10.6	8.1	9.8	9.5	15.1	16.8	18.7	16.8

Table 2 continued:

	1000 S.W.gms.				N.se/sil.				N.sil/pl.				S.Y/pl.gms.				Oil%			
	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.
p_1xp_2	2.9	3.8	3.7	3.5	30.6	23.8	25.2	26.5	667	473	586	575	59.6	43.2	55.7	52.9	46.1	39.1	42.1	42.4
P_2xp_1	2.9	3.7	4.0	3.5	30.8	28.2	28.6	29.2	655	357	418	477	58.4	37.4	48.1	48.0	46.9	43.2	43.1	44.4
p_1xp_3	3.4	4.0	4.1	3.8	29.1	30.0	31.4	30.2	505	272	339	372	50.5	32.6	44.6	42.6	43.0	40.1	41.2	41.4
P_3xp_1	3.5	2.9	3.1	3.2	24.8	29.3	30.7	28.2	705	476	556	579	61.1	40.3	53.2	51.5	43.1	40.1	40.1	41.1
p_1xp_4	2.2	3.9	3.9	3.3	28.4	27.3	28.8	28.2	948	378	459	595	57.4	40.9	52.4	50.3	45.2	36.4	40.1	40.6
P_4xp_1	3.8	3.3	3.7	3.6	31.1	23.4	25.3	26.6	536	541	574	550	64.2	42.2	53.7	53.4	46.4	41.7	42.2	43.4
p_1xp_5	2.4	3.9	3.8	3.4	32.0	27.0	26.1	28.4	705	334	481	507	54.5	35.2	48.3	46.0	42.2	37.4	39.3	39.6
P_5xp_1	2.7	3.5	3.6	3.3	27.5	28.0	29.0	28.2	470	179	269	306	38.1	17.8	28.6	28.2	43.1	41.3	41.2	41.9
p_1xp_6	2.8	3.8	3.6	3.4	29.9	27.4	27.9	28.4	950	565	685	733	81.4	58.3	69.4	69.7	48.0	42.4	43.3	44.6
P_6xp_1	3.9	2.9	3.0	3.3	29.4	29.1	29.4	29.3	487	426	518	477	55.5	33.9	46.7	45.4	48.1	42.8	43.1	44.6
p_1xp_7	3.7	4.0	4.2	4.0	25.0	25.7	25.6	25.4	424	204	326	318	39.5	19.8	32.8	30.7	38.3	40.3	39.1	39.2
P_7xp_1	1.9	3.7	3.9	3.2	24.8	29.4	28.4	27.5	902	280	383	522	43.5	31.6	42.5	39.2	46.2	40.0	41.1	42.4
p_1xp_8	2.9	3.4	3.6	3.3	31.9	27.7	26.8	28.8	785	565	664	671	74.4	53.7	63.4	63.8	35.1	37.8	37.1	36.7
P_8xp_1	2.4	3.5	3.8	3.2	33.0	25.7	27.6	28.8	734	418	467	540	58.5	38.4	49.7	48.9	40.4	39.5	39.4	39.7
p_1xp_9	3.8	3.7	3.7	3.7	36.3	31.4	30.4	32.7	566	471	567	535	76.3	55.4	65.1	65.6	39.3	36.5	38.2	38.0
P_9xp_1	2.4	2.7	2.9	2.7	27.1	22.5	25.1	24.9	476	413	490	460	46.5	25.3	36.9	36.2	40.1	38.5	38.2	38.9
p_1xp_{10}	2.8	3.8	3.9	3.5	26.3	30.2	30.0	28.8	515	141	214	290	38.7	16.6	26.7	27.3	41.2	38.1	40.1	39.8
$P_{10}xp_1$	2.8	3.8	3.9	3.5	28.6	25.7	25.7	26.7	907	554	647	703	75.6	54.6	65.1	65.1	45.2	44.8	43.1	44.4
p_2xp_3	3.5	3.4	3.5	3.5	30.6	25.8	26.4	27.6	565	405	499	490	60.3	35.8	47.0	47.7	45.0	41.7	43.1	43.2
P_3xp_2	3.5	3.2	3.2	3.3	30.3	27.8	28.3	28.8	644	505	613	587	67.3	45.6	56.1	56.4	48.1	43.0	45.1	45.4
p_2xp_4	2.2	3.2	3.4	2.9	29.8	27.4	28.8	28.6	878	387	471	579	59.1	34.5	46.8	46.8	37.2	37.2	38.3	37.5
P_4xp_2	3.6	3.8	3.6	3.7	28.9	26.5	27.8	27.8	392	190	291	291	40.7	20.0	29.2	30.0	42.1	40.4	43.2	41.9
P_2xp_5	3.5	4.0	4.1	3.9	30.7	27.2	27.0	28.3	487	279	366	378	52.6	30.9	42.4	42.0	39.3	35.9	38.1	37.7
p_5xp_2	3.8	3.4	3.5	3.5	29.8	28.1	30.4	29.4	506	338	417	420	57.5	32.6	44.6	44.9	48.3	42.2	43.1	44.5
P_2xp_6	2.8	3.2	3.3	3.1	28.6	25.3	25.4	26.4	703	397	517	539	54.9	32.3	43.7	43.6	44.1	38.2	41.0	41.1
p_6xp_2	2.8	2.6	2.9	2.8	28.1	23.4	25.6	25.7	611	447	511	523	49.4	27.8	38.8	38.7	48.2	41.2	45.0	44.8
P_2xp_7	3.7	3.9	4.0	3.9	25.0	20.0	22.2	22.4	633	429	508	524	58.7	33.3	45.7	45.9	44.2	37.8	42.3	41.4
p_7xp_2	3.2	3.0	2.9	3.0	26.7	25.0	27.6	26.4	887	763	828	826	73.8	57.1	66.8	65.9	41.1	39.2	40.7	40.3
P_2xp_8	4.0	2.5	2.4	3.0	25.8	24.6	23.9	24.8	463	404	643	503	48.4	25.5	38.4	37.4	46.0	40.7	42.1	42.9
p_8xp_2	3.6	3.4	3.6	3.5	28.3	27.1	29.8	28.4	674	514	543	577	70.4	47.3	59.3	59.0	45.2	40.2	41.1	42.1

Table 2 continued:

	1000 S.W.gms.				N.se/sil.				N.sil/pl.				S.Y/pl.gms.				Oil%			
	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.
P_2xp_9	3.7	4.0	3.9	3.9	35.5	25.9	27.0	29.5	386	275	374	345	51.6	28.2	39.2	39.7	44.1	37.9	40.4	40.8
p_9xp_2	2.2	3.1	3.2	2.8	30.6	30.3	32.5	31.1	797	329	397	507	51.8	30.5	41.4	41.3	47.3	43.2	42.6	44.4
P_2xp_{10}	2.6	3.9	3.6	3.4	31.8	24.5	25.0	27.1	719	320	462	501	60.1	30.2	42.4	44.2	43.9	38.9	41.1	41.3
$p_{10}xp_2$	3.4	3.5	3.7	3.6	28.2	22.6	24.6	25.1	753	674	691	706	73.1	54.4	63.3	63.6	43.2	39.3	38.9	40.4
P_3xp_4	3.5	3.6	3.5	3.5	29.2	26.6	26.3	27.4	648	400	533	527	64.6	38.7	49.4	50.9	44.1	43.1	42.2	43.1
p_4xp_3	3.5	2.7	2.9	3.0	28.8	29.2	30.6	29.5	534	388	463	461	51.7	30.7	41.6	41.3	48.1	42.2	44.1	44.8
P_3xp_5	3.5	2.7	3.0	3.1	30.9	25.2	24.6	26.9	647	685	813	715	69.1	48.0	59.5	58.9	43.2	38.1	40.3	40.5
p_5xp_3	3.0	4.4	4.1	3.8	25.6	28.8	28.0	27.5	921	378	496	598	67.6	47.7	57.3	57.5	45.9	41.1	42.2	43.1
P_3xp_6	3.1	3.4	3.6	3.4	28.6	25.6	26.6	26.9	792	590	645	676	71.5	51.3	61.5	61.4	46.1	40.8	43.1	43.3
p_6xp_3	2.9	3.7	3.6	3.4	32.4	26.9	29.4	29.6	686	456	527	556	65.1	45.5	55.0	55.2	48.1	42.9	44.4	45.1
P_3xp_7	4.0	3.8	4.0	3.9	24.6	29.7	31.4	28.5	645	344	387	459	63.5	39.0	48.5	50.3	39.3	38.2	38.1	38.5
p_7xp_3	3.8	2.9	2.8	3.1	28.7	24.6	26.1	26.5	621	574	747	647	66.0	43.3	54.2	54.5	40.3	37.8	37.2	38.4
P_3xp_8	3.4	4.5	4.3	4.1	27.5	26.2	27.2	27.0	464	220	319	334	43.5	26.4	37.4	35.8	43.2	41.8	40.9	42.0
p_8xp_3	2.6	3.6	3.9	3.3	26.7	29.8	28.2	28.2	1083	553	617	751	76.2	46.3	67.7	63.4	41.2	37.1	38.7	39.0
P_3xp_9	2.8	3.2	3.6	3.2	34.8	26.3	27.7	29.6	438	248	339	342	41.6	21.9	33.8	32.5	45.1	41.5	42.1	42.9
p_9xp_3	2.5	2.7	3.1	2.8	32.6	25.4	27.6	28.5	765	631	653	683	63.4	33.9	55.1	50.8	48.1	42.8	43.6	44.8
P_3xp_{10}	3.3	4.1	4.2	3.9	27.8	26.4	25.4	26.5	619	273	374	422	57.3	29.6	40.8	42.5	47.1	41.2	43.0	43.8
$p_{10}xp_3$	2.6	3.5	3.6	3.2	28.2	29.5	27.6	28.4	1056	558	665	760	76.5	40.2	66.3	61.0	43.2	39.3	41.7	41.4
P_4xp_5	3.6	3.7	3.5	3.6	27.7	27.0	26.8	27.1	496	276	415	396	50.3	28.1	39.8	39.4	42.2	36.9	40.1	39.7
p_5xp_4	3.5	3.3	3.2	3.3	25.2	25.6	25.6	25.5	995	489	632	705	60.7	40.6	52.1	51.1	44.8	44.9	44.7	44.8
P_4xp_6	3.0	2.7	2.9	2.9	26.1	23.7	25.1	25.0	724	567	644	645	56.4	36.5	47.8	46.9	45.4	41.2	42.3	42.9
p_6xp_4	2.9	2.9	3.1	3.0	33.1	28.4	28.3	29.9	596	497	557	550	58.7	40.5	49.5	49.6	47.1	44.8	46.9	46.3
P_4xp_7	2.2	2.5	2.7	2.5	26.2	25.0	27.2	26.1	856	445	534	612	48.2	27.4	39.2	38.3	48.1	45.8	46.1	46.7
p_7xp_4	3.5	3.4	3.6	3.5	26.7	29.0	30.8	28.8	565	320	377	421	53.4	31.7	42.1	42.4	47.3	44.9	47.2	46.5
P_4xp_8	2.7	3.9	4.2	3.6	28.1	32.8	34.3	31.7	979	442	455	625	73.5	57.0	65.3	65.3	45.1	41.6	44.3	43.6
p_8xp_4	2.8	2.4	2.7	2.6	28.9	24.5	26.1	26.5	534	425	468	475	45.7	25.6	34.0	35.1	44.1	38.9	41.2	41.4
p_4xp_9	2.9	3.6	3.7	3.4	27.2	34.5	33.6	31.7	702	263	354	440	56.6	32.9	44.3	44.6	44.2	39.9	40.9	41.7
p_9xp_4	2.8	2.8	3.1	2.9	27.1	29.7	25.8	27.5	643	325	467	478	50.8	27.1	38.7	38.9	48.0	42.8	44.6	45.2
P_4xp_{10}	2.8	2.6	2.9	2.8	30.1	29.1	29.3	29.5	531	268	392	397	45.6	20.6	33.9	33.4	47.1	41.0	43.1	43.7
$p_{10}xp_4$	2.5	3.9	4.1	3.5	29.9	24.8	25.9	26.9	1014	525	599	713	75.6	51.5	63.5	63.5	48.1	41.9	44.1	44.7

Table 2 continued:

	1000 S.W.gms.				N.se/sil.				N.sil/pl.				S.Y/pl.gms.				Oil%			
	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.	E_1	E_2	E_3	Comb.
P_5xp_6	3.6	3.4	3.6	3.5	26.2	25.4	27.1	26.2	913	437	496	615	57.8	36.8	48.5	47.7	41.3	38.8	40.1	40.1
p_6xp_5	3.8	3.3	3.5	3.5	33.9	31.0	30.9	31.9	437	217	306	320	43.1	22.5	32.9	32.8	44.9	40.1	42.2	42.4
P_5xp_7	3.2	4.2	4.4	3.9	30.0	25.7	25.8	27.2	558	289	368	405	53.7	31.5	42.5	42.6	42.1	36.9	39.2	39.4
p_7xp_5	3.3	3.8	3.9	3.7	26.8	19.9	23.8	23.5	625	474	484	527	56.7	36.4	45.8	46.3	41.2	37.2	40.1	39.5
P_5xp_8	3.4	2.9	3.1	3.1	33.9	32.5	32.3	32.9	444	302	405	383	51.5	28.3	40.5	40.1	42.0	37.8	40.1	40.0
p_8xp_5	3.5	2.5	3.0	3.0	28.2	27.7	29.9	28.6	547	450	475	490	55.3	30.6	43.2	43.0	44.1	40.2	41.6	42.0
P_5xp_9	3.7	4.1	4.3	4.0	30.2	29.5	29.7	29.8	692	455	531	559	78.5	54.5	67.1	66.7	41.3	36.7	38.1	38.7
p_9xp_5	3.6	2.8	2.7	3.0	31.7	24.4	24.5	26.9	519	603	799	640	58.8	41.7	52.4	51.0	42.4	39.5	40.0	40.6
P_5xp_{10}	3.4	4.2	4.6	4.1	32.4	29.6	27.8	29.9	578	360	430	456	63.3	44.3	55.9	54.5	47.3	42.0	43.2	44.2
$p_{10}xp_5$	2.8	2.5	2.9	2.7	30.4	28.2	30.9	29.9	708	391	431	510	59.2	28.3	39.4	42.3	48.0	42.2	43.1	44.4
P_6xp_7	3.6	3.4	3.5	3.5	22.5	23.5	26.1	24.0	742	520	556	606	59.4	41.6	50.2	50.4	45.4	46.1	44.2	45.2
p_7xp_6	2.7	2.4	2.6	2.5	25.8	19.3	21.0	22.0	998	1085	1070	1051	69.4	49.7	58.5	59.2	43.1	37.9	40.6	40.5
P_6xp_8	2.7	3.3	3.1	3.0	27.1	31.1	30.1	29.4	734	320	446	500	53.2	32.6	42.3	42.7	45.1	40.0	41.3	42.1
p_8xp_6	3.0	3.1	3.1	3.1	23.4	24.4	26.6	24.8	916	597	614	709	63.9	45.4	54.1	54.5	45.3	41.2	41.2	42.6
P_6xp_9	3.6	4.0	4.2	3.9	32.0	26.9	28.1	29.0	444	295	344	361	52.9	31.3	40.0	41.4	39.1	36.9	38.1	38.0
p_9xp_6	2.7	2.9	3.1	2.9	31.4	24.6	27.1	27.7	704	521	590	605	58.2	37.4	49.1	48.3	44.4	40.4	42.5	42.4
P_6xp_{10}	4.0	3.4	3.7	3.7	32.1	33.4	31.8	32.5	326	186	249	253	41.4	20.9	29.9	30.7	47.0	41.0	42.4	43.5
$p_{10}xp_6$	3.3	3.6	3.8	3.5	28.2	25.5	26.3	26.7	689	442	427	519	63.0	40.2	52.5	51.9	46.1	42.3	42.9	43.8
P_7xp_8	3.2	2.8	3.0	3.0	28.0	27.7	30.0	28.6	525	328	376	409	46.4	25.7	34.5	35.5	43.2	40.2	42.1	41.8
p_8xp_7	3.6	2.9	2.6	3.0	28.2	25.2	24.2	25.9	609	563	793	655	61.5	40.8	50.4	50.9	44.7	38.2	40.1	41.0
P_7xp_9	2.7	2.9	3.1	2.9	33.4	29.0	28.3	30.2	771	611	674	686	71.8	51.5	61.0	61.5	43.1	41.1	41.2	41.8
p_9xp_7	2.8	3.6	3.8	3.4	26.5	25.8	28.1	26.8	1042	546	581	723	72.1	50.7	62.1	61.6	48.1	42.3	44.5	45.0
P_7xp_{10}	2.7	2.2	2.7	2.5	29.6	24.3	26.2	26.7	598	509	568	558	50.4	27.4	39.2	39.0	48.1	42.2	43.3	44.5
$p_{10}xp_7$	2.3	3.0	3.2	2.8	27.7	27.9	30.1	28.6	1086	629	643	786	72.0	52.6	62.0	62.2	45.2	41.4	41.2	42.6
P_8xp_9	3.1	2.6	2.8	2.8	30.4	24.5	25.7	26.9	582	560	623	588	54.0	35.8	45.7	45.2	42.0	37.4	39.1	39.5
p_9xp_8	3.6	4.1	4.4	4.0	34.0	30.8	30.3	31.7	578	388	446	471	71.7	48.6	60.0	60.1	42.1	38.1	40.1	40.1
P_8xp_{10}	2.9	3.1	3.4	3.1	27.9	26.4	27.5	27.3	705	452	488	548	57.6	37.7	46.5	47.3	42.2	37.1	40.1	39.8
$p_{10}xp_8$	3.1	3.8	4.1	3.7	30.2	24.3	26.4	27.0	564	358	392	438	51.7	32.9	42.6	42.4	45.2	41.1	41.1	42.5
P_9xp_{10}	2.4	3.3	3.6	3.1	31.4	25.6	28.2	28.4	952	635	645	744	73.5	53.4	64.6	63.9	44.1	39.0	40.3	41.1
$p_{10}xp_9$	3.8	3.9	4.2	4.0	33.4	29.7	28.9	30.7	344	165	253	254	44.4	19.5	31.1	31.7	46.3	38.8	41.3	42.1

Weight of 1000 seeds in grams (1000S.W.gms.) varied from one hybrid to another. The hybrid P_7 x P_1 gave the lightest weight of 1.9 gms. at E_1. On the other hand, the hybrid P_5 x P_{10} gave the heaviest weight of 4.6 gms. at E_3. It appeared that fertile soil yielded lighter seed weight than poor soils with high level of salinity. These results were clearly apparent for all F_1 hybrids and their reciprocals where heavier seed weight was obtained at poor soils. The combined data showed that the hybrid P_5 x P_{10} had the heaviest seeds with the weight of 4.1 gms.. The same hybrid was also the heaviest hybrid for weight of seed at the three environments. The two F_1 hybrids P_7 x P_6 and P_7 x P_{10} had the lightest seed weight of 2.5 gms..

Number of seeds per siliqua (N.se./sil.) varied not only from one hybrid to another but also from one environment to another for the same hybrid. The hybrid between P_7 x P_6 gave the smaller number of seeds of 19.3 seeds at E_2. On the other hand, the hybrid between P_2 x P_9 gave the larger number of seeds of 35.5 seeds at E_1. The combined data showed that the hybrid P_5 x P_8 had the larger number of seeds of 32.9 seeds, while the hybrid P_7 x P_6 had the fewer number of seeds of 22 seeds.

Number of siliqua per plant (N.sil./pl.) varied not only from one hybrid to another but also from one environment to another for the same hybrid. The hybrid between P_1 x P_{10} gave the fewer number of siliqua of 141 siliqua at E_2. On the other hand, the hybrid P_{10} x P_7 gave the larger number of siliqua of 1086 siliqua at E_1. The combined data showed that the hybrid P_7 x P_6 had the largest number of siliqua of 1051 siliqua per plant, while the hybrid P_6 x P_{10} had the fewest number of siliqua of 253 siliqua.

Seed yield per plant in grams (S.Y/pl. gms.) varied not only from one hybrid to another but also from one environment to another for the same hybrid. The hybrid P_1 x P_{10} gave the lowest yield of 16.6 gms. for this trait at E_2. On the other hand, the hybrid P_1 x P_6 gave the highest yield of 81.4 gms. at E_1. The combined data showed that the hybrid P_1 x P_6 had the highest yield per plant of 69.7 gms., while the hybrid P_1 x P_{10} had the lowest yield of 27.3 gms. per plant.

Oil percent (Oil %) varied not only from one hybrid to another but also from one environment to another for the same hybrid. The hybrid P_1 x P_8 gave the lowest percent ratio of (35.1) oil % at E_1. On the other hand, the hybrid P_5 x P_2 gave the highest percent ration of 48.3 % oil at E_1. The combined data showed that the hybrid P_4 x P_7 produced more oil % of 46.7 %, while the hybrid P_1 x P_8 produced less oil of 36.7 %.

The results obtained for yield and yield component traits showed that N.se./sil. and N.sil./pl. were very effective in determination S.Y./pl. in grams, while 1000 S.W.gms. was less effective. Therefore, selection for more N.sil./pl. and more N.se./sil. would increase yield. In this connection similar results obtained by Kandil *et al.* (1996), Halaka (2000), Teilep (2003) and Kassab (2004).

Correlation coefficient measures the power of association between any two traits. When the correlation coefficient is positive and significant it indicates that the increase in one trait would accordingly increase the other. The analyses of covariance in addition to the analyses of variance of all pairs of traits would result in the estimation of phenotypic (r_{ph}) and genotypic (r_g)

correlations between these pairs of traits. It is usually expected that the magnitude of r_{ph} correlation is larger than its corresponding estimate of r_g correlation. This is true because the environmental factors affecting the r_{ph} correlation more than the r_g correlation.

In the present investigation, the r_{ph} and r_g correlations were separately estimated for the parents and the F_1 hybrids. The results of these estimates are presented in Tables 3 and 4 for parents and hybrids, respectively.

Phenotypic and genotypic correlations within the parental lines:

For parental lines, the results showed variable directions of correlations since some estimates were negative and the others were positive. Most of these estimates were insignificantly positive or negative with except the r_{ph} and r_g correlation values obtained between plant height (P.H.cms.) and height of the first branch (H.f.br.cms.), 1000 seed weight in grams (1000S.W.gms.) and each of number of siliqua per plant (N.sil./pl.) and seed yield per plant in grams (S.Y./pl. gms.) and finally between number of siliqua per plant (N.sil./pl.) and seed yield per plant in grams (S.Y./pl. gms.). The values of r_{ph} and r_g correlation coefficients between those pairs of traits reported earlier were positive and significant. This finding indicated the presence of high association between them. The positive and significant r_{ph} and r_g correlations between P.H. cms. and H.f.br. cms. indicated that the height of first branch started higher from the surface of the soil, when the plant was tall. Although the direction of r_{ph} and r_g correlations were positive, it is undesirable because, in this case, plants would give less number of primary branches per plant. This result was insured by the presence of negative r_{ph} and r_g correlations between P.H. cms. and N.pr.br./pl..

The most desirable r_{ph} and r_g correlations were obtained between N.sil./pl. and S.Y./pl. gms. and between 1000 S.W.gms. and S.Y./pl. gms. which showed positive and significant values. Therefore, these three traits showed a desirable association. This finding indicated that selection program to increase one trait would, indeed increase the others. It is very important to indicate that S.Y./pl. gms was positively correlated with oil %, although it was not significant. This results is economically desirable because the increase in both S.Y./pl. gms. and in oil % would increase the final oil yield.

It should be mentioned that all negative r_{ph} and r_g correlations were insignificant indicating that this type of association was not important specially the values of r_{ph} and r_g correlations were very small. The negative r_{ph} and r_g correlations between 1000 S.W. gms and N.se./sil. indicating that when siliqua had more seeds, the size and the weight of seeds become lighter.

In general, it could be concluded that S.Y./pl. gms is a function of N.sil./pl. and 1000 S.W. gms.. The selection for heavier seed and more N.sil./pl. would, indeed, increase the total seed yield and therefore, the total oil yield.

Phenotypic and genotypic correlations within hybrids:

Table 3: Phenotypic (r_{ph}) and genotypic (r_g) correlation between pairs of all studied traits for the 10 parents obtained from the combined data over three environments.

Traits	Corr.	P.H. cms	N.pr.br. /pl.	H.f.br.	1000 s.w.	N.seed/ sil.	N. sil./pl.	S.Y./ pl.	Oil %
D.50%f.	r_{ph}	0.445	-0.070	0.463	-0.487	0.195	-0.022	-0.288	0.158
	r_g	0.533	-0.073	0.506	-.0677	0.280	-0.013	-0.308	0.195
P.H. Cms	r_{ph}		-0.023	0.86**	-0.047	0.119	-0.093	0.077	-0.102
	r_g		-0.026	0.91**	0.021	0.093	-0.068	0.069	-0.132
N.pri. bra./pl.	r_{ph}			0.274	0.183	-0.312	0.028	0.061	-0.254
	r_g			0.297	0.279	-0.429	-0.002	0.061	-0.261
H.f.bra.	r_{ph}				-0.254	0.307	-0.019	-0.011	-0.266
	r_g				-0.308	0.399	-0.018	0.002	-0.255
1000 s.w.	r_{ph}					-0.395	0.314	0.663**	0.323
	r_g					-0.628	0.941**	0.880**	0.380
N.seed/ sil.	r_{ph}						-0.456	-0.158	0.153
	r_g						-0.587	-0.207	0.241
N. sil./pl.	r_{ph}							0.807**	0.201
	r_g							0.950**	0.252
S.Y./pl	r_{ph}								0.360
	r_g								0.348

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

Table 4: Phenotypic (r_{ph}) and genotypic (r_g) correlation between pairs of all studied traits for F_1 hybrids and F_{1r} reciprocal hybrids obtained from the combined data over three environments.

Trait	Corr.	P.H. cms	N.pr.br. /pl.	H.f.br.	1000 s.w.	N.seed/ sil.	N. sil./pl.	S.Y./ pl.	Oil %
D.50%f.	r_{ph}	0.062	0.027	0.071	0.024	-0.096	0.044	0.016	0.014
	r_g	0.059	0.027	0.070	0.027	-0.101	0.045	0.016	0.011
P.H. Cms	r_{ph}		0.166	0.067	-0.024	-0.095	0.087	0.061	0.122
	r_g		0.166	0.061	-0.019	-0.085	0.082	0.062	0.120
N.pri. bra./pl.	r_{ph}			-0.010	0.023	-0.023	0.044	0.056	0.034
	r_g			-0.004	0.015	-0.029	0.051	0.057	0.037
H.f.bra.	r_{ph}				-0.036	-0.076	-0.031	-0.063	0.003
	r_g				-0.039	-0.088	-0.029	-0.065	0.005
1000 s.w.	r_{ph}					0.086	-0.185	0.021	-0.094
	r_g					0.078	-0.118	0.018	-0.095
N.seed/ sil.	r_{ph}						-0.171	-0.019	0.008
	r_g						-0.128	-0.019	0.003
N. sil./pl.	r_{ph}							0.289**	0.016
	r_g							0.289**	0.017
S.Y./pl	r_{ph}								-0.016
	r_g								-0.017

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

The results showed variable directions for correlations, since some estimates were negative and some others were positive. The most desirable r_{ph} and r_g correlations were obtained between S.Y./pl. gms. and N.sil./pl. which showed positive and significant values. Therefore, these two traits showed a desirable association indicating that selection to increase one trait would, indeed, increase the other. It should be mention that all negative r_{ph} and r_g correlations were insignificant indicating that this type of association was not important, the values of r_{ph} and r_g correlations were small. The negative r_{ph} and r_g correlations between 1000 S.W. gms. and N.sil./pl.

indicated that: when plant had more siliqua, the size and weight of seeds become less.

The results of this investigation for r_{ph} and r_g were different from the results obtained by Sharief and Keshta (2002), Marinkovic *et al.* (2003), Teilep (2003) and Kassab (2004). On the other hand, the results obtained by El-Baz and El-Shakhess (2001) and Maria *et al.* (2003) were very close to the results obtained in this investigation.

REFERENCES

Cockerham, W.G. and G.M. Cox (1963). Experimental Desigen. 2nd ed. Hojn Wily, Sons, Inc. New York, USA pp. 595.

El-Baz, M.G.M. and S.A.M. El-Shakhess (2001). Stability and correlation studies of some economic characters of rapeseed (*Brassica napus* L.) in Egypt. J. Agric. Sci. Mansoura Univ., 26(10): 5939-5949.

Halaka, M.A.(2000). Evaluation of homozygous and hybrids of canola under different plant population. M. Sc. Thesis, Faculty of Agric. Mansoura Univ., Egypt.

Hamed, M.F. (1993). Evaluation of some rapeseed cultivars performance to water requirements and fertilization in light soils. Ph. D. Thesis, Faculty of Agric. Ain Shams Univ., Egypt.

Hammad, K.M. (1998). Heterosis and combining ability in rapeseed (*Brassica napus* L.) by diallel analysis. J. Agric. Sci. Mansoura Univ., 23(7): 2991-3000.

Kandil, A.A.; S.I. El-Mohandes and N.M. Mahrous (1996). Heterosis in intervarietal crosses of oilseed rape "Canola" (*Brassica napus* L.). Proc. 7th Conf. Agronomy, El-Mansoura, 9-10 Sept., pp. 471-476.

Kassab, M.A. (2004). Evaluation of some canola hybrid. M. Sc. Thesis, Faculty of Agric. Al-Azhar Univ., Egypt.

Maria, O.; A. Liersch and I.B. Broda (2003). Relationship between yield and biometric characters of hybrid and open pollinated varieties of winter rapeseed. Proceeding of the 11th International Rapeseed Congress, Copenhagen, Denmark, 6-10 July, pp. 441-444.

Marinkovic, R.; A.M. Jeromela; J. Crnobarac and J. Lazareviv (2003). Path-coefficient analysis of yield components of rapeseed (*Brassica napus* L.). Proceeding of the 11th International Rapeseed Congress, Copenhagen, Denmark, 6-10 July, pp. 988-991.

Ozer, H.; E. Oral and U. Dogru (1999). Relationships between yield and yield components on currently improved spring rapeseed cultivars. Turkish J. Agric. And Forestry, 23(6): 603-607.

Riaz, G.L.; Z. Quresh; M.S. Swati and C.F. Guiros (2001). Genetic diversity of oil seed (*Brassica napus* L.) inbred lines based on sequence related amplified polymorphism and its relation to hybrid performance. Plant breeding, 120(5): 411-415.

Sharief, A.E. and M.M. Keshta (2002). Influence of sowing dates and plant density on growth and yield of canola (*Brassica napus* L.) under salt affected soils in Egypt. Scientific Journal of King Faisal University (Basic and Applied Sciences), 3(1): 65-77.

Singh, R.K. and B.D. Chaudhary (1985). Biometrical methods in quantitative genetic analysis. Kalyani Pub. New Delhi-Ludhiana. 3rd ed.

Steel, R.K.D. and J.H. Torrie (1960). Principles and procedures of statistics. Mc Graw Hill Book Company Inc., New York, USA.

Teilep, W.M. (2003). Breeding studies on rapeseed crop in new land (Brassica napus L.). M. Sc. Thesis, Faculty of Agric. Al-Azhar Univ., Egypt.

سلوك الآباء والهجن بينها وطبيعة الارتباط للصفات الاقتصادية في الكانولا

علي ماهر العدل*، أشرف حسين عبد الهادى*، معاطى معاطى قشطة**، السيد فهمى العزونى**

* قسم الوراثة – كلية الزراعة – جامعة المنصورة

** قسم بحوث المحاصيل الزيتية – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية

تعتبر الكانولا من المحاصيل الجديدة في مصر والتي تزرع من أجل الحصول على الزيت من بذورها حيث تحتوى على نسبة عالية من الزيت (٤٠% – ٤٥%) تقريبا ، ونظرا لكونها محصولا جديدا فان الأبحاث التي أجريت عليها بغرض التحسين الوراثي قليلة ، ولذا كانت هذه الدراسة إحدى الخطوات المهمة لسد النقص في هذا الاتجاه.

استخدم في هذا البحث ١٠ سلالات نقية من الكانولا تم الحصول عليها من قسم بحوث المحاصيل الزيتية بمحطة البحوث الزراعية بالسرو– مركز البحوث الزراعية ، وهى سبع سلالات مصرية وهي: سرو٤ (P_1) ، سرو٦ (P_2) ، سرو٣٧ (P_3) ، سرو٦٤ (P_4) ، سرو٩٨ (P_5) ، سرو١٠١ (P_6) ، سرو١٠٣ (P_7) ، و ثلاث سلالات مستورد وهي: مستورد ٣٢٥ (P_8) ، مستورد ١٦٣ (P_9) ، مستورد ١٦٤ (P_{10}).

تم التهجين بين هذه السلالات الأبوية العشرة وذلك طبقا للنظام الدوري الكامل للحصول على ٤٥ هجينا و ٤٥ هجينا عكسيا. تم تقييم الجيل الأول والاباء في ثلاث بيئات مختلفة وهي: الجمالية (E_1) ٢٠٠٢/ ٢٠٠٣ ، السرو (E_2) ٢٠٠٢ / ٢٠٠٣ ، السرو (E_3) ٢٠٠٣ / ٢٠٠٤

وكانت النتائج المتحصل عليها كالتالي:

- وجود تباينات عالية بين التراكيب الو راثية المختلفة.
- كانت السلالة ٣٢٥ (P_8) هي الأكثر تبكيرا ، بينما السلالة سرو٦ (P_2) أفضل الآباء في ارتفاع النبات وعدد البذور/ القرن ، والسلالة سرو٣٧ (P_3) الأكبر فى عدد الفروع على النبات ، بينما السلالة سرو٤ (P_1) افضل محصول / النبات بالجرام ، و السلالة ١٦٤ (P_{10}) الأفضل فى وزن الألف بذرة ونسبة الزيت. وكان الهجين بين ($P_4 \times P_7$) أفضل الهجن في نسبة الزيت ، بينما الهجين بين ($P_1 \times P_8$) الأقل في نسبة الزيت.

وقد أظهرت الدراسة وجود ارتباط مظهري ووراثي موجب وعالي المعنوية بين ارتفاع النبات/ السم وارتفاع أول فرع بالسنتيمتر وكذلك بين وزن الـ١٠٠٠ بذرة وكل من عدد القرون/ النبات ومحصول البذور/النبات بالجرام لسلالات الأباء. كذلك وجد ارتباط وراثي ومظهري موجب وعالي المعنوية بين عدد القرون/ النبات ومحصول البذور/ النبات بالجرام للهجن.