Indian J. Genet., **63**(1): 89-90 (2003)

Short Communication

Combining ability analysis in varietal crosses of fennel (*Foeniculum vulgare* Mill.)

Abhay Dashora[1], E.V. D. Sastry, D. Singh and A. K. Nagda[1]

Department of Plant Breeding and Genetics, S.K.N. College of Agriculture, R.A.U., Jobner 303 329

(Received: May 2002; Revised: February 2003; Accepted: February 2003)

Fennel (*Foeniculum vulgare* Mill), an important spice crop, is being cultivated for its seeds which are used for mastication and chewing. The crop has potential as cash crop in the state of Rajasthan, yet it has not received due attention for its genetic improvement. In the present investigation, an effort was made to study the combining ability effects for yield and its components in fennel.

Material for the study comprised of nine genetically diverse varieties (open pollinated populations) namely RF-125, UF(M)-1, UF-90, RF-101, UF-134, JF-29, HF-71, HF-102 and local type. Diallel crosses, excluding reciprocals, were made during rabi 1997-98 and their progenies evaluated in rabi 1998-99. Thirty-six F_1s along with their nine parents were evaluated in randomized complete block design with three replications. In each replication, parents and F_1s were sown in a plot of 2.0 m × 0.9 m size accommodating two rows of 2.0 meters length spaced 45 cm apart with an intra-row spacing of 20 cm maintained by dibbling. Observations were recorded on ten randomly selected plants from each plot for height up to main umbel (cm), total plant height (cm) branches per plant, umbels per plant, umbellets per umbel, seeds per umbel, biological yield per plant (g), harvest index (%) and seed yield per plant (g) while for days to 50% flowering and test weight (g), the data were recorded on whole plot basis. Data on growth and yield attributes were subjected to the analysis of variance of variety cross diallel and estimation of genetic constants was done as per the method II as enumerated by Gardner and Eberhart [1]. This model assumes that parents used are a fixed set of random mating varieties with no epistasis and diverse gene frequencies. The genetic effects are defined as functions ot gene frequencies and additive and dominance effects for individual loci.

Combining ability studies help to assess the prepotency of parents in hybrid combinations. A Judicious choice of parents promotes in improvement process leading to a well-planned hybridization programme. When the parents are inbreds, Griffing [2] combining ability analysis may be applied. However, when the parents are a set of open pollinated varieties, Gardner and Eberhart [1] varietal diallel analysis is an ideal choice. Singh and Paroda [3] compared different techniques of half diallel and received the inter-relationship among various parameters obtained from these analyses. They concluded that the analysis proposed by Gardner and Eberhart [1] model II appears to be superior. Besides providing information on combining ability of parents, it gives clear cut idea about the genetic aspects of heterosis by partitioning the total sum of squares (hjj') into different components of heterosis. Thus analysis II is believed to be the best for the material studied.

The analysis of variance in the present study (Table 1) indicated significant differences for most of the traits revealing the existence of variability among parents and their hybrids. Partitioning of variation due to entries into different components suggested that both the variety as well as heterosis (over all) components were significant for most of the traits. Further more, the proportion of hjj' components accounted for more than 70% of the entries sum of squares indicating the importance of heterosis in the expression of the character. This was true even for the character test weight where the heterosis mean sum of squares was non-significant, the contribution was more than 85% of the entries sum of squares. Significance of vj and hjj' indicating the importance of both additive and non-additive gene effects in their expression. A further partitioning of variation due to heterosis revealed that average heterosis ($\bar{h}$) mean sum of squares was significant for days to 50% flowering while varietal heterosis (*hj*) and specific heterosis (*sjj'*) mean sum of squares were significant for most of the traits except days to 50% flowering and test weight, for varietal heterosis mean sum of squares and branches per plant and test weight, for specific heterosis mean sum of squares indicating that in general all the three

[1]Present address: Department of Plant Breeding and Genetics, Rajasthan College of Agriculture, Udaipur 313 001

Table 1. Percentage of entries sum of squares accounted for by the heterosis sum of squares; per cent heterosis sum of squares accounted for by average heterosis, variety heterosis and specific combining ability sum of squares

Character	Heterosis ss (*hjj'*) as % of entries ss	% heterosis SS accounted for by		
		Average ($\bar{h}$)	Variety (*hj*)	*sca* (*Sjj'*)
Days to 50% flowering	91.56	38.57	12.97#	48.47
Height up to main umbel	80.94	4.14#	28.99	66.87
Total plant height	86.91	1.49#	25.54	72.97
Branches per plant	78.82	0.00#	43.55	56.45#
Umbels per plant	80.19	0.28#	20.99	78.72
Umbellets per umbel	85.54	3.37#	26.62	70.00
Seeds per umbel	83.07	3.19#	32.10	64.70
Test weight	89.05#	3.27#	21.09	75.63#
Biological yield per plant	85.38	0.08#	32.12	67.79
Harvest index	72.49	0.37#	28.69	70.94
Seed yield per plant	86.74	0.36#	15.98	83.66

#Mean sum of squares were not significant at p=0.05

components contributed significantly to the inheritance of the traits.

Partitioning of overall heterosis variation indicated that contribution of specific combining ability was considerably higher (about 50% in general) among the three components. This suggests that data would fit the model 4 and the data did fit to the model supporting the observation of complex inheritance including additive, dominance and epistatic components [4]. Because of the confounding effect, each of the genetic components in the model II of Gardner and Eberhart [1] cannot be estimated separately.

The estimates of genetic constants for eleven characters have been presented in Table 2. None of the constants were found to be significant for days to 50% flowering, height up to main umbel, branches per plant, test weight & harvest index. Varietal heterosis (*hj*) effect was observed to be significant for umbels per plant while specific heterosis (*sjj'*) effects exhibited significant differences for most of the traits. This further supports the conclusion reached regarding the presence of complex type of inheritance. Specific heterosis effects of UF-134 × HF-71 (8.02**), JF-29 × Local (6.14*), RF-125 × HF-102 (5.58*), RF-125 × JF-29 (5.49*), UF-134 × JF-29 (5.37*) and UF(M)-1 × RF-101 (5.11*) was found positive and significant for seed yield per plant. The cross UF (M)-1 × RF-101 showed high *sjj'* effects for seeds per umbel and biological yield per plant besides seed yield per plant. Hence improvement in yield can be expected even when selections are based on these component traits. This cross had the high heterobeltiosis (data not presented) and therefore, the most heterotic combination. Parents UF(M)-1 and RF-101 consistently appeared in majority of crosses which showed superiority on the basis of sjj. The other parents worth considering are UF-90 and JF-29.

Table 2. Varieties and crosses showing the best effects in fennel

Characters	Varietal effect (vj)	Varietal heterosis effect (hj)	Specific heterosis effect (Sjj')
Days to 50% flowering	-	-	-
Height up to main umbel	-	-	-
Total plant height	-	-	UF-90 × Local (-22.40*)
Branches per plant	-	-	-
Umbels per plant	UF-134 (8.96*)	-	HF-102 × Local (14.85**)
			UF-134 × HF-71 (13.31**)
			JF-29 × Local (9.79**)
			RF-125 × UF-90 (8.99*)
			UF-90 × RF-101 (8.17*)
			RF-125 × HF-102 (7.68*)
			UF(M)-I × UF-90 (6.96*)
Umbellets per umbel	-	-	UF-90 × HF-71 (5.82*)
Seeds per umbel	-	-	UF(M)-1 × RF-101 (154.73*)
			UF-90 × HF-71 (124.34*)
Test weight	-	-	-
Biological yield per plant	-	-	JF-29 × Local (27.94**)
			UF(M)-1 × RF-101 (21.61*)
Harvest index	-	-	-
Seed yield per plant	-	-	UF-134 × HF-71 (8.02**)
			JF-29 × Local (6.14*)
			RF-125 × HF-102 (5.58*)
			RF-125 × JF-29 (5.49*)
			UF-134 × JF-29 (5.37*)
			UF(M)-1 × RF-101 (5.11*)

Only significant and desirable crosses listed
*Significant at p=0.05, **Significant at p=0.01

UF(M)-1 and RF-101 merit attention as parents in the development of hybrids. Crossing in fennel is difficult due to small flower size, hence use of recurrent selection and development of composites are suggested to improve yielding ability in fennel.

References

1. **Gardner C. O. and Eberhart A. A.** 1966. Analysis and interpretation of the variety cross diallel and related populations. Biometrics, **22**: 439-452.
2. **Griffing B.** 1956. Concept of general and specific combining ability in relation to a diallel crossing system. Aust. J. Biol. Sci., **9**: 789-809.
3. **Singh O. and Paroda R. S.** 1984. A comparison of different diallel analyses. Theor. Appi. Genet., **67**: 541-545.
4. **Bailey T. B., Qualset Jr. C. O. and Cox D. F.** 1980. Predicting heterosis in wheat. Crop. Sci., **20**: 339-342.