SHORT COMMUNICATION

Genetic Variability, Correlation and Path Coefficient Analysis for Fruit Yield and its Component Traits in Crambe (*Crambe abyssinica* Hochst. ex RE Fries)

Vandana Joshi, Ranbir Singh, S Mandal and SK Mishra
National Bureau of Plant Genetic Resources, New Delhi 110 012

Key words: ***Crambe abyssinica*, Correlation, Morphotypes, Path analysis, Variability**

Crambe abyssinica Hochst. ex RE Fries belongs to family Cruciferae and is a new industrial oilseed plant species, having oil high in erucic acid content (upto 60%) for industrial purposes (Anthony *et al.*, 1993). Crambe is an erect, herbaceous annual plant with stiff stem, covered with fine short hairs. The main stem branches close to the ground from secondary branches. Leaves are glabrous and basically ovate/lyrate. The inflorescence is a cyme, which with progressive growth become long and indeterminate flowering panicle with racemes of white flowers. Fruit is a capsule (siliqua), initially pale green but turns yellowish on maturity. Each capsule contains a single spherical brown seed. The single seeded fruits are spherical. The pod or hull remains on the seed at harvest and is considered a part of the harvested product (Papathanasiou *et al.*, 1966). Derivatives of erucic acid from seed oil can be used for various chemical applications such as slip agents, plasticizers, lubricants, softeners, anti foamers, fixatives in perfumes etc. (Weiss, 2000). Polymers made from this serve as insulation for high voltage electric lines. It can be used for manufacture of nylons, paint and coating that do not shrink or swell with changes in moisture. Crambe oil due to good stability at high temperature, is also very well suited as lubricant for steel casting.

C. abyssinica is primarily a self pollinated plant but some natural outcrossing has been reported (Beck *et al.*, 1975). Lessman and Meier (1972) reported a lack of adequate genetic variability among initial introductions of crambe for important agronomic traits. Scanty information is available about the existence of genetic variability for fruit yield in *Crambe abyssinica* (Papathanasiou *et al.*, 1966 and Lessman, 1975). But *Crambe abyssinica* germplasm has not been screened in India both for fruit as well as oil yield. The present investigation was undertaken for evaluating some exotic lines with respect to extent of variability and nature of association among oil yield and related characters.

A total of 56 exotic germplasm lines of *Crambe abyssinica* obtained from United States Department of Agriculture (USDA), ARS, Beltsville, Maryland, USA were grown during rabi 2002-03 and 2003-04 at NBPGR, Pusa campus, New Delhi in an augmented block design. Each entry was grown in three rows plot of 3 m length each with row spacing of 45 cm distance and plant spacing of 15 cm. The two checks viz. EC400058 and EC400059 were randomized in each block. The crop was raised adopting standard package and practice under rainfed condition. Data was recorded on five randomly selected plants on various agro-morphological characteristics viz. plant height, number of branches per plant, number of fruits per primary branch, length of primary branch, length of main fruiting branch, number of fruits per main fruiting branch, days to 50% flowering and days to maturity. For determination of total oil content, seeds were dried to 4-5% moisture level in oven at 108°C for 16-18 hrs. The total oil content of the seed samples was determined by a non-destructive method using a Newport NHR analyzer {model-4000} from Oxford Analytical Instruments Ltd UK after calibrating with pure seed oil. Fatty acid analysis was done by Gas Liquid Chromatography (GLC). GLC method developed by Mandal *et al.*, 2002 was followed for establishing erucic acid level of the crambe accessions.

The data after computing for each character was subjected to statistical analysis. Phenotypic coefficient of variation was estimated by the formula suggested by Burton (1952). Phenotypic correlation coefficients were worked out by the method described by Al Jibouri *et al.* (1958) and the direct and indirect effects of independent traits on number of fruits per primary

Table 1. Phenotypic (P) correlation coefficients among eight characters in *Crambe abyssinica*

Characters	Plant height (cm)	Number of primary branches	Days to 50% flowering	Days to mean maturity	Length of primary branch	Number of fruits/ primary branch	Length of main fruiting branch	Number of fruits/main fruiting branch
Plant height (cm)	1.00							
Number of primary branches	0.230							
Days to 50% flowering	-0.367**	0.216						
Days to mean maturity	-0.389**	0.109	0.782**					
Length of primary branch	0.458	-0.025	-0.418**	-0.476**				
Number of fruits/primary branch	0.092	0.287*	0.326*	0.234	-0.003			
Length of main fruiting branch	0.117	-0.398**	-0.499**	-0.316*	0.126	0.052		
Number of fruits/main fruiting branch	0.243	-0.230	-0.324*	-0.183	0.147	0.392*	0.841**	1.00

*: P £ 0.05, **: P £ 0.01

branches were estimated by the method of Dewey and Lu (1959). The data recorded on these checks was averaged individually and then compared with different genotypes. Significant variability was observed in *Crambe abyssinica* germplasm. The variability ranged from 73.00-128.80 cm for plant height, 4.40-52.00 for number of primary branches, 24.00-117.20 cm for length of primary branch, 95.50-568.00 for number of fruits per primary branch, 7.20-44.30 cm for length of main fruiting branch and 8.20-57.20 for number of fruits per main fruiting branch. Seed size varied from 0.8-2.6 mm in diameter and 1000 seed weight varied from 1.83-3.66 g (Mandal *et al.*, 2002). The range of oil content and erucic acid varied from 27.91-44.95 and 45.16-62.20% respectively. The highest phenotypic coefficient of variation was observed for length of main fruiting branch (58.00%) followed by number of fruits per main fruiting branch (45.30%) and number of fruits per primary branches (41.40%). Moderate phenotypic coefficient of variation was observed for number of primary branches (28.90%), length of primary branch (21.10%) and plant height (19.10%). However, days to 50% flowering and days to mean maturity showed low estimates of phenotypic coefficient of variation.

Phenotypic correlation coefficients among eight characters are shown in Table 1. Number of fruits per main fruiting branch showed highly significant and positive association with length of main fruiting branch and number of fruits per primary branch and a negative significant association with days to 50% flowering. Number of fruits per primary branches showed significant and positive association with number of primary branches as well as to days to 50% flowering. Length of main fruiting branch showed significant negative association with number of primary branches, days to 50% flowering and days to mean maturity. Length of primary branch showed highly significant positive association with plant height.

Path coefficient analysis (Table 2) revealed that length of main fruiting branch had the maximum direct effect on number of fruits per main fruiting branch followed by number of fruits per primary branches and plant height. Among these length of main fruiting branch and number of fruits per primary branch had a significant positive correlation with number of fruits per main fruiting branch. No other character had significant direct effect. Number of fruits per primary branch though had a high direct effect as well as significant positive association with number of fruits per main fruiting branch but had maximum indirect effect through length of main fruiting branch. Plant height with a good positive effect had no association with number of fruits per main fruiting branch and showed the maximum positive effect with length of main fruiting branch thus plant height does not fit into a criteria for increasing number of fruits per main fruiting branch in *crambe*.

Length of main fruiting branch might be a good selection criterion for improving the number of fruits per main fruiting branch, since it had highest positive significant association with this characteristic and also showed the high positive direct effect on number of fruits per main fruiting branch. So, selection for length of main fruiting branch might result in significant improvement in number of fruits per main fruiting branch in *Crambe abyssinica*. Number of fruits per primary branches also had highly significant and positive association with number of fruits per main fruiting branch. In the light of the above findings, it may be concluded that improvement in characters like length of main fruiting branch and number of fruits per primary

Table 2. Path coefficient analysis of phenotypic correlation coefficients to determine the direct and indirect effects of different traits on number of fruits per main fruiting branch in *Crambe abyssinica*

Characters	Plant height (cm)	Number of primary branches	Days to 50% flowering	Days to mean maturity	Length of primary branch (cm)	Number of fruits/ primary branch	Length of main fruiting branch (cm)	Correlation coefficient with no. of fruits main fruiting branch @
Plant height (cm)	0.156	-0.004	-0.005	-0.032	0.007	0.023	0.097	0.243
Number of primary branches	0.036	-0.019	0.003	0.009	-0.014	0.073	-0.331	-0.23
Days to 50% flowering	-0.057	-0.004	0.012	0.064	-0.007	0.083	-0.416	-0.324*
Days to mean maturity	-0.061	-0.002	0.010	0.082	-0.008	0.059	-0.264	-0.183
Length of primary branch (cm)	0.072	0.001	-0.005	-0.039	0.016	-0.001	0.105	0.147
Number of fruits/primary branch	0.014	-0.006	0.004	0.019	-0.001	0.254	0.043	0.392*
Length of main fruiting branch	0.018	0.008	-0.006	-0.026	0.002	0.013	0.833	0.841**

@ Correlation coefficient with no. of fruits per main fruiting branch; **significant at 0.01 level; *significant at 0.05 level

branch will help in improving the fruit yield of main fruiting branch in *Crambe*.

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