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Heritability And Correlation Coefficient Analysis For Fruit Yield And Its Components In Coriander (*Coriandrum Sativum* L.)

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Abstract

The objectives of this study were to estimate the phenotypic and genotypic coefficients of variation, broad sense heritability, genetic gain and correlations in coriander (*Coriandrum sativum* L.). The experiment was laid out in a randomized complete block design with three replications in the Institute of Agriculture, Karnobat, Bulgaria during a three-year period (2011–2013) and involved 9 coriander genotypes. Genotypes differed significantly at (p>0.001) for all the traits studied. Genotypic coefficients of variation were lower than the corresponding phenotypic coefficients in all the traits studied, indicating considerable influence of the environment on the expression of the traits. High broad sense heritability estimates ranged from 55,88 % for fruit weight per umbel to 94,41 % for number of primary branches per plant, while fruit yield showed 82,80 % heritability. High heritability and genetic advance were recorded for the number of umbels per plant. Fruit yield exhibited significantly positive correlation with the number of umbels per plant (r = 0,858) and fruit weight per plant (r =0,789). Therefore, the results suggest that the number of umbels per plant may be considered as important characters in breeding programs aiming to coriander yield improvement.

Keywords: coriander, heritability, correlation, fruit yield, yield components

Introduction

Coriander (*Coriandrum sativum* L.) is an annual spice herb that belongs to the family of Umbelliferae/Apiaceae. It is used as a spice in culinary, medicine and in perfumery, food, beverage, and pharmaceutical industries (Diederichsen, 1996; Marufi et al. 2010, Chawla at al. 2013).

The development of high yielding-cultivars is the main objective of any breeding program (Ehdaie and Waines, 1989). Development of high-yielding cultivars requires a thorough knowledge of the existing genetic variation for yield and its components. Analysis of variability among the traits and the association of a particular character in relation to other traits contributing to yield of a crop would be of great importance in planning a successful breeding program (Mary and Gopalan, 2006).

Plant breeders commonly select for yield components which indirectly increase yield. Heritability (h2) of a trait is important in determining its response to selection. Breeding to increase grain yield would be most effective, if the components involved are highly heritable and genetically independent or positively correlated

with grain yield. Knowledge of heritability is essential for selection based improvement as it indicates the extent of transmissibility of a character into future generations (Sabesan et al., 2009).

Therefore, the objectives of this study were to estimate the heritability of fruit yield and yield components, and to compute the correlation of fruit yield with yield components among the coriander genotypes.

Materials and Methods

The study was conducted in the Institute of Agriculture - Karnobat, during the period 2011-2013. The experiment was laid out in a randomized complete block design with three replications on plots of 10 m^2. Standard agronomic and plant protection practices were used.

The study included 9 coriander genotypes: №1 - a local variety; №2, №3, №4 - populations developed in the Institute of Agriculture - Karnobat; №5 - Cori 280; №6 - Cori 292;№7 - Cori 412; №8 - Cori 278; №9 - Ames 24913.

At maturity ten plants were randomly selected from each plot and data were collected for plant height, number of branches per plant, number of umbels per plant, number of fruits per umbel, fruit weight per umbel, 1000-fruits weight and fruit weight per plant. The plot yield was converted to t.ha^{-1}.

Analysis of variance, using randomized complete block design, was computed for all the traits evaluated using the computer software system of SPSS 16.00 for Windows 16.0 (SPSS Inc., 2007). Estimates of variance components were generated. Broad-sense heritability (h^2) was calculated as the ratio of the genotypic variance to the phenotypic variance using the formula according to Allard (1960). Genetic advance was calculated at 5% selection intensity (i=2.06). Phenotypic coefficients of correlation were computed using Pearson's linear correlation outlined by Steel and Torrie (1984).

Results and discussion

The analysis of variance revealed significant variations among the genotypes for all the characters examined (Table 1). Effect of genotype by year interaction was found to be significant for all the traits. Effect of year was significant for all the traits except the number of umbels per plant.

Table 1. Mean squares for fruit yield and some yield related traits in coriander /2011-2013/

Traits	Genotype	Year	Interaction
Plant height	468,762*	5561,526*	166,974*
Number of primary branches per plant	29,309*	5,094*	1,638*
Number of umbels per plant	3400,229*	18,925ns	412,387*
Number of fruits per umbel	151,548*	264,652*	28,417*
Fruit weight per umbel	0,004*	0,144*	0,006*
Fruit weight per plant	19,874*	9,748*	1,756*
1000-fruits weight	32,475*	157,381*	10,407*
Fruit yield	0,373*	2,705*	0,064*

*Significant at 0.01 % level of probability;

The mean values of the traits studied are shown in Table 2. Plant height ranged from 59.93 to 82.74 cm. Maximum number of primary branches per plant of 12.05 was exhibited by genotype №6 whereas minimum number of primary branches per plant of 6.99 was recorded for the genotype №4. Number of umbels per plant varied from 31.63 for genotype №9 to 87.25 g for genotype №5. Data for the number of fruits per umbel ranged between 18,50 and 32,92. Maximum fruit weight per umbel was recorded for genotype №7 – 0.27 g, whereas minimum was recorded for №2 - 0.19 g. Fruit weight per plant varied from 4.46 g for №9 to 9.25 g for №5. Weight of 1000-fruits ranged from 6.98 g to 14.33 g in the genotypes evaluated. Maximum mean fruit yield was recorded for genotype № 2 - 1.21 t.ha-1 and minimum fruit yield for № 9 - 0.54 t.ha-1.

Genotypic variance, phenotypic variance, genotypic coefficient of variability (GCV), phenotypic coefficient of variability (PCV), broad sense heritability, and genetic advance expressed for studied traits are presented in Table 3. Number of umbels per plant and plant height and has exhibited high genotypic (σ2g) and phenotypic (σ2ph) variances. Phenotypic coefficient of variability (PCV) values ranged from 9.20% for the fruit weight per umbel to 30.43% for the number of umbels per plant, whereas the genotypic coefficient of variability (GCV) ranged from 6.87% for fruit weight per umbel to 28.52% for number of umbels per plant. PCV value was generally higher than their corresponding GCV values for all the characters considered. According to Deshmukh et al. (1986), PCV and GCV values roughly more than 20% are regarded as high, whereas values less than 10% are considered to be low and values between 10 and 20% to be medium. Based on this delineation, PCV value was low for fruit weight per umbel; medium for plant height, number of primary branches per plant, number of fruits per umbel and 1000-fruits weight; high for number of umbels per plant, fruit weight per plant and fruit yield.

Table 2. Means for fruit yield and some yield related traits of 9 coriander genotypes /2011-2013/

Geno-type	Plant height (cm)	Number of primary branches per plant	Number of umbels per plant	Number of fruits per umbel	Fruit weight per umbel (g)	Fruit weight per plant (g)	1000-fruits weight (g)	Fruit yield ($t.ha^{-1}$)
№1	82,74	8,63	58,20	32,92	0,20	7,55	6,98	0,91
№2	62,81	7,73	67,43	22,19	0,19	6,95	10,45	1,21
№3	62,86	9,51	73,89	20,73	0,23	8,37	10,82	1,01
№4	60,87	6,99	77,62	18,50	0,22	7,51	11,00	0,98
№5	67,27	10,85	87,25	25,12	0,24	9,25	9,86	1,06
№6	70,86	12,05	61,83	21,22	0,22	7,40	11,54	0,99
№7	71,09	11,33	81,33	21,91	0,27	8,82	14,33	1,07
№8	63,13	8,87	35,71	21,94	0,22	5,84	10,27	0,69
№9	59,93	7,43	31,63	23,66	0,23	4,46	10,36	0,54
Mean	66,84	9,26	63,88	23,13	0,23	7,35	10,62	0,94
Minimum	59,93	6,99	31,63	18,50	0,19	4,46	6,98	0,54
Maximum	82,74	12,05	87,25	32,92	0,27	9,25	14,33	1,21

Estimates of heritability in broad sense ranged from 55.88% for fruit weight per umbel to 94.41% for number of primary branches per plant. According to Singh (2001), if heritability of a character is very high, say 80% or more, selection for such characters could be fairly easy. This is because there would be a close correspondence between the genotype and the phenotype due to the relative small contribution of the environment to the phenotype. Although, for characters with low heritability, say 40% or less, selection may be considerably difficult or virtually impractical due to the masking effect of environment. Considering this benchmark, heritability estimate was high (>80%) for fruit yield, fruit weight per plant, number of fruits per umbel, number of umbels per plant and number of primary branches per plant. It was moderate (56 to 80%) for the remaining quantitative characters.

Since high heritability does not always indicate a high genetic gain, heritability with genetic advance considered together should be used in predicting the ultimate effect for selecting superior varieties (Ali et al., 2002). Genetic advance was the highest for number of umbels per plant (35,18 %). Other characters showed from moderate to low genetic advance. Panse (1957) stated that high heritability coupled with high genetic advance indicates the additive gene effects while high heritability coupled with low genetic advance indicates the non-additive gene effects for control of the particular character. However, high heritability and low genetic advance were observed for fruit yield indicating that the yield could be improved through the use of hybridization. Plant height, number of umbels per plant, number of fruits per umbel can be improved by selection, as these characters exhibited moderate genotypic and phenotypic coefficient of variations along with both medium to high heritability and genetic advance. Low genetic coefficient of variation, heritability and genetic advance obtained for fruit weight per umbel. Therefore, direct selection for this trait may not be possible.

The knowledge of correlation coefficients between different yield attributes helps the breeder to find out the nature and magnitude of the association between these traits which are mostly used to attain better yield of the crop. Values of phenotypic correlation coefficients estimated for all studied characters are presented in Table 4. Fruit yield per plot exhibited a significant and positive correlation with the number of umbels per plant (r = 0,858) and fruit weight per plant (r = 0,789). Plant height had positive correlation with number of fruits per umbel (r = 0,783). The phenotypic correlation of number of umbels per plant with fruit weight per plant was highly significant (r = 0.933). Number of fruits per umbel had negative correlation with 1000-fruits weight (*r* = -0.726). Positive association between number of umbels per plant and fruit yield in coriander has been reported by Jindla et al. (1985), Bahandari and Gubta (1991) and Meena et al. (2014).

Table 3. Estimates of variance and genetic parameters for fruit yield and yield related traits in coriander

Traits	σ^2g	σ^2ph	h^2 /%/	GCV /%/	PCV /%/	GA
Plant height	33,5320	52,0847	64,38	8,66	10,80	9,57
Number of primary branches per plant	3,0745	3,2565	94,41	18,94	19,49	3,51
Number of umbels per plant	331,9825	377,8032	87,87	28,52	30,43	35,18
Number of fruits per umbel	13,6812	16,8387	81,25	15,99	17,74	6,87
Fruit weight per umbel	0,0003	0,0004	55,88	6,87	9,20	0,02
Fruit weight per plant	2,0131	2,2082	91,16	19,30	20,22	2,79
1000-fruits weight	2,4519	3,6083	67,95	14,74	17,89	2,66
Fruit yield	0,0343	0,0414	82,80	19.70	21.65	0.35

σ^2g - genotypic variance; σ^2ph - phenotypic variance; h^2 - heritability in broad sense; GCV - genotypic coefficient of variation; PCV - phenotypic coefficient of variation; GA - genetic advance;

The present study indicated that the number of umbels per plant showing high heritability and high genetic advance and positive correlations with fruit yield and consequently may be considered as important characters in breeding programs aiming to coriander yield improvement.

Table 3. The phenotypic correlations among the traits

Traits	Plant height	Number of primary branches per plant	Number of umbels per plant	Number of fruits per umbel	Fruit weight per umbel	Fruit weight per plant	1000-fruits weight
Fruit yield	0,201	0,327	0,858**	-0,127	-0,070	0,789**	0,241
Plant height	1	0,417	0,158	0,783**	-0,097	0,380	-0,347
Number of primary branches per plant		1	,381	-0,001	0,479	0,580	0,416
Number of umbels per plant			1	-0,158	0,285	0,933**	0,308
Number of fruits per umbel				1	-0,304	0,027	-0,726*
Fruit weight per umbel					1	0,340	0,714*
Fruit weight per plant						1	0,219
1000-fruits weight							1

** - correlation is significant at the 0.01 level; * - correlation is significant at the 0.05 level

Conclusion

Genotypes differed significantly for all the traits studied. Genotypic coefficients of variation were lower than the corresponding phenotypic coefficients in all the traits studied, indicating considerable influence of the environment on the expression of the traits. High broad sense heritability estimates ranged from 55,88 % for fruit weight per umbel to 94,41 % for number of primary branches per plant, while fruit yield showed 82,80 % heritability. High heritability and genetic advance were recorded for the number of umbels per plant. This suggests that this trait is primarily under genetic control and selection for it can be achieved through its phenotypic performance. Fruit yield exhibited significantly positive correlation with the number of umbels per plant (r = 0,858) and fruit weight per plant (r =0,789). Thus, the results indicate that the number of umbels per plant can be used for fruit yield selection.

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