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CORRELATION ANALYSIS OF TRAITS IN ELITE GENOTYPES OF CORIANDER

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SUMMARY

Coriander (*Coriandrum sativum* L.) has been cultivated for a long time in different parts of India and the world. This study aimed to identify the role of coriander seeds towards improved nutrition, which is essential for biological processes. The present investigation was carried on 64 coriander genotypes to identify the traits associated with seed yield and their attributes. Results revealed that seed yield plant^{-1} exhibited a positive and significant correlation with number of fruits umbel^{-1} but negative correlation with days to 50% flowering and days to 80% maturity. Almost all genotypes studied revealed diverse properties, making them suitable genetic materials for breeding homogenous coriander cultivars. Our research goal was to elucidate the diversity of agronomic, physiological and yield traits in coriander. In the present investigation, genotypic correlation coefficients were higher than the phenotypic ones because of the masking effect of genotypes for the expression of characters. Seed yield plant^{-1} exhibited a positive and significant correlation with number of fruits umbel^{-1} but was negatively correlated with days to 50% flowering and 80% maturity, whereas number of fruits umbellet^{-1} expressed a positive significant correlation with number of fruits umbel^{-1} and 1000-seed weight. A positive correlation was also noted between 1000-seed weight and number of fruits umbel^{-1}.

Keywords: Coriander, correlation coefficient, genotypic correlation, phenotypic correlation

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INTRODUCTION

Coriander (*Coriandrum sativum* L.) is an annual herb that belongs to the family Apiaceae (Umbelliferae) and is known to originate from the Mediterranean region (Hedberg and Hedberg, 2003). The Egyptians call this herb the "spice of happiness," probably because of its aphrodisiac property (Uhl 2000). It shows broad adaptation as a crop around the world, growing well under different kinds of soil and weather conditions (Simon 1990, Pedro *et al.*, 2008), even at extreme latitudes and elevations. In addition, the short life cycle of most coriander cultivars allows farmers to fit their cultivation into some part of the growing season in almost any region. Coriander has long been cultivated in the Mediterranean region, southern Europe, Asia Minor and the Caucasus. In recent years, principal commercial coriander producers include members of the former Soviet Union, Hungary, Poland, Romania, Czech Republic, Slovakia, Morocco, Canada, India, Pakistan, Iran, Turkey, Guatemala, Mexico and Argentina (Kiehn and Reimer 1992, Agri-facts 1998).

In India, coriander is mainly cultivated in Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Assam, Maharashtra, Rajasthan, Uttar Pradesh and Punjab. More recent applications include its use as a green vegetable and as flavoring of dishes and food such as pickles, sauces and confectionery. It is increasingly becoming important in the oleo-chemical industry. Coriander produces a lot of nectar and attracts many different insects for pollination. It is also a good melliferous (yielding or producing honey) plant, allowing bees to collect a lot of honey. All parts of the plant are edible but it is mostly grown for the green vegetable and seeds, which when dried, have a mild aromatic flavor. Thus, it is mainly grown as a dual-purpose crop for seeds (dry fruits) as well as for its leaves.

There are many different uses of coriander and these are based on the different parts of the plant. Traditional uses of the plant, which are based on the primary products (the fruits and the green herb), are two-fold: medicinal and culinary. During industrialization, specific chemical compounds of coriander were recognized and identified, and these became important raw materials for industrial use and further processing. The seeds are used as an important ingredient in various food preparations and the leaves are often used for garnishing dishes. The leaves, stalks and seeds of coriander contain certain essential oils. The essential and fatty oils of the fruits are used in industry, either separately or combined. Coriander freely cross-pollinates and does so without showing signs of inbreeding depression. Although coriander is one of the most important spices, very little attention has been given for its improvement. There are few recognized commercial varieties in India. It is necessary to develop more suitable varieties for seed production to fulfill the increasing demand for this spice crop.

A germplasm collection with good variability for desirable characters is a basic requirement of any crop improvement program (Singhania *et al*., 2006). Knowledge of the magnitude and direction of interrelationship between yield and its component characters is of great importance in breeding programs to select desirable types. The present study addresses this goal by examining 64 species of coriander.

MATERIALS AND METHODS

The experiment was carried out at the Vegetable Research Farm, Department of Horticulture, College of Agriculture, JNKVV, Jabalpur (MP) during the rabi seasons of 2010-11 and 2011-12. Sixty-four diverse genotypes were raised in Randomized block design with 3 replications. The seeds were split into 2 mericarps and sown directly into experimental plots with a spacing of 30 x 10 cm between 2 consecutive rows and plant.

Chlorophyll content in coriander leaves was estimated by the use of a chlorophyll meter. Correlation coefficients were calculated for all quantitative character combinations at the phenotypic, genotypic and environmental levels using the formula given by Miller *et al*. (1958). The genotypic, phenotypic and environmental correlations were computed by substituting the corresponding variance and covariance in the above mentioned formula. The estimation of covariance between 2 traits was derived in the same way as that for corresponding variance components.

RESULTS

Correlation provides the degree and direction of a relationship between variables at phenotypic, genotypic and environmental levels. Correlation coefficients were calculated at these three levels for all possible combinations of 14 characters (Tables 1, 2 and 3). Results indicated that genotypic correlation coefficients in general were of higher magnitude than the corresponding phenotypic correlation coefficients. Phenotypic correlation generally gives an idea about the association between 2 variables. The results of the present study are discussed below.

With regard to the results of first year (Table 1), plant height at maturity recorded a positive and significant association with chlorophyll content at 60 DAS (0.392), seed yield plant^{-1} (0.260), days to 80% maturity (0.152), days to 50% flowering (0.148) and number of primary branches plant^{-1}(0.137).

Table 1. Estimates of genotypic and phenotypic correlation coefficients for yield and its contributing characters in coriander (1st year).

Character		Chlorophyll content at 60 DAS	No. of primary branches	No. of fruiting nodes	Days to 50% flowering	Days to 80% maturity	No. of umbels plant^{-1}	No. of umbellets umbel^{-1}	No. of fruits umbellet^{-1}	No. of fruits umbel^{-1}	Diameter of fruit (mm)	Vegetative yield (kg)	1000-seed weight (g)	Seed yield plant^{-1} (g)
Plant height at maturity	G	0.405	0.155	0.061	0.150	0.151	0.092	0.211	0.069	0.167	-0.052	0.123	0.043	0.262
	P	0.392**	0.137*	0.060	0.148*	0.152*	0.080	0.111	0.060	0.086	-0.035	0.114	0.043	0.260**
Chlorophyll content at 60 DAS	G		0.419	0.129	0.275	0.251	0.194	0.291	0.211	0.208	-0.016	0.243	0.071	0.361
	P		0.360**	0.126	0.266**	0.240**	0.176*	0.124	0.187**	0.104	0.009	0.240**	0.070	0.335**
No. of primary branches	G			0.519	-0.008	-0.030	0.528	0.719	0.521	0.711	0.417	-0.13	-0.034	0.600
	P			0.465**	0.004	-0.007	0.441**	0.359**	0.390**	0.348**	0.279**	-0.103	-0.032	0.522**
No. of fruiting nodes	G				0.121	0.122	0.961	0.907	0.268	0.784	0.021	-0.046	-0.016	0.846
	P				0.124	0.126	0.920**	0.476**	0.233**	0.476***	0.022	-0.038	-0.018	0.819**
Days to 50% flowering	G					0.991	0.128	0.183	-0.163	-0.052	-0.053	0.307	-0.287	0.315
	P					0.976**	0.121	0.116	-0.145*	-0.039	-0.040	0.283**	-0.282**	0.303**
Days to 80% maturity	G						0.128	0.213	-0.174	-0.031	-0.081	0.282	-0.273	0.326
	P						0.109	0.146*	-0.147*	-0.019	-0.063	0.267**	-0.270**	0.310**
No. of umbels plant^{-1}	G							0.861	0.190	0.676	0.066	-0.034	-0.083	0.869
	P							0.431**	0.147*	0.445**	0.038	-0.037	-0.083	0.819**
No. of umbellets umbel^{-1}	G								0.593	1.043	0.174	0.090	0.146	0.896
	P								0.289**	0.464**	0.035	0.031	0.07	0.428*
No. of fruits umbellet^{-1}	G									0.831	-0.027	-0.097	0.289	0.175
	P									0.480**	-0.003	-0.062	0.257**	0.158*
No. of fruits umbel^{-1}	G										-0.133	-0.001	0.190	0.745
	P										-0.033	-0.008	0.110	0.400**
Diameter of fruit (mm)	G											-0.272	-0.126	0.135
	P											-0.199**	-0.092	0.100
Vegetative yield (kg)	G												-0.123	0.130
	P												-0.119	0.119
1000-seed weight (g)	G													-0.106
	P													-0.104

*, **Significant at 5 and 1% level, respectively.

Chlorophyll content at 60 DAS showed a positive and highly significant correlation with number of primary branches plant^{-1} (0.360), seed yield plant^{-1} (0.335), days to 50% flowering (0.266), days to 80% maturity (0.240), vegetative yield plot^{-1} (0.240), number of fruits umbellet^{-1} (0.187) and number of umbels plant^{-1} (0.176). Highly significant and positive association of primary branches plant^{-1} was observed with seed yield plant^{-1} (0.522), number of fruiting nodes plant^{-1} (0.465), number of umbels plant^{-1} (0.441), number of fruits umbellet^{-1} (0.390), number of umbellets umbel^{-1} (0.359), number of fruits umbel^{-1} (0.348) and diameter of fruits (0.279).

The correlation of number of fruiting nodes plant^{-1} was significant and positive with number of umbels plant^{-1} (0.920), seed yield plant^{-1} (0.819), number of umbellets umbel^{-1} (0.476), number of fruits umbel^{-1} (0.476) and number of fruits umbellet^{-1} (0.233). Days to 50% flowering had highly significant and positive association with days to 80% maturity (0.976), seed yield plant^{-1} (0.303) and vegetative yield plot^{-1} (0.283). The association was negative and significant with 1000-seed weight (-0.282) and number of fruits umbellet^{-1} (-0.145). Days to 80% maturity had a significant and positive correlation with seed yield plant^{-1} (0.310), vegetative yield plot^{-1} (0.267), and number of umbellets umbel^{-1} (0.146), whereas 1000-seed weight (-0.270) and number of fruits umbellet^{-1} (-0.147) showed significant and negative association.

Highly significant and positive association of number of umbels plant^{-1} was recorded with seed yield plant^{-1} (0.819), number of fruits umbel^{-1} (0.445), number of umbellets umbel^{-1} (0.431) and number of fruits umbellet^{-1} (0.147). A very strong positive and significant association of number of umbellets umbel^{-1} with number of fruits umbel^{-1} (0.464), seed yield plant^{-1} (0.428) and number of fruits umbellet^{-1} (0.289) was observed. The association of number of fruits umbellet^{-1} was significant and positive with number of fruits umbel^{-1} (0.480), 1000-seed weight (0.257) and seed yield plant^{-1} (0.158). Number of fruits umbel^{-1} expressed a positive and significant correlation with seed yield plant^{-1} (0.400) while fruit diameter exhibited a negative and significant correlation with vegetative yield plot^{-1} (-0.199).

In the second year (Table 2), plant height at maturity had a significant and positive association with chlorophyll content at 60 DAS (0.414), seed yield plant^{-1} (0.238), days to 50% flowering (0.165) and days to 80% maturity (0.158). The association of chlorophyll content at 60 DAS was significant and positive with seed yield plant^{-1} (0.344), number of primary branches plant^{-1} (0.333), days to 50% flowering (0.287) and 80% maturity (0.252), vegetative yield plot^{-1} (0.230), number of umbels plant^{-1} (0.182) and number of fruits umbel^{-1} (0.149). Number of primary branches plant^{-1} had significant and positive association with seed yield plant^{-1} (0.573), number of umbels plant^{-1} (0.517), number of fruiting nodes plant^{-1} (0.468), number of umbellets umbel^{-1} (0.403) and number of fruits umbellet^{-1} (0.395), fruit diameter (0.287) and number of fruits umbel^{-1} (0.264).

A strong positive association of number of fruiting nodes plant^{-1} was observed with number of umbels plant^{-1} (0.951), seed yield plant^{-1} (0.805), number of umbellets umbel^{-1} (0.609), number of fruits umbel^{-1} (0.409) and number of fruits umbellet^{-1} (0.316). Days to 50% flowering showed positive and highly significant correlation with days to 80% maturity (0.988), vegetative yield plot^{-1} (0.306) and seed yield plant^{-1} (0.285). On the other hand, it was negatively associated with 1000-seed weight (-0.272). Days to 80% maturity had a positive association with vegetative yield plot^{-1} (0.306) and seed yield plot^{-1} (0.283), however; it exhibited a significant negative association with 1000-seed weight (-0.268) and number of fruits umbellet^{-1} (-0.144).

A strong positive correlation of umbels plant^{-1} was seen with seed yield plant^{-1} (0.830), number of umbellets umbel^{-1} (0.608), number of fruits umbel^{-1}(0.422) and number of fruits umbellet^{-1}(0.306). The number of umbellets umbel^{-1} recorded a significant positive association with seed yield plant^{-1} (0.564), number of fruits umbel^{-1} (0.404) and number of fruits umbellet^{-1} (0.352). The number of fruits umbellet^{-1} had a positive and significant correlation with seed yield plant^{-1} (0.291), number of fruits umbel^{-1} (0.291) and 1000-seed

Table 2. Estimates of genotypic and phenotypic correlation coefficients for yield and its contributing characters in coriander (2nd year).

Character		Chlorophyll content 60 DAS	No. of primary branches	No. of fruiting nodes	Days to 50% flowering	Days to 80% maturity	No. of umbels plant^{-1}	No. of umbellets umbel^{-1}	No. of fruits umbellet^{-1}	No. of fruits umbel^{-1}	Diameter of fruit (mm)	Vegetative yield (kg)	1000-seed weight (g)	Seed yield plant^{-1} (g)
Plant height at maturity	G	0.415	0.093	0.039	0.165	0.158	0.071	0.149	0.042	-0.008	-0.029	0.128	0.001	0.245
	P	0.414**	0.087	0.039	0.165*	0.158*	0.071	0.096	0.033	-0.005	-0.015	0.121	0.001	0.238**
Chlorophyll content 60 DAS	G		0.363	0.115	0.289	0.254	0.186	0.184	0.184	0.166	-0.006	0.248	0.010	0.359
	P		0.333 **	0.116	0.287**	0.252**	0.182**	0.121	0.149*	0.092	-0.002	0.230**	0.010	0.344**
No. of primary branches	G			0.519	0.016	-0.025	0.567	0.649	0.556	0.550	0.501	-0.136	-0.124	0.634
	P			0.468**	0.015	-0.021	0.517**	0.403**	0.395**	0.264**	0.287**	-0.117	-0.097	0.573**
No. of fruiting nodes	G				0.109	0.105	0.972	0.950	0.417	0.732	0.012	-0.037	-0.067	0.843
	P				0.107	0.103	0.951**	0.609**	0.316**	0.409**	0.019	-0.039	-0.076	0.805**
Days to 50% flowering	G					0.991	0.084	0.187	-0.165	-0.110	-0.066	0.324	-0.281	0.295
	P					0.988**	0.082	0.118	-0.129	-0.063	-0.043	0.306**	-0.272 **	0.285**
Days to 80% maturity	G						0.075	0.183	-0.181	-0.110	-0.093	0.323	-0.277	0.293
	P						0.074	0.122	-0.144*	-0.056	-0.055	0.306**	-0.268**	0.283**
No. of umbels plant^{-1}	G							0.931	0.398	0.750	0.082	-0.020	-0.095	0.868
	P							0.608**	0.306**	0.422**	0.043	-0.019	-0.093	0.830**
No. of umbellets umbel^{-1}	G								0.588	0.901	0.122	0.004	0.047	0.897
	P								0.352**	0.404**	0.029	0.009	0.011	0.564**
No. of fruits umbellet^{-1}	G									0.818	0.015	-0.177	0.263	0.334
	P									0.291**	-0.042	-0.103	0.190 **	0.291**
No. of fruits umbel^{-1}	G										-0.162	0.047	0.027	0.669
	P										-0.011	0.008	0.032	0.320**
Diameter of fruit (mm)	G											-0.319	-0.151	0.113
	P											-0.199**	-0.096	0.090
Vegetative yield (kg)	G												-0.167	0.157
	P												-0.137*	0.142*
1000-seed weight (g)	G													-0.153
	P													-0.140*

*,**Significant at 5 and 1% level, respectively.

weight (0.190). The number of fruits umbel^{-1} exhibited a significant positive association with seed yield plant^{-1} (0.320) while it was negatively associated with vegetative yield plot^{-1} (-0.199). Vegetative yield plot^{-1} had a significant positive association with seed yield plant^{-1} (0.142) but a negative correlation with 1000-seed weight (-0.137). Thousand-seed weight was also negatively correlated with seed yield plant^{-1} (0.140).

On the basis of pooled data, coefficients of correlation of yield and its component traits has been depicted in Table 3. Seed yield plant^{-1} exhibited a positive and significant correlation with number of fruits umbellet^{-1} (0.233) but it was negatively correlated with days to 50% flowering (-0.286), days to 80% maturity (-0.280) and vegetative yield plot^{-1} (-0.141). Plant height at maturity had a significant positive association with chlorophyll content at 60 DAS (0.409), 1000-seed weight (0.252), days to 50% flowering (0.157) and days to 80% maturity (0.155). Chlorophyll content at 60 DAS showed positive and significant association with number of primary branches plant^{-1} (0.355), 1000-seed weight (0.349), days to 50% flowering (0.279) and 80% maturity (0.249), vegetative yield plot^{-1} (0.232), number of umbels plant^{-1} (0.184) and number of fruits umbellet^{-1} (0.173). Number of primary branches plant^{-1} exhibited a positive significant correlation with 1000-seed weight (0.565), number of umbels plant^{-1} (0.490), number of fruiting nodes plant^{-1} (0.475), number of fruits umbellet^{-1} (0.411), number of umbellets umbel^{-1} (0.401), number of fruits umbel^{-1} (0.327) and diameter of the fruit (0.310).

Strong positive and significant association of number of fruiting nodes plant^{-1} was observed with number of umbels plant^{-1} (0.944), 1000-seed weight (0.822), number of umbellets umbel^{-1} (0.572), number of fruits umbel^{-1} (0.454) and number of fruits umbellet^{-1} (0.279). Highly significant and positive correlation of days to 50% flowering with days to 80% maturity (0.986), vegetative yield plot^{-1}(0.309), and 1000-seed weight (0.297) was noted while a negative correlation with number of fruits umbellet^{-1} (-0.146) was observed. Days to 80% maturity had a positive and significant correlation with vegetative yield plot^{-1} (0.298), 1000-seed weight (0.298) and number of umbellets umbel^{-1} (0.138); it was negative with number of fruits umbellet^{-1} (-0.156).

A highly positive association of number of umbels plant^{-1} was recorded with 1000-seed weight (0.836), number of umbellets umbel^{-1} (0.552), number of fruits umbel^{-1} (0.451) and number of fruits umbellet^{-1} (0.237). Number of umbellets umbel^{-1} showed a positive and significant association with 1000-seed weight (0.523), number of fruits umbel^{-1} (0.482) and number of fruits umbellet^{-1} (0.320). Number of fruits umbellet^{-1} expressed a positive significant correlation with number of fruits umbel^{-1} (0.401) and 1000-seed weight (0.232). Thousand seed weight was also positively correlated with number of fruits umbel^{-1} (0.372) while diameter of the fruit was negatively correlated with vegetative yield plot^{-1} (-0.205).

DISCUSSION

The correlation coefficient is a statistical tool that is used to find out the degree (strength) and direction of relationship between 2 or more variables. A positive value shows that changes in 2 variables are in the same direction i.e., the value of 1 variable is associated with the other variable, whereas a negative value shows that the movements of the variables are in the opposite direction i.e., the high value of one variable is associated with the low value of the other.

The association between 2 variables that can be directly observed is called phenotypic correlation. It includes both genotypic and environmental effects and therefore it differs under different environmental conditions. Genotypic correlation is the inherent association between two variables. This type of correlation is more stable and is of paramount importance for a plant breeder to bring about genetic improvement in one character by selecting the other character of a pair that is genetically correlated. Environmental correlation is entirely due to environmental effects and error variance. This is not of much importance as it is not heritable and stable. In the present investigation, correlation coefficients were estimated between yield and its components at

Table 3. Estimates of genotypic and phenotypic correlation coefficients for yield and its contributing characters in coriander (pooled data).

Character		Chlorophyll content 60 DAS	No. of primary branches	No. of fruiting nodes	Days to 50% flowering	Days to 80% maturity	No. of umbels plant^{-1}	No. of umbellets umbel^{-1}	No. of fruits umbellet^{-1}	No. of fruits umbel^{-1}	Diameter of fruit (mm)	Vegetative yield (kg)	1000-seed wt. (g)	Seed yield plant^{-1} (g)
Plant height at maturity	G	0.413	0.133	0.050	0.158	0.154	0.083	0.172	0.053	0.079	-0.045	0.119	0.255	0.018
	P	0.409**	0.125	0.050	0.157*	0.155*	0.079	0.108	0.045	0.039	-0.030	0.114	0.252**	0.017
Chlorophyll content 60 DAS	G		0.387	0.121	0.282	0.253	0.190	0.218	0.201	0.209	-0.013	0.240	0.362	0.038
	P		0.355**	0.121	0.279**	0.249**	0.184**	0.135	0.173*	0.108	0.001	0.232**	0.349**	0.037
No. of primary branches	G			0.511	0.011	-0.019	0.540	0.661	0.532	0.650	0.464	-0.147	0.615	-0.075
	P			0.475 **	0.014	-0.013	0.490**	0.401**	0.411**	0.327**	0.310**	-0.126	0.565**	-0.066
No. of fruiting nodes	G				0.115	0.113	0.968	0.910	0.334	0.799	0.008	-0.042	0.847	-0.043
	P				0.115	0.114	0.944**	0.572**	0.279**	0.454**	0.016	-0.042	0.822**	-0.047
Days to 50% flowering	G					0.991	0.105	0.181	-0.164	-0.087	-0.067	0.318	0.305	-0.288
	P					0.986**	0.103	0.122	-0.146*	-0.054	-0.047	0.309**	0.297**	-0.286**
Days to 80% maturity	G						0.100	0.192	-0.178	-0.082	-0.093	0.308	0.309	-0.280
	P						0.096	0.138*	-0.156*	-0.040	-0.065	0.298**	0.298**	-0.280**
No. of umbels plant^{-1}	G							0.884	0.288	0.754	0.061	-0.028	0.870	-0.088
	P							0.552**	0.237**	0.451**	0.035	-0.025	0.836**	-0.082
No. of umbellets umbel^{-1}	G								0.566	0.983	0.125	0.036	0.880	0.083
	P								0.320**	0.482**	0.028	0.021	0.523**	0.047
No. of fruits umbellet^{-1}	G									0.861	-0.002	-0.143	0.256	0.283
	P									0.401**	-0.015	-0.112	0.232**	0.233**
No. of fruits umbel^{-1}	G										-0.158	0.013	0.751	0.128
	P										-0.023	-0.007	0.372**	0.072
Diameter of fruit (mm)	G											-0.27	0.111	-0.129
	P											-0.205**	0.084	-0.095
Vegetative yield (kg)	G												0.140	-0.149
	P												0.132	-0.141*
1000-seed weight (g)	G													-0.130
	P													-0.125

*, **Significant at 5 and 1% level, respectively.

genotypic, phenotypic and environmental levels to identify the interrelationship among different traits. It was found that genotypic correlation coefficients were higher than phenotypic ones because of the masking effect of genotypes for the expression of characters.

Seed yield plant^{-1} exhibited a positive and significant correlation with number of fruits umbel^{-1} but showed negative correlation with days to 50% flowering and 80% maturity. The results confirm the findings of Ali *et al.* (2004), Prabhu and Balakrishnamoorthy (2005), Singh *et al.* (2006), and Dalkani *et al.* (2011). In contrast, Selvarajan *et al.* (2002) observed a positive association of seed yield with days to 50% flowering.

Plant height at maturity had a significant positive association with chlorophyll content at 60 DAS, 1000-seed weight, days to 50% flowering and 80% maturity. The results are in close proximity with those of Tripathi *et al.* (2000), Selvarajan *et al.* (2002), Prabhu and Balakrishnamoorthy (2005) and Dalkani *et al.* (2011). Chlorophyll content at 60 DAS showed positive and significant association with number of primary branches plant^{-1}, 1000-seed weight, days to 50% flowering and 80% maturity, vegetative yield plot^{-1}, number of umbels plant^{-1} and number of fruits umbellet^{-1}.

The number of primary branches plant^{-1} exhibited a positive significant correlation with 1000-seed weight, number of umbels plant^{-1}, number of fruiting nodes plant^{-1}, number of fruits umbellet^{-1}, number of umbellets umbel^{-1}, number of fruits umbel^{-1} and diameter of the fruit. The present findings agree with earlier results of Rajput *et al.* (2004), Singh *et al.* (2007), Singh and Prasad (2006) and Singh *et al.* (2007). Strong positive and significant association of number of fruiting nodes plant^{-1} was observed with number of umbels plant^{-1}, 1000-seed weight, number of umbellets umbel^{-1}, number of fruits umbel^{-1} and number of fruits umbellet^{-1}. Singh *et al.* (2007) observed similar results.

Highly significant and positive correlation of days to 50% flowering with days to 80% maturity, vegetative yield plot^{-1}, and 1000-seed weight was noted and a negative correlation with number of fruits umbellet^{-1} was observed. These results support the findings of Ali *et al.* (2004), Rajput *et al.* (2004), and Prabhu and Balakrishnamoorthy (2005). However, Singh *et al.* (2007) observed a positive association of days to 50% flowering with number of fruits umbel^{-1} and umbellet^{-1}.

Days to 80% maturity had a positive and significant correlation with vegetative yield plot^{-1}, 1000-seed weight, and number of umbellets umbel^{-1}; it had negative correlation with number of fruits umbellet^{-1}. The same results were reported by Rajput *et al.* (2004) and Prabhu and Balakrishnamoorthy (2005). Highly positive association of number of umbels plant^{-1} was recorded with 1000-seed weight, number of umbellets umbel^{-1}, number of fruits umbel^{-1}, and number of fruits umbellet^{-1}. Singh *et al.* (2004, 2007) found quite similar results.

Number of umbellets umbel^{-1} showed a positive and significant association with 1000-seed weight, number of fruits umbel^{-1}, and number of fruits umbellet^{-1}. The present findings confirmation the observations of Prabhu and Balakrishnamoorthy (2005); Singh and Prasad (2006) and Dalkani *et al.* (2011). Number of fruits umbellet^{-1} expressed a positive significant correlation with number of fruits umbel^{-1} and 1000-seed weight. Thousand-seed weight was also positively correlated with number of fruits umbel^{-1}, whereas fruit diameter was negatively correlated with vegetative yield plot^{-1}, results in close proximity to the findings of Singh *et al.* (2007).

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