Original Research Article

Correlation and regression analysis of various viability and vigour parameters in coriander (*Coriandrum sativum* L.)

ABSTRACT

In the present investigation freshly harvested seeds of four genotype of coriander viz., DH-228, DH-246, DH-5 and DH-36 were subjected to study the effect of foliage cuttings and growth regulators on seed yield and seed quality of coriander. Correlation coefficient analysis was employed to find out the correlation and regression analysis of various viability and vigour parameters in coriander viz., standard germination, seedling length, seedling dry weight, vigour index-I, vigour index-II, electrical conductivity, dehydrogenase activity test, field emergence index and seedling establishment. Seedling establishment is positively and significant correlated with Seedling dry weight (0.884**), vigour index-II (0.883**), vigour index-I (0.794**), dehydrogenase enzyme activity (0.786**), field emergence index (0.746**), standard germination (0.725**), seedling length (0.664**), and whereas, electrical conductivity was found negatively and significant correlation (-0.560**) with the seedling establishment. The maximum value of coefficient of regression (0.781) was obtained for seedling dry weight followed by vigour index-II (0.779), vigour index-I (0.631), dehydrogenase enzyme activity (0.618), field emergence index (0.556), standard germination (0.525), seedling length (0.440) and electrical conductivity (0.313), as these tests are highly correlated with seedling establishment. Among all the seed quality parameters seedling dry weight, vigour index-II and standard germination were found highly correlated with seedling establishment for all the genotypes hence they can be used as reliable predictors of seedling establishment.

Keywords: Coriander, Foliage cuttings, Growth regulators, Seed yield and Quality.

1. Introduction

Coriander (*Coriandrum sativum* L.) is an important seed spices crop of family Apiaceae (Umbelliferae) and possess 2n=22 chromosomes with cross-pollination as mode of reproduction. The seed type is dicot and having epigeal germination. It is extensively cultivated in the arid and semi-arid region of India during rabi season. This spice is used by man as common flavouring substances. It is not only add flavor and taste to our food but also enhance keeping quality of food. The stem, leaves and grain have a pleasant aroma. Coriander seed have aromatic odour and taste of coriander fruits due to an essential oil, which is made up of hydrocarbon and oxygenated compounds. Besides the essential oil, the seed contains 16.1% fatty oil, 14.1% protein, 21.6% carbohydrate, 32.6% fibers, 11.2% moisture and 4.4% mineral matters and coriander leaves are very rich in Vitamin A and Vitamin C. This plant is highly aromatic and has multiple uses in food and in other industries (Sahib [1]). Plants have played a critical role in maintaining human health and civilizing the quality of human life for thousands of years (Dhankar [2]).Coriander has been reported to possess many pharmacological activities like antioxidant (Darughe [3]), anti-diabetic (Eidi [4]), antilipidemic (Sunil [5]).

Agricultural research, till now, has been primarily concerned with increasing crops yields by use of fertilizers, pesticides, irrigation, better crop management coupled with variety development and genetic improvements. Coriander plant has regenerative capacity and hence 2 to 3 cuttings can be undertaken very easily. Leaf plucking of coriander seed crop at early stages can provide an extra income to the farmers. Foliage cutting at the appropriate time before flowering causes multiplies of the branches that lead to increase in inflorescence number and seed yield. Whereas delayed cutting or cutting near to flowering reduces the plant growth and ultimately decrease the seed yield. So overall to take good yield of foliage and seed the crop should be left for seed production on time, at last

foliage cutting. For green leafy vegetables i.e. coriander, harvested by clipping of the leaves and young shoots and repeated cutting influences the seed yield and quality (Datta [6]).

Several intrinsic and extrinsic factors effect on growth, development and secondary metabolites biosynthesis of medicinal and aromatic plants. Phytohormones and plant growth regulators (PGRs) have been defined as one of the main factors influences plants growth and their primary and secondary metabolites pool. The use of PGRs in the field of agriculture has become commercialized. Plant growth regulators (PGRs), have emerged as magic chemical that could increase agricultural production at an unprecedented rate and help in removing or circumventing many of the barrier imposed by genetics and environment (Nickel [7]).

Seed is an important component and the quality seed plays a crucial role in agricultural production as well as in national economy. Availability of viable and vigorous seed at the planting time is important for achieving targets of agricultural production because good quality seed acts as a catalyst for realizing the potential of other inputs. Since the total cultivable area is decreasing due to over growing population, the increased agricultural productivity is the only option. The good quality seed is pre-requisite to enhance the production and productivity. Use of quality seeds increased productivity of crop by 15-20% (Sidhawani [8]).

2. Material and methods

Seed material comprised of four genotype namely DH-228 (Hisar Bhoomit), DH-246 Hisar Surbhi), DH-36 (Hisar Sugandh), DH-5 (Hisar Anand). Two PGRs namely NAA and GA_3 each at 50 ppm and a control (water spray) were used as treatments at the time of 50% flowering. Seed were sown during the second week (11^{th}) of October in plots of size 3.0 × 1.5 m at spacing of 50 × 20 cm. Sowing and other cultural operation were done using recommended practices. Growth parameters such as plant height, number of branches per plant, number of umbels per plant, number of seeds per umbel, number of seed per umbellate, seed yield and seed quality parameters such as test weight, standard germination, seedling length, seedling dry weight, vigor index-I & vigor index-II, dehydrogenase enzyme activity, field emergence index and seedling establishment were recorded for the study. The five plants in each plot were randomly selected and data on particular parameters were measured at harvesting time and average was computed for growth and yield parameters.

Seed quality parameters such as test weight (1000 seed weight) and Standard germination (%) was observed using one hundred seeds of each genotype in three replicates were placed in between papers (BP) and kept at 20^0 C in seed germinator. The first count was taken on 5th day and final count on 14th day and only normal seedlings were considered for percent germination according to the rules of International Seed Testing Association (ISTA [9]). Seedling length (cm) of ten randomly selected normal seedlings from three replication of standard germination test was measured to get the averaged seedling length in centimeter. Seedling dry weight (g) was assessed after the final count in the standard germination test (14 days). The randomly selected normal seedlings from the three replication of standard germination test were taken and dried in a hot air oven for 24 hrs at 80 ± 1^o C. The dried seedlings of each replication were weighed and average seedling dry weight of each genotype was calculated.

Seedling vigor indices were calculated according to the method suggested by Baki and Anderson [10].

I. **Vigor index-I** (on seedling length basis):

Vigor index–I = Standard Germination (%) × Average seedling length (cm)

II. **Vigor Index–II** (on seedling dry weight basis):

Vigor index–II = Standard Germination (%) × Average seedling dry weight (g)

To measure the electrical conductivity, 50 normal and uninjured seeds in three replications were soaked in 75 ml deionized water in 100 ml beakers. Seeds were immersed completely in water and beakers were covered with foil. Thereafter, these samples were kept at 25^0C for 24 h. The electrical

conductivity of the seed leachates was measured using a direct reading conductivity meter. The conductivity was expressed in dS cm^{-1} $seed^{-1}$. Dehydrogenase activity (OD g-1 ml-1) was observed using one gram seed of each lot replicated thrice were ground to pass through a 20 mesh draw. The 200 mg flour was soaked in 5 ml of 0.5% tetrazolium solution at 38^0C for 3-4 h. Then it was centrifuged at 10000 rpm for 3 minutes and the supernatant was poured off. The formazan was extracted with 10 ml acetone for 16 h. followed by centrifugation and absorbance of the solution was determined by Systronic spectrophotometer 169 at 480 nm. These observations were expressed as change in OD g-1 ml-1 and this procedure was performed as per Kittock and Law [11].

To determine the Field emergence index, one hundred freshly harvested seeds of each genotype as per treatment were sown in three replication during rabi season, 2013-2014 at the Seed Science and Technology Research farm, CCS Haryana Agricultural University, Hisar. The number of seedling emerged daily, counted up to stable emergence. The field emergence index was estimated as follow.

$$\frac{\text{No. of seedlings emerged}}{\text{First day of sowing}} + \text{.....} + \frac{\text{Number of seedlings emerged}}{\text{Day of last count}}$$

The seedling establishment was determined by counting the total number of seedlings when the emergence was completed i.e. there was no further addition in the total emergence. Statistical analysis of data collected during the study was done by applying the technique of analysis of variance (ANOVA) as suggested by Gomez and Gomez [12] and Panse and Sukhatme [13]. All the statistical analysis was carried out by using OPSTAT statistical software.

3. Result and Discussion

3.1 Prediction of regression and correlation coefficient by various viability and vigour tests in four genotype of coriander with the interaction of foliage cuttings and growth regulators.

The coefficient of regression (r^2) and correlation (r) between field and laboratory parameters of freshly harvested seed is given in table 1. It is evident that all the parameters were significantly correlated with each other. The maximum value of coefficient of regression (0.781) was obtained for seedling dry weight followed by vigour index-II (0.779), vigour index-I (0.631), dehydrogenase enzyme activity (0.618), field emergence index (0.556), standard germination (0.525), seedling length (0.440) and electrical conductivity (0.313), as these tests are highly correlated with seedling establishment. Seedling establishment is positively and significant correlated with Seedling dry weight (0.884**), vigour index-II (0.883**), vigour index-I (0.794**), dehydrogenase enzyme activity (0.786**), field emergence index (0.746**), standard germination (0.725**), seedling length (0.664**), and whereas, electrical conductivity was found negatively and significant correlation (-0.560**) with the seedling establishment. Correlation studies revealed (Table 2) highly significant and positive correlation between all the seed quality parameters. Field emergence index was found highly correlated with (0.663**) seedling dry weight followed by vigour index-II (0.660**). Standard germination was found highly correlated with dehydrogenase enzyme activity (0.872**) followed by vigour index-II (0.836**). Seedling length was found highly correlated with vigour index-I (0.955**) whereas, seedling dry weight found highly correlation with vigour index-II (0.998**). Electrical conductivity was found negatively and highly correlated with dehydrogenase enzyme activity (-0.683**). These results are same in accordance with the finding of Kumar [14], Kumar [15], Deshraj [16] in coriander; Kumari [17] in fenugreek and Punia [18] in Indian mustard.

Table 1: Prediction of regression (seedling establishment %) by various viability and vigour test in four genotypes of coriander.					
Parameter Studied	Mean		Regression		
	Actual mean of independent parameter (x)	Estimated mean of dependent parameter	a+(b)x	R-Square	Correlation
Field emergence index	5.39	79.86	-11.24+(16.90)x	0.556	0.746**
Standard germination (%)	87.77	79.81	-41.66+(1.38)x	0.525	0.725**
Seedling length (cm)	25.03	79.79	40.18+(1.58)x	0.440	0.664**
Seedling dry weight (mg)	0.24	79.77	64.59+(63.22)x	0.781	0.884**
Vigour index-I	2207.02	80.28	38.35(0.019)x	0.631	0.794**
Vigour index-II	21.27	79.79	65.60(0.67)x	0.779	0.883**
Electrical conductivity µs/cm/seed	0.25	79.81	94.78+(-58.69)x	0.313	-0.560**
Dehydrogenase enzyme activity	0.07	80.21	66.55+(195.19)x	0.618	0.786**
Seedling establishment (%) is dependent parameter. Actual mean = 79.78					

Table 2: Prediction of correlation (r) between field and laboratory parameters of coriander									
	SE	FEI	SG	SL	SDW	VI-I	VI-II	EC	DHA
SE	1.000								
FEI	0.746**	1.000							
SG	0.725**	0.563**	1.000						
SL	0.664**	0.470**	0.591**	1.000					
SDW	0.884**	0.663**	0.812**	0.550**	1.000				
VI-I	0.794**	0.570**	0.560**	0.955**	0.730**	1.000			
VI-II	0.883**	0.660**	0.836**	0.544**	0.998**	0.732**	1.000		
EC	-0.560**	-0.652**	-0.477**	-0.670**	-0.646**	-0.680*	-0.636**	1.000	
DHA	0.786**	0.630**	0.872**	0.840**	0.830**	0.476**	0.847**	-0.683**	1.000

****Significant at 1% (**p=0.01)

SE= Seedling Establishment, FEI= Field Emergence index, SG= Standard Germination, SL= Seedling Length SDW= Seedling Dry weight, VI-I= Vigour index-I, VI-II= Vigour index-II, EC= Electrical Conductivity, DHA= Dehydrogenase enzyme activity test.

3.2 Prediction of regression and correlation coefficient by various viability and vigour tests in four genotype of coriander under the effect of foliage cuttings.

The coefficient of regression (r^2) and correlation (r) between field and laboratory parameters of freshly harvested seed under the treatment of foliage cuttings is given in table 3. It is evident that all the parameters were significantly correlated with each other. The maximum value of coefficient of regression (0.931) was found for dehydrogenase enzyme activity followed by seedling length (0.911), vigour index-II (0.892), vigour index-II (0.870), seedling dry weight (0.835), electrical conductivity (0.424), field emergence index (0.423) and minimum value (0.409) of coefficient of regression was found for standard germination. Seedling establishment is positively and significant correlated with dehydrogenase enzyme activity (0.965**) followed by seedling length (0.954**), vigour index-II (0.945**), vigour index-I (0.933**), seedling dry weight (0.914**), standard germination (0.639**)

and field emergence index (0.651**) whereas, electrical conductivity was found negatively and significant correlation (-0.651**) with the seedling establishment. Correlation studies revealed that (Table 4) highly significant and positive correlation (except electrical conductivity) between all the seed quality parameters. Field emergence index was found highly correlated with (-0.835**) electrical conductivity followed by standard germination (0.818**). Standard germination was found also highly correlated with electrical conductivity (-0.900**) followed by vigour index-I (0.802**). Seedling length was found highly correlated with vigour index-I (0.970**) whereas, seedling dry weight found highly correlation with vigour index-II (0.968**). Electrical conductivity was found negatively and highly correlated with dehydrogenase enzyme activity (-0.775**). These present results are also in corroborate with the finding of Srivastava [19] in barseem; Mor [20] in fennel and Yadav [21] in okra.

Table 3: Prediction of regression by various viability and vigour test in four genotypes of coriander by the effect of foliage cuttings.

Parameter Studied	Mean		Regression		
	Actual mean of independent parameter (x)	Estimated mean of dependent parameter	a+(b)x	R-Square	Correlation
Field emergence index	5.20	73.25	41.20+(6.16)x	0.423	0.651**
Standard germination (%)	83.23	73.19	30.25+(0.52)x	0.409	0.639*
Seedling length (cm)	22.60	73.23	49.03+(1.07)x	0.911	0.954**
Seedling dry weight (mg)	0.20	73.63	53.79+(99.20)x	0.835	0.914**
Vigour index-I	1885.81	73.39	54.54+(0.01)x	0.870	0.933**
Vigour index-II	16.34	73.22	55.19+(1.06)x	0.892	0.945**
Electrical conductivity µs/cm/seed	0.19	72.84	101.29+(-149.73)x	0.424	-0.651*
Dehydrogenase enzyme activity	0.05	72.93	67.17+(115.27)	0.931	0.965**
Seedling establishment (%) is dependent parameter. Actual mean = 73.22					

Table 4: Prediction of correlation (r) between field and laboratory parameters of coriander by the effect of foliage cuttings

	SE	FEI	SG	SL	SDW	VI-I	VI-II	EC	DHA
SE	1.000								
FEI	0.651**	1.000							
SG	0.639*	0.818**	1.000						
SL	0.954**	0.712**	0.635**	1.000					
SDW	0.914**	0.670**	0.766**	0.910**	1.000				
VI-I	0.933**	0.802**	0.802**	0.970**	0.846**	1.000			
VI-II	0.945**	0.704**	0.672**	0.944**	0.968**	0.937**	1.000		
EC	-0.651**	-0.835**	-0.900**	-0.718**	-0.630**	-0.836**	-0.699**	1.000	
DHA	0.965	0.678**	0.746**	0.950**	0.879	0.957**	0.940**	-0.775	1.000

****Significant at 1% (**p=0.01)

SE= Seedling Establishment, FEI= Field Emergence index, SG= Standard Germination, SL= Seedling Length

SDW= Seedling Dry weight, VI-I= Vigour index-I, VI-II= Vigour index-II, EC= Electrical Conductivity, DHA= Dehydrogenase enzyme activity test.

3.3 Prediction of regression and correlation coefficient by various viability and vigour tests in four genotype of coriander by the effect of growth regulators.

The coefficient of regression (r^2) and correlation (r) between field and laboratory parameters of freshly harvested seed under the treatment of foliage cuttings is given in table 5. It is resulted that all the parameters were significantly correlated with each other. The maximum value of coefficient of regression (0.818) was found for seedling dry weight followed by vigour index-II (0.815), field emergence index (0.719), electrical conductivity (0.701), dehydrogenase enzyme activity (0.691), vigour index-I (0.669), seedling length (0.473) and minimum value (0.465) of coefficient of regression was found for standard germination. Seedling establishment is highly positively and significant correlated with vigour index-II (0.903**) and seedling dry weight (0.903**) followed by field emergence index (0.848**), dehydrogenase enzyme activity (0.832**), vigour index-I (0.818**), seedling length (0.688**) and standard germination (0.682**) whereas, electrical conductivity was found negatively and significant correlation (-0.838**) with the seedling establishment. Correlation studies revealed that (Table 6) highly significant and positive correlation (except electrical conductivity [-]) between all the seed quality parameters. Field emergence index was found highly correlated with (-0.824**) electrical conductivity followed by vigour index-II (0.785**) and field emergence index was found low correlation with standard germination (0.627*) and seedling length (0.611*). Standard germination was found also highly correlated with electrical conductivity (-0.917**) followed by vigour index-II (0.810**) and standard germination was found low correlation with seedling length (0.695) and vigour index-I (0.771). Seedling length was found highly correlated with vigour index-I (0.957**) and found low correlation with seedling dry weight (0.652*) and vigour index-II (0.629*), whereas, seedling dry weight found highly correlation with vigour index-II (0.998**). Electrical conductivity was found negatively and highly correlated with dehydrogenase enzyme activity (-0.909**). These results are same in accordance with the finding of Kumar [22] in coriander; kumar [23] in onion and Sadik [24] in ajwain.

Table 5: Prediction of regression coefficient by various viability and vigour tests in four genotype of coriander under the effect of growth regulators.

Parameter Studied	Mean		Regression		
	Actual mean of independent parameter (x)	Estimated mean of dependent parameter	a+(b)x	R-Square	Correlation
Field emergence index	5.63	82.33	-158+(42.87)x	0.719	0.848**
Standard germination (%)	89.04	82.91	-43.51+(1.41)x	0.465	0.682**
Seedling length (cm)	25.84	82.37	40.95+(1.06)x	0.473	0.688**
Seedling dry weight (mg)	0.27	82.37	65.43+(62.54)x	0.818	0.903**
Vigour index-I	2307.19	82.28	38.45+(0.019)x	0.669	0.818**
Vigour index-II	24.34	82.37	66.53+(0.65)x	0.815	0.903**
Electrical conductivity µs/cm/seed	0.16	82.20	115.94+(-210.81)x	0.701	-0.838**
Dehydrogenase enzyme activity	0.08	83.31	65.39+(224.03)x	0.691	0.832**

Seedling establishment (%) is dependent parameter. Actual mean = 82.38

Table 6: : Prediction of correlation (r) between field and laboratory parameters of coriander by the effect of growth regulators

	SE	FEI	SG	SL	SDW	VI-I	VI-II	EC	DHA
SE	**1.000**								
FEI	**0.848****	**1.000**							
SG	**0.682***	**0.627***	**1.000**						
SL	**0.688***	**0.611***	**0.695**	**1.000**					
SDW	**0.903****	**0.783****	**0.778****	**0.652***	**1.000**				
VI-I	**0.818****	**0.728****	**0.771**	**0.957****	**0.814****	**1.000**			
VI-II	**0.903****	**0.785****	**0.810****	**0.629***	**0.998****	**0.803****	**1.000**		
EC	**-0.838****	**-0.824****	**-0.917****	**-0.735****	**-0.857****	**-0.662***	**-0.879****	**1.000**	
DHA	**0.832****	**0.765****	**0.843****	**0.867****	**0.771****	**0.890**	**0.793****	**-0.909****	**1.000**

****Significant at 1% (**p=0.01)

***Significant at 5% (p=0.05)**

SE= Seedling Establishment, FEI= Field Emergence index, SG= Standard Germination, SL= Seedling Length SDW= Seedling Dry weight, VI-I= Vigour index-I, VI-II= Vigour index-II, EC= Electrical Conductivity, DHA= Dehydrogenase enzyme activity test.

4. Conclusion

On the basis of present investigation it is concluded that foliage cuttings, growth regulator and their interaction significantly affect the field and laboratory parameters. Various seed quality parameters were positively and significantly correlated with seedling establishment while electrical conductivity was negatively and significantly correlated seedling establishment. As vigour index-II, vigour index-I, seedling dry weight, standard germination were highly associated with seedling establishment. The coefficient of regression was concluded that vigour index-II, seedling dry weight and electrical conductivity can be used as reliable predictor of seedling establishment.

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