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Interrelationship between Different Seed Quality Parameters in Fennel

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A B S T R A C T

The present investigation was carried out on fennel seeds of fifteen genotypes *viz*., HF 33, HF 101, HF 102, HF 103, HF 104, HF 105, HF 106, HF 107, HF 108, HF 109, HF 114, HF 115, HF 118, HF 122 and HF 124 with three lots of seed *viz*., freshly harvested seed (Lot-1), one year old seed (Lot-2) and two year old seed (Lot-3). The seeds were subjected to study the effect of ambient storage on different seed viability and vigour parameters. Correlation coefficient analysis was employed to find out the interrelationship between various seed quality parameter *viz*., test weight, standard germination, seedling length, seedling fresh weight, seedling dry weight, seedling vigour index-I, seedling vigour index- II, accelerated ageing test, Tetrazolium test, dehydrogenase activity test, electrical conductivity test, pH exudates test and field emergence (%). Field emergence showed positive and significant correlation with seedling length (0.839), standard germination (0.879), seedling fresh weight (0.808), seedling dry weight (0.742), vigour index-I (0.880), vigour index-II (0.772), tetrazolium test (0.890), accelerated ageing test (0.729), dehydrogenase activity test (0.757) and pH exudates test (0.734) while negative and significant correlation was found with electrical conductivity (0.845). As standard germination, seedling vigour index-I and tetrazolium test were found highly correlated with field emergence they can be used as reliable predictors of field emergence (%).

Introduction

Fennel (*Foeniculum vulgare* Mill.) which belongs to the family Apiaceae is one of the widely cultivated seed spice in temperate and sub tropical regions of the world. A diet with desired quantity of fennel could bring potential health benefits due to its valuable nutritional composition with respect to presence of essential fatty acids (Barros *et al*., 2010).

In recent years, increased interests in improvement of agricultural yield of fennel due to its medicinal properties and essential oil content has encouraged cultivation of the plant on large scale. High quality seed is the key to successful agriculture. Modern agriculture with its favouritism for technology and precision, demands that each and every seed should readily germinate and produce a healthy seedling to ensure high yield. Uniformity of growth and synchrony in development are highly desirable characters for mechanized cultural operations. As such, only high quality *i.e*., genetically pure and morphologically, pathologically and physiologically sound seed is capable of increasing the productivity. The seeds should also have better storability to produce good

crop during the next season. The laboratory germination test provides information about the seedling emergence potential of seed lots under favourable conditions (Perry, 1978). In the present study attempt has been made to evaluate and compare various seed quality tests with a view to identify dependable tests for seed testing laboratories to know the planting value of seeds

Materials and Methods

The present study was carried out on fennel seeds of fifteen genotypes *viz*., HF 33, HF 101, HF 102, HF 103, HF 104, HF 105, HF 106, HF 107, HF 108, HF 109, HF 114, HF 115, HF 118, HF 122 and HF 124 with three lots of seed *viz*., freshly harvested seed (Lot_1), one year old seed (Lot_2) and two year old seed (Lot_3) collected from Department of Vegetable Science, CCS H.A.U, Hisar during 2014-15. All the seed lots were stored under ambient condition analyzed for test weight, standard germination test (%), seedling length (cm), seedling fresh weight, seedling dry weight (mg), seedling vigour index-I, seedling vigour index-II, accelerated ageing test (%), tetrazolium test (viability %), pH exudate test (%), dehydogenase activity test (OD g^{-1} ml^{-1}), electrical conductivity test (µS cm^{-1} $seed^{-1}$) and field emergence (%) in seed testing laboratory, Department of Seed Science and Technology, CCS Haryana Agricultural University.

The experiment was conducted in a Completely Randomized Design for laboratory parameters and, for field parameters; the same was designed in Randomized Block. The angular transformation was applied to the percent data and the transformed data were subjected to the statistical analysis on the basis of the model described by Ostle and Mensing (1975). The correlation coefficient between various seed viability and vigour parameters in laboratory and field emergence was carried out as per standard procedure given below:

$$r = \frac{\text{Cov. (XY)}}{\sqrt{\text{Variance of X x Variance of Y}}}$$

Where,
r = Correlation coefficient
Cov(x, y) = Covariance between characters x and y

Results and Discussion

The correlation between field and laboratory parameters of freshly harvested seed lot is given in Table 1. Standard germination is positively and significantly correlated with test weight (0.849) seedling length (0.910), seedling fresh weight (0.829), vigour index-I (0.968), vigour index-II (0.940), tetrazolium test (0.907), accelerated ageing test (0.548), dehydrogenase activity test (0.853), pH exudates test (0.849) and field emergence (0.974) while negatively and significant correlation was found with electrical conductivity (0.972). Field emergence showed positive and significant correlation with test weight (0.843) seedling length (0.930), seedling fresh weight (0.807), vigour index-I (0.971), vigour index-II (0.883), tetrazolium test (0.882), accelerated ageing test (0.543), dehydrogenase activity test (0.867), pH exudates (0.809) and negative and significant correlation with electrical conductivity (0.976). Correlation studies revealed highly significant and positive correlation between standard germination, pH exudate and field emergence, suggesting that these tests can be used as reliable predictor of field emergence of fennel seeds. The results obtained by Ram *et al.,* (1991) support this finding, that vigour indices showed positive significant association with field emergence in pigeon pea. Similar results were also reported in coriander (Kumar *et al*., 2015) and in fenugreek (Kumari *et al.,* 2014).

Table.1 Interrelationship between different laboratory parameters of seed quality and field emergence (%) of freshly harvested seed of fennel

Parameters	TW	SL	SG	SFW	SDW	VI-I	VI-II	TZ	AAT	DHA	EC	pH	FE (%)
TW													
SL	0.863**												
SG	0.849**	0.910**											
SFW	0.713**	0.762**	0.829**										
SDW	0.720**	0.718**	0.873**	0.738**									
VI-I	0.885**	0.984**	0.968**	0.810**	0.794**								
VI-II	0.789**	0.797**	0.940**	0.793**	0.987**	0.872**							
TZ	0.801**	0.863**	0.907**	0.609**	0.730**	0.897**	0.804**						
AAT	0.658**	0.610**	0.548*	0.475	0.349	0.604*	0.426	0.519*					
DHA	0.870**	0.888**	0.853**	0.608**	0.700**	0.900**	0.772**	0.804**	0.697**				
EC	-0.880**	-0.924**	-0.972**	-0.823**	-0.831**	-0.966**	-0.901**	-0.880**	-0.525*	-0.834**			
pH	0.803**	0.823**	0.849**	0.843**	0.731**	0.854**	0.791**	0.718**	0.739**	0.812**	-0.826**		
FE (%)	0.843**	0.930**	0.974**	0.807**	0.805**	0.971**	0.883**	0.882**	0.543*	0.867**	-0.976**	0.809**	

*Significant at 5% (p = 0.05)

** Significant at 1% (p = 0.01)

TW = Test Weight, SL = Seedling length, SG =standard germination, SFW = Seedling fresh weight, SDW = Seedling dry weight, VI-I = Vigour index-I, VI-II = Vigour index-II, TZ = Tetrazolium test, AA = Accelerated ageing test, DHA = Dehydrogenase activity test, EC = Electrical conductivity test, pH = pH exudates test, FE = Field emergence.

Table.2 Interrelationship between different laboratory parameters of seed quality and field emergence (%) of one year stored seed of fennel

Parameters	TW	SL	SG	SFW	SDW	VI-I	VI-II	TZ	AAT	DHA	EC	pH	FE (%)
TW													
SL	0.750**												
SG	0.737**	0.794**											
SFW	0.720**	0.769**	0.739**										
SDW	0.817**	0.918**	0.889**	0.820**									
VI-I	0.789**	0.976**	0.907**	0.799**	0.952**								
VI-II	0.824**	0.908**	0.931**	0.822**	0.994**	0.961**							
TZ	0.722**	0.785**	0.931**	0.708**	0.794**	0.874**	0.839**						
AAT	0.692**	0.618**	0.607**	0.626**	0.562*	0.653**	0.590*	0.758**					
DHA	0.859**	0.675**	0.747**	0.693**	0.759**	0.735**	0.773**	0.790**	0.739**				
EC	-0.587*	-0.775**	-0.787**	-0.720**	-0.867**	-0.816**	-0.864**	-0.683**	-0.439	-0.640**			
pH	0.762**	0.749**	0.772**	0.865**	0.775**	0.800**	0.796**	0.753**	0.633**	0.657**	-0.588*		
FE (%)	0.795**	0.804**	0.805**	0.739**	0.819**	0.850**	0.837**	0.834**	0.786**	0.720**	-0.729**	0.706**	

*Significant at 5% (p = 0.05)
** Significant at 1% (p = 0.01)
TW = Test Weight, SL = Seedling length, SG =standard germination, SFW = Seedling fresh weight, SDW = Seedling dry weight, VI-I = Vigour index-I, VI-II = Vigour index-II, TZ = Tetrazolium test, AA = Accelerated ageing test, DHA = Dehydrogenase activity test, EC = Electrical conductivity test, pH = pH exudates test, FE = Field emergence.

Table.3 Interrelationship between different laboratory parameters of seed quality and field emergence (%) of two year stored seeds of fennel

Parameters	TW	SL	SG	SFW	SDW	VI-I	VI-II	TZ	AAT	DHA	EC	pH	FE (%)
TW													
SL	0.441												
SG	0.613**	0.702**											
SFW	0.413	0.782**	0.685**										
SDW	0.433	0.958**	0.611**	0.794**									
VI-I	0.599*	0.917**	0.926**	0.787**	0.850**								
VI-II	0.562*	0.956**	0.791**	0.815**	0.965**	0.950**							
TZ	0.373	0.820**	0.822**	0.795**	0.769**	0.881**	0.842**						
AAT	0.649**	0.617**	0.879**	0.621**	0.545*	0.817**	0.705**	0.779**					
DHA	0.378	0.732**	0.717**	0.633**	0.718**	0.781**	0.774**	0.768**	0.793**				
EC	-0.226	-0.032	-0.364	-0.273	0.004	-0.221	-0.125	-0.229	-0.462	-0.099			
pH	0.290	0.608**	0.627**	0.670**	0.489*	0.655**	0.558*	0.612**	0.640**	0.581*	-0.471		
FE (%)	0.295	0.570*	0.540*	0.544*	0.488*	0.603*	0.553*	0.623**	0.526*	0.420	-0.374	0.314	

*Significant at 5% (p = 0.05)

** Significant at 1% (p = 0.01)

TW = Test Weight, SL = Seedling length, SG =standard germination, SFW = Seedling fresh weight, SDW = Seedling dry weight, VI-I = Vigour index-I, VI-II = Vigour index-II, TZ = Tetrazolium test, AA = Accelerated ageing test, DHA = Dehydrogenase activity test, EC = Electrical conductivity test, pH = pH exudates test, FE = Field emergence.

Table.4 Interrelationship between different laboratory parameters of seed quality and field emergence (%) of means of naturally aged seed of fennel

Parameters	TW	SL	SG	SFW	SDW	VI-I	VI-II	TZ	AAT	DHA	EC	pH	FE (%)
TW													
SL	0.753**												
SG	0.702**	0.924**											
SFW	0.595*	0.829**	0.822**										
SDW	0.704**	0.911**	0.927**	0.832**									
VI-I	0.741**	0.973**	0.987**	0.839**	0.935**								
VI-II	0.735**	0.948**	0.934**	0.843**	0.994**	0.956**							
TZ	0.713**	0.964**	0.945**	0.780**	0.880**	0.970**	0.911**						
AAT	0.749**	0.758**	0.647**	0.576*	0.524*	0.712**	0.590*	0.743**					
DHA	0.814**	0.867**	0.861**	0.668**	0.806**	0.882**	0.831**	0.885**	0.777**				
EC	-0.518*	-0.896**	-0.824**	-0.860**	-0.812**	-0.871**	-0.844**	-0.863**	-0.677**	-0.742**			
pH	0.701**	0.879**	0.810**	0.858**	0.808**	0.851**	0.842**	0.831**	0.747**	0.796**	-0.800**		
FE (%)	0.653**	0.839**	0.879**	0.808**	0.742**	0.880**	0.772**	0.890**	0.729**	0.757**	-0.845**	0.734**	

*Significant at 5% (p = 0.05)

** Significant at 1% (p = 0.01)

TW = Test Weight, SL = Seedling length, SG =standard germination, SFW = Seedling fresh weight, SDW = Seedling dry weight, VI-I = Vigour index-I, VI-II = Vigour index-II, TZ = Tetrazolium test, AA = Accelerated ageing test, DHA = Dehydrogenase activity test, EC = Electrical conductivity test, pH = pH exudates test, FE = Field emergence.

The correlations between field and laboratory parameters of one year old seed lot are presented in Table 2. Field emergence showed positive and significant correlation with test weight (0.795), seedling length (0.804), standard germination (0.805), seedling fresh weight (0.739), seedling dry weight (0.819), vigour index- I (0.850), vigour index-II (0.837), tetrazolium test (0.834), accelerated ageing test (0.786), dehydrogenase activity test (0.720) and pH exudates (0.706) while negative and significant correlation was found with electrical conductivity (0.729). Standard germination showed positive and significant correlation with test weight (0.750), seedling length (0.794), seedling fresh weight (0.739), vigour index-I (0.907), vigour index-II (0.931), tetrazolium test (0.931), accelerated ageing test (0.607), dehydrogenase activity test (0.747), pH exudates test (0.772) and field emergence (0.805) while negatively and significant correlation was found with electrical conductivity (0.787). Shridhar and Nagaraja (2004) reported that the standard germination test in cotton had a positive significant correlation with field emergence. Kuklik and Yaklich (1982) and Egli and Tekrony (1985) observed that standard germination and AA tests were significantly correlated with field emergence in soybean Similar results were also reported in coriander (Deshraj, 2002) and in indian mustard (Punia *et al*., 2006).

The correlations between field and laboratory parameters of two year old seed lot are presented in Table 3. Field emergence showed positive and significant correlation with seedling length (0.570), standard germination (0.540), vigour index-I (0.603), vigour index-II (0.553), tetrazolium test (0.623) and accelerated ageing test (0.526). Yadav and Dhankar (2001) reported that vigour indices were positively and significantly correlated with standard germination, seedling length and seedling dry weight and negatively correlated with electrical conductivity in okra. Above results are in agreement with various workers in different crops such as fennel (Mor *et al.*, 2009) and in coriander (Kumar, 2007).

The correlation between field and laboratory parameters of means of naturally aged seed of fennel is presented in Table 4. Standard germination is positively and significantly correlated with vigour index-I (0.987), vigour index-II (0.934), tetrazolium test (0.945), accelerated ageing test (0.647), dehydrogenase activity test (0.861), pH exudates test (0.810) and field emergence (0.879) while negatively and significantly correlated with electrical conductivity (0.824). Field emergence was positively and significantly correlated with seedling length (0.839), standard germination (0.879), seedling fresh weight (0.808), seedling dry weight (0.742), vigour index-I (0.880), vigour index-II (0.772), tetrazolium test (0.890), accelerated ageing test (0.729), dehydrogenase activity test (0.757), pH exudates test (0.734) while negatively and significantly correlated with electrical conductivity (0.845). As standard germination, seedling vigour index-I and tetrazolium test are highly correlate with field emergence they can be used as reliable predictors of field emergence (%). Usha (2009) reported that standard germination test is the best indicator of seed vigour in onion, as highest correlations ($P < 0.01$) were obtained between initial germination (%) and field emergence ($r = 0.937^{**}$). The present results are also in corroborate with the findings of Kumar *et al.*, 2015 in coriander, Kumar, 2004 in onion and Sadik, 2012 in ajwain.

In conclusion, present study revealed that different seed quality parameters were positively and significantly correlated with field emergence except test weight while electrical conductivity was negatively and

significantly correlated with field emergence. As standard germination, tetrazolium test and dehydrogenase activity test were highly associated with field emergence, they can be used as reliable predictors of field emergence (%).

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