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VARIATION FOR SEED GERMINATION IN TOBACCO GENOTYPES STORED UNDER NORMAL CONDITIONS

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Quality seed is the critical input for raising adequate and healthy seedlings in the nurseries. Tobacco farmers, often face the problems of seed germination. Tobacco seed is also vulnerable to deterioration during field weathering, harvesting, and storage conditions leading to loss of seed viability. A set of eleven FCV drought breeding lines and three check varieties stored for twelve months period under normal storage conditions were assessed for their germination potential as per the ISTA guidelines. The considerable genetic variability for germination per centage and germination rate among genotypes indicates the differential response of genotypes to storage periods indicating the effect of prevailing temperature and relative humidity during the storage period. High PCV, GCV and high heritability estimates indicate the involvement of additive gene action and effectiveness of simple selection for genetic improvement of seed viability in tobacco. Three genotypes KDB 4, KDB 10 and KDB 11 showed the least reduction in germination percentage even after 12 months of storage, which will serve as potential donors for seed vaiability improvement.

INTRODUCTION

Tobacco (*Nicotiana tabacum* L.) is a major cash crop belongs to family Solanaceae. India stands second position in production and export of tobacco. Tobacco is grown in an area of 0.44 million hectares and production of 761 million kg tobacco with average productivity of 1699 kg/ha in India (FAOSTAT, 2020). From India, a quantity of 2,11,631 metric tonnes of tobacco and tobacco products worth of 6,305.94 crores during 2020-21 (Tobacco Board annual report, 2020-21). India is bestowed with diverse agro-climatic regions which made possible to produce the tobacco in two different seasons (*Kharif* season in Karnataka and *Rabi* season in Andhra Pradesh). Flue Virginia Cured tobacco is cultivated in Andhra Pradesh and Karnataka and having high export potential.

As tobacco is the most valued cash crop in India. The seeds of tobacco are very small, egg shaped slightly flattened and characterized by prominent raphe along one side. Seed germination in tobacco is positive photoblastic nature. Seed germination is also a major determinant of seed rate. High quality seed could significantly contribute to adequate establishment of seedlings in the nurseries for profitable seedling production and healthy seedlings. The quality of seed could be evaluated by testing its germination percentage. Tobacco seed is also vulnerable to deterioration during field weathering, harvesting and storage conditions leading to loss of seed vigour. The occurrence of high temperature and relative humidity during storage conditions are the main causes of seed viability in many seed crops. The studies on the germination of some commercial tobacco varieties (Pal and Gopalachari, 1957; Pal, 1958), mechanism of seed germination, effect of temperature (Pal *et al.,* 1958, Rao *et al.,* 2002), moisture content (Bangarayya and Ramam, 1979), biochemical changes during storage (Rao et al., 2003) and improvement of tobacco seed germination with low temperature treatments (Pal *et al.,* 1959) and hormones (Bangarayya and Sarma, 1974, Pal and Bangarayya, 1976) was reviewed periodically by various researchers in tobacco. Andrade (2018) revealed the morphological, physiological, and biochemical indicators of quality of tobacco fruits and seeds. The crop improvement programme majorly depends on variability in the germplasm/parent material. It is important to assess the genetic

Key words: seed viability, Flue Cured Virginia tobacco, seed germination, rate of germination

variability and selection of desirable donor sources for different economical traits like seed viability and germination potential. In this regards estimation of various genetic parameters like range, phenotypic coefficient of variation, genotypic coefficient of variation, broad-sense heritability, and genetic advance as a percent mean are helpful in assessing the variability in the germplasm accessions. Judicious use of donor parents in breeding programmes has a significant effect on genetic gains. Hence, an attempt has been made to assess the genetic variability for seed germination and germination rate of tobacco seeds stored under normal conditions, which will be useful for identifying the diverse parents for hybridization and further genetic improvement of FCV tobacco for enhanced seed viability.

MATERIALS AND METHODS

The material for present study consists of eleven FCV breeding lines and three released varieties maintained at ICAR CTRI Research Station, Kandukur. Seeds of eleven FCV tobacco breeding lines along with three released varieties were stored under normal conditions to assess the seedquality. Fresh and twelve months old, stored seeds of fourteen genotypes were subjected to standard germination test. For each genotype, three replications of 100 seeds each were arranged in a randomized complete block design. The seeds of all the genotypes were put in 90 mm Petri dishes containing sterilized Whatman paper and maintained wet at regular intervals. The number of seeds germinated in each genotype was recorded daily till the end of the experiment. Time to 50% germination indicates the time required to achieve 50% of final germination (Coolbear *et al.,* 1984). Germination percentage and the rate of germination were determined by using following formula:

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

$$\text{Germination rate} = \frac{\text{Number of germinated seeds on 7th day}}{\text{Total number of seeds sown}} \times 100$$

Statistical analysis

Mean values days to 50% percent germination, germination rate and total cumulative germination percentage at the end of each germination experiment was used for statistical analysis. Analysis of variance (ANOVA) for Randomized Block design was calculated using Proc GLM of SAS. Genotypic and phenotypic coefficients of variation were determined by using formula suggested by Burton and De Vane (1953), heritability and genetic advance were calculated according to Johnson (1955) and Robinson et al. (1949).

RESULTS AND DISCUSSION

Germination per centage

The percentage of germination indicates the viability of seeds. Seed germination is a basic and critical initial stage that significantly influences the population establishment. Seed rate depends on the quantity of seed required to sow unit area of land for optimum seedling production, which varied with the changes of germination per centage. There are significant differences among genotypes and genotype storage period interaction effects for germination percentage (Table 1). In the first experiment (fresh seed), the germination per centage varied from 64% (KDB 7) to 98 % (Siri) with an average of 86%. This wide range of germination percentage may be due to differential response of genotypes to prevailing temperature and relative humidity conditions during storage. Except KDB 7, all the genotype exhibited more than 80 % seed germination. In the second experiment (12 months after storage), the germination per centage ranged from 51 % (KDB 7, KDB 8) to 87 % (KDB 4) with an average of 75 %. Three genotypes (KDB 1, KDB 4 and Siri) showed more than 80 % germination even after 12 months of storage under normal conditions (Figure 1). High PCV, GCV estimates and high heritability coupled with high genetic advance as per cent of mean was observed in both the experiments (Table 2).

Germination rate

The rate of germination suggests the time course of germination and is an indicator of seed vigour, which in turn determines the seedling establishment and stress tolerance in the field. The

length of time required for all seeds to germinate, and the speed of germination also impacts different cultural practices like transplanting of seedling, fertilizing, plant protection and harvesting in tobacco cultivation. Significant genotype and genotypes storage period interaction effects were observed for germination rate (Table 1). In the first experiment (fresh seed), germination rate varied from 44 % (KDB 7) to 98 % (Siri) with mean value of 81 %. The wide range of germination rate among genotypes indicates significant effect of storage conditions. The Siri variety exhibited 98 % germination rate. In second experiment (12 months after storage), germination rate ranged from 45 % (KDB 8) to 86 % (KDB 4, KDB 11) with an average of 71 %. Three genotypes, KDB 4, Siri and KDB 11 exhibited more than 80 % germination rate even after 12 months of storage under normal conditions

Table 1: ANOVA for germination (%), germination rate and time to reach 50% germination of fourteen tobacco genotypes stored under normal conditions

Trait	Months	Source of variation	df	Sum of Squares	Mean Square	CV	LSD (0.05)
Germination (%)	**1MAS**	Genotype	13	2140	164.6**	4.3	6.2
		Replication	2	15.5	7.79		
		Error	26	355.1	13.66		
	12MAS	Genotype	13	5536	425.9**	5.2	6.5
		Replication	2	11.29	5.64		
		Error	26	390	15		
	Pooled	Genotype	13	5765.9	443.5**	4.72	4.39
		Months	1	2742.8	2742.8		1.66
		Replication(Months)	4	26.86	6.71		
		Genotype Months	13	1911.4	147**		6.2
		Error	52	745.1	14.33		
Germination rate	**1MAS**	Genotype	13	6002.5	461.7**	9.52	7.04
		Replication	2	14.3	7.17		
		Error	26	837	32.19	7.51	9.03
	12MAS	Genotype	13	7101.9	546.3**		
		Replication	2	47.2	23.6		
		Error	26	753.3	28.9		
	Pooled	Genotype	13	9457.3	727.4**	7.26	6.41
		Months	1	1665.1	1665.1		2.42
		Replication(Months)	4	61.6	15.4		
		Genotype Months	13	3647.1	280.5**		9.06
		Error	52	1590.3	30.5		
Time to 50% germination (T50)	**1MAS**	Genotype	13	31.7	2.44**	6.9	0.53
		Replication	2	0.05	0.02		
		Error	26	2.62	0.1		
	12MAS	Genotype	13	71.6	5.51**	13.8	1.17
		Replication	2	0.76	0.38		
		Error	26	12.57	0.48		
	Pooled	Genotype	13	66.8	5.14**	11.29	0.63
		Months	1	4.76	4.76		0.24
		Replication(Months)	4	0.81	0.2		0.89
		Genotype Months	13	36.57	2.81**		
		Error	52	15.19	0.29		

1 MAS – 1 month after storage 12 MAS – 12 months after storage

(Figure 2). High PCV, GCV estimates, and high heritability coupled with high genetic advance as per cent of mean was observed in both the experiments (Table 2).

Time to 50 % germination

Time to 50% germination indicates the time

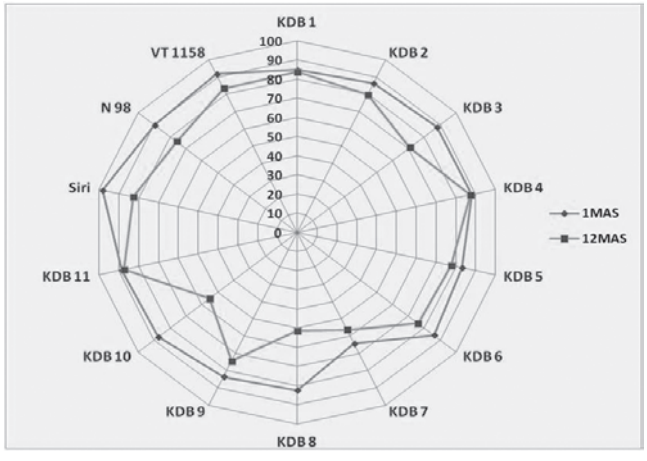

Fig. 1: Radar plot showing germination (%) of fourteen tobacco genotypes tested for ermination after one and twelve months after storage

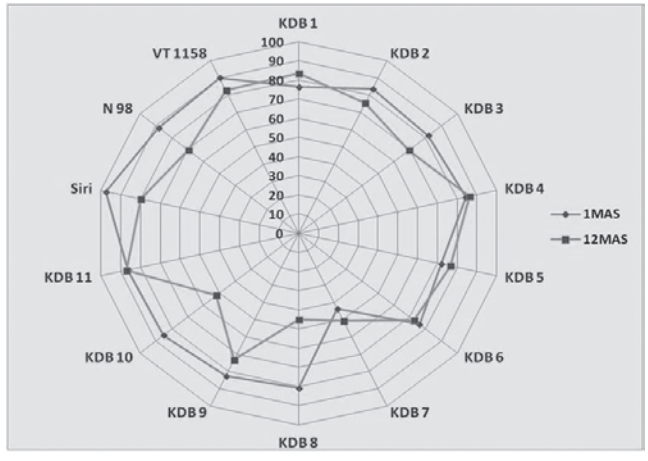

Fig. 2: Radar plot showing germination rate of fourteen tobacco genotypes tested for ermination after one and twelve months after storage

required to achieve 50 % of final germination. In the first experiment (fresh seed), time to 50 % germination ranged from 4 to 7 days with an average of 4 days. Except KDB 7, all the genotypes achieved 50 % seed germination within four days. High PCV, GCV estimates and high heritability coupled with high genetic advance as per cent of

Table 2: Genetic parameters for germination (%), germination rate and time to reach 50% germination of tobacco

Parameters	Germination per centage		Germination rate		Time to 50% germination	
	1 M	12 MAS	1 M	12 MAS	1 M	12 MAS
Minimum	63	50	31	36	4	4
Maximum	100	93	100	93	8	9
Range	37	43	69	57	4	5
Mean	85.8	74.4	80.6	71.7	4.55	5
ó e	13.6	15	32.1	28.9	0.10	0.48
ó g	50.3	136.9	143.1	172.4	0.78	1.68
ó p	63.9	151.9	175.3	201.4	0.88	2.16
PCV	9.3	16.5	16.4	19.7	20.6	29.2
GCV	8.2	15.7	14.4	18.3	19.4	15.17
$h^2_{(bs)}$	78.6	90.1	81.6	85.6	88.5	77.6
GAM	15.1	30.75	27.6	34.82	37.6	46.7

ó g – Genotypic variance GCV- Genotypic coefficient of variance $h^2_{(bs)}$ – Heritability
ó p –Phenotypic variance PCV- Phenotypic coefficient of varianceGAM –Genetic advance as per cent of mean

1 MAS – 1 month after storage 12 MAS – 12 months after storage

mean was observed. In second experiment (12 months after storage), time to 50% germination ranged from 4 to 8 days with an average of 5 days. Two genotypes (KDB 7 and KDB 8) achieved 50 % seed germination after 7 days. This wider range of variability for days to 50 % germination may be due to loss of seed viability to prevailing temperature and relative humidity conditions during storage (Figure 3). High PCV, GCV estimates and high heritability coupled with high genetic advance as per cent of mean was observed (Table 2).

Loss of seed germination due to extreme storage enviorment conditions particularly temperature and relative humidity is a common

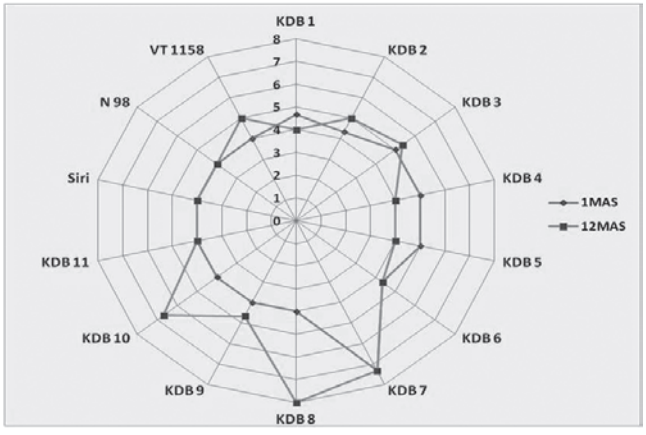

Fig. 3: Radar plot showing time to 50% germination of fourteen tobacco genotypes tested for germination after one and twelve months after storage

phenomenon in many crop sees parituclary commercial crops. The variability for germination and loss of seed viability due to adverse effects of temperature on seed viability was also recorde by various researchers (Pal and Gopalachari, 1957, Pal, 1958; Pal *et al.,* 1958, Li *et al.,* 2018) in tobacco.

it is conculded that the wide range of germination per centage, germination rate and time to 50% seed germination indicates the differential response of genotypes to storage periods and prevailing temperature and relative humidity during the storage period. In general, longer the storage period under normal conditions, the significant loss in seed viability was observed. High PCV, GCV and high heritability estimates indicates the involvement of additive gene action and effectiveness of simple selection for genetic improvement of seed viability in tobacco. Two genotypes KDB 4 and Siri showed considerable seed viability even after twelve months of storage under normal conditions, which needs to validation under controlled conditions with optimum levels of storage treatments and physio-molecular mechanism needs be elucidated in future line of work.

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