Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(6): 328-331
Received: 22-09-2019
Accepted: 24-10-2019

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Assessment of genetic variability for seed germination per cent and seedling vigour traits in sesame (*Sesamum indicum* L.)

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Abstract
The present investigation was conducted using 24 genotypes of sesame for analysis of genetic variability, heritability and genetic advance of among 7 seedling parameters. The present study revealed that the character seedling vigour index-I showed moderate GCV and PCV values indicating thereby good amount of variation in these characters. Higher magnitude of PCV as compared to GCV indicated the greater effect of environment on the expression of these characters. High heritability estimates in broad sense along with medium expected genetic advance over mean was observed for vigour index length indicating that this character would respond positively to selection. Moderate values of heritability along with low value of expected genetic advance were observed for the characters like shoot length and vigour index mass indicating that these characters were governed by non-additive component of variation, which is non-fixable so heterosis breeding can be fruitfully exploited for improving these characters. The genotypes differed significantly for all characters under study.

Keywords: Genetic variability, seed germination, vigour traits, *Sesamum indicum* L

Introduction
Sesame seed is highly nutritive which contain approximately 50% oil and 25% protein and its oil quality is outstanding because of the presence of natural antioxidants such as sesamin and sesamol (Pathak *et al.*, 2014) [13]. In India, sesame productivity is approximately 432 Kg/ha which is very low as compared to the yield potential which is nearly 2000 Kg/ha (Kumar *et al.*, 2013) [10]. In spite of the potential for high productivity of sesame, there are various challenges which constraining its production and productivity. Among various factors which limits sesame productivity, most important constraints are the poor seed supply system, high cost for crop production and lower return to the farmers (Umar *et al.*, 2011) [15]. Seed is critical to the success of the agricultural enterprise. In traditional agriculture, seed is usually an integral part of the farmer's operation (Louwaars and De Boef, 2012) [11]. Seed germination percentage mainly define the viability of seed while seed vigor determines the capacity of seed to emerge rapidly and uniformly and develop into normal seedlings under a range of conditions. Low germination percentage and poor seedling establishment of sesame is the most frequent problem being faced by the farmers (Khare and Bhale, 2016.) [9]. Poor seedling vigour is the main factors responsible for poor germination and irregular seedling establishment (Khan *et al.*, 2017). The seed quality parameters *viz.*, germination percentage and vigour index influence the yield by altering plant population density *i.e.*, field emergence, spatial arrangements and crop duration (Khare and Bhale, 2016) [9]. Due to uncertainty of weather and soil conditions, there is adequate justification for planting high germination and vigour seeds as vigours seedlings have ability to cope up with adverse conditions particularly drought resulting in adequate field emergence and stand establishment (Darfour, 2019) [2]. The study of seedling parameters such as root and shoot characteristics are useful when the objective is to development of moisture stress tolerant genotype (Riaz *et al.*, 2013) [14]. A detailed study on the extent of variability in different characters and knowledge on the nature of their heritability are the prime requisites for an efficient plant breeding programme. The level of research work on seed germination (%), seedling vigour index and related traits in sesame is low. Therefore, the present study was undertaken to assess the genetic variability, heritability and genetic advance among seed vigour and related traits in 24 genotypes of sesame

Materials and methods
The experimental material comprised of 24 diverse genotypes of sesame procured from Oilseeds Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural

University, Hisar. The description of genotypes is given in Table 1. Seed quality parameters viz. standard germination (%), shoot length (cm), root length (cm), seedling length (cm), seedling dry weight (mg), seedling vigour index-I & seedling vigour index-II were estimated and recorded in the seed quality testing laboratory of the Department of Seed Science and Technology from the harvested seeds of selected plants. For the estimation of standard germination (%), 3 replications with 100 seeds per replication for each genotype were placed on sufficiently moistened rolled germination papers in petri dishes (top of the paper method of standard germination testing) at 25 ℃ temperature with 90-95% relative humidity in the seed germinator. Final count for germination was recorded on 6th day (as per International Seed Testing Association, 2009). At the time of final seedling evaluation, seeds were classified as normal seedling, abnormal seedling, fresh un-germinated seeds and dead seed. Normal seedlings including fresh un-germinated seeds were expressed as per cent germination. Shoot length (cm) and root length (cm) were estimated using 30 seedlings selected randomly from the normal seedlings in each replication for all genotypes at the time of final count of standard germination and average shoot and root length of each genotypes were measured. Seedling length (cm) was calculated using the same seedlings used for calculating shoot and root lengths in each replication for all the genotypes and average seedling length was measured as Seedling length = Root length + Shoot length**.** Seedling dry weight (mg) was measured using the same 30 normal seedlings that were taken for measuring the root and shoot length and these seedlings were kept further in hot air oven at 80℃ for 24 hours and average dry weight per seedling was recorded in milligrams. From the observations of standard germination test, the seedling vigour index-I and seedling vigour index-II were calculated according to the method suggested by Baki and Anderson (1973) [1] using the following formulae *viz.*, Seedling vigour index-I = Standard Germination (%) x Seedling length (cm) and Seedlings vigour index-II = Standard Germination (%) x Seedling dry weight (mg). Analysis of variance was done as per the method suggested by Panse and Sukhatme (1967). Genotypic and phenotypic coefficients of variation were estimated as per formulae given by Burton (1951). Heritability (Broad sense) and genetic advance as per cent of mean were estimated as per Johnson *et al*. (1955) [5].

Results and Discussions

Analysis of variance revealed highly significant mean sum of squares due to genotypes was present for the characters viz., standard germination (%), root length (cm), seedling length (cm), seedling vigour index-I and seedling vigour index-II (Table 2) which indicated the presence of sufficient genetic variability among the genotypes under study.

Mean genotypic performance

Genotype OC 201 (96%) recorded highest standard germination and lowest for TKG 22 (72%). The overall mean was recorded as 87.69 per cent. The genotypes CST 2001-9, HT 20, RT 54, Shekhar, HT 9913, HT 9907, HT 45, KMR 60, HT 9316, HT 1 (LC) and HT 2 (LC) exhibited higher standard germination (>87.69 %) than the overall mean value. Seedling vigour index-I was maximum for the genotype HT 20 (1132.29) and minimum for TKG 22 (670.80). The overall mean was 861.42. The genotypes CST 2001-9, OC 201, OC 251, RT 54, HT 9913, HT 9907, HT 9316 and HT 1 (LC) had showed higher values (>861.42) than the overall mean value. Seedling vigour index-II was maximum for the genotype HT 20 (307.58) and minimum for HT 2000 (198.30). The overall mean was 248.13. The genotypes CST 2001-9, OC 201, OC 251, RT 54, Shekhar, HT 9913, HT 9907, HT 45, KMR 60, HT 9316, HT 2 (LC) and HTC 1 (black) had higher values (>248.13) than the overall mean value (Table 3).

Component of genetic variation, Heritability and Genetic advance

The mean values, the range of different characters, heritability and genetic advance values are presented in Table 3. Phenotypic coefficient of variation (PCV) was found higher than the genotypic coefficient of variation (GCV) for all the traits under study, which suggesting the role of environmental factors on the expression of these characters, also suggested by Khajudparn and Tantasawat (2011) [7]. Among the various characters studied, seedling vigour index-I exhibited the highest level of genotypic (GCV) and phenotypic coefficients of variance (PCV) (13.41 and 17.61) followed by root length (10.67 and 16.47). Similar results were also obtained by Garg *et al.*, (2017) [3] in green gram and Kalpande *et al.*, (2015) [6] in sorghum for seed vigor index I. Other characters viz., standard germination (%), shoot length, seedling length, seedling dry weight and seedling vigour index-II recorded low variability. Similar results for one or more of these traits were also obtained by Kalpande *et al.*, (2015) [6] in sorghum and Garg *et al.*, (2017) [3] in green gram. Heritability (broad sense) was observed to be low to moderate (16.07-57.95%), while genetic advance as per cent of mean was observed from low to high (3.53-21.3) for all the characters studied. Moderate heritability coupled with high genetic advance was observed for seedling vigour index I which suggested the preponderance of additive gene action with very low environmental effect for the expression of this trait and there is good scope for further improvement of this trait using simple phenotypic selection. Similar findings were also observed by Garg *et al.*, (2017) [3] in mung bean for seedling vigour index-I and other traits.

Table 1: List of 24 genotypes under study

S. No.	Genotypes	Source/origin	S. No.	Genotypes	Source/origin
1.	CST 2001-9	CSAUA&T, Kanpur (U.P.)	13.	HT 9913	CCS HAU, Hisar (Haryana)
2.	RT 125	SKRAU, Jodhpur (Rajasthan)	14.	TKG 22	ZARS, Tikamgarh (M.P.)
3.	HT 15	CCS HAU, Hisar (Haryana)	15.	HT 9907	CCS HAU, Hisar (Haryana)
4.	HT 20	CCS HAU, Hisar (Haryana)	16.	T 78	CSAUA&T, Kanpur (U.P.)
5.	OC 201	OUA&T, Bhubaneswar (Odisha)	17.	HT 2000	CCS HAU, Hisar (Haryana)
6.	JLS 110-12	Jalagaon, Maharashtra	18.	HT 45	CCS HAU, Hisar (Haryana)
7.	OC 251	OUA&T, Bhubaneswar (Odisha)	19.	KMR 60	UAS, Dharwad (Karnataka)
8.	HT 24	CCS HAU, Hisar (Haryana)	20.	HT 9316	CCS HAU, Hisar (Haryana)
9.	RT 54	SKRAU, Jodhpur (Rajasthan)	21.	HT 1 (LC)	CCS HAU, Hisar (Haryana)
10.	Pragati	CSAUA&T, Kanpur (U.P.)	22.	HT 2 (LC)	CCS HAU, Hisar (Haryana)

11.	NC187	NAU, Navsari (Gujarat)	23.	HTC 1 (black)	CCS HAU, Hisar (Haryana)
12.	Shekhar	CSAUA&T, Kanpur (U.P.)	24.	KMR 41	UAS, Dharwad (Karnataka)

Table 2: analysis of variance for various seed quality traits in sesame

S.V.	d.f.	Mean sum of squares						
		Standard germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Seedling dry weight (mg)	Seedling vigour index I	Seedling vigour index II
Replications	2	32.89	0.62	1.19	3.42	0.14	27832.54	308.19
Genotypes	23	109.33**	0.30	1.65**	2.66**	0.17	49708.07**	2833.21**
Error	46	24.89	0.18	0.52	0.81	0.82	9680.69	787.33
C.V. (%)		5.69	10.51	12.55	9.20	10.14	11.42	11.31

**Significant at P = 0.01 Level

Table 3: Mean performance for seed quality traits in different genotypes of sesame

Genotypes	SL	RL	SdL	SdW	VG 1	VG 2	SG
CST 2001-9	4.30	5.33	9.63	2.88	879.86	262.93	91.33
RT 125	3.65	5.02	8.67	2.73	723.32	227.77	83.33
HT 15	4.31	5.12	9.43	2.55	798.00	215.89	84.67
HT 20	4.78	7.16	11.95	3.24	1132.29	307.58	94.67
OC 201	4.26	6.68	10.93	2.87	1049.60	275.20	96.00
JLS 110-12	3.80	4.92	8.72	2.82	719.77	233.36	82.67
OC 251	4.06	6.53	10.59	3.17	896.29	266.24	84.67
HT 24	4.00	5.52	9.52	2.60	817.93	223.87	86.00
RT 54	4.30	6.36	10.66	2.97	981.22	272.85	92.00
Pragati	4.16	5.61	9.77	2.85	824.02	240.79	84.67
NC 187	4.05	5.15	9.21	2.67	794.71	230.55	86.67
Shekhar	3.78	5.84	9.62	2.89	853.11	256.37	88.67
HT 9913	4.10	6.62	10.72	3.08	1012.75	291.61	94.67
TKG 22	3.85	5.35	9.20	2.82	670.80	204.17	72.00
HT 9907	4.18	6.88	11.06	3.02	1034.53	282.57	93.33
T 78	4.08	5.18	9.26	2.42	791.12	206.09	84.67
HT 2000	3.55	5.48	9.03	2.31	776.65	198.30	86.00
HT 45	3.88	4.37	8.26	2.82	727.31	248.21	88.00
KMR 60	3.82	5.10	8.91	3.00	798.43	267.85	90.00
HT 9316	4.35	6.79	11.13	3.01	1056.04	285.28	94.67
HT 1 (LC)	4.16	6.38	10.54	2.39	993.54	224.50	94.00
HT 2 (LC)	3.32	5.66	8.98	2.98	815.43	270.72	90.67
HTC 1 (black)	4.14	5.28	9.42	2.92	816.69	252.87	86.67
KMR 41	3.62	5.87	9.49	2.81	710.73	209.59	74.67
Mean	4.02	5.76	9.78	2.87	861.42	252.05	87.69
S.E. (m)	0.24	0.42	0.52	0.17	56.81	16.20	2.88
C.D. (5%)	NS	1.19	1.48	0.47	162.23	46.26	8.23
C.V. (%)	10.51	12.55	9.20	10.14	11.42	11.31	5.69

SL = Shoot length (cm), **RL** = Root length (cm), **SdL** = Seedling length (cm), **SdW** = Seedling dry weight (mg), **VG 1** = Seedling vigour index I, **VG 2** = Seedling vigour index II, **SG** = Standard germination (%), **C.D.** = Critical difference, **C.V.** = Coefficient of variation, **NS** = Non-Significant

Table 4: Estimates of mean performance, range, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense) and genetic advance (GA) as per cent of mean for seed quality traits in sesame

Seed quality traits	Mean ± SE	Range	Coefficient of variation (%)		Heritability (%) (broad sense)	Genetic advance as per cent of mean (%)
			Genotypic (GCV)	Phenotypic (PCV)		
Standard Germination (%)	87.69±4.07	72.00-96.00	6.05	8.31	53.07	9.08
Shoot length (cm)	4.02±0.35	3.32-4.78	4.96	11.62	18.18	4.35
Root length (cm)	5.76±0.59	4.37-7.16	10.67	16.47	41.95	14.23
Seedling length (cm)	9.78±0.73	8.26-11.95	8.03	12.21	43.25	10.88
Seedling dry weight (mg)	2.87±0.23	2.31-3.17	4.27	10.65	16.07	3.53
Seedling vigour index I	861.42±80.33	670.80-1132.29	13.41	17.61	57.95	21.03
Seedling vigour index II	252.05±23.06	198.30-307.58	8.59	14.12	37.00	10.76

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