Effect of Seed Vigour on Field Performance and Seed Yield in Okra (*Abelmoschus esculentus* L.)

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Abstract

The present investigation was undertaken with freshly harvested seed of okra hybrid, *Uphar*, with different seed vigor levels after subjecting to accelerated ageing at 40 ± 1⁰C and 85 ± 5 % relative humidity for 4, 8, 12 and 16 days to study the effect of seed vigor on initial seed quality, field performance and yield. The initial seed quality declined with increase in period of accelerated ageing. Plants established from low vigor seed lots exhibited poor field performance as evidenced by reduced plant height, reduction in dry matter production and leaf area per plant at different stages of crop growth, delay in days to 50 % flowering and days to first picking. The initial seed vigor levels exhibited a significant influence on yield and its contributing characters, but the same showed a declining trend with increase in duration of accelerated ageing.

1. Introduction

The quality of seed is a major concern in agriculture throughout the world. Seed quality is typically measured by different standard germination tests. While the results of a standard germination test may correlate well with field emergence when soil conditions are favorable for rapid emergence, the test cannot predict field performance when soil and environmental conditions impose stress on the germinating seeds, as it often occurs with early planting (Tekrony and Egli, 1991). Seed vigor is a reflection of those properties that determine the potential for rapid, uniform emergence and the development of normal seedlings under a wide range of field conditions. Thus, seed vigor is an inherent character and it indicates, in totality, those seed attributes which will favour stand establishment in a varied field conditions.

Okra (*Abelmoschus esculentus* L.) is one of the most commonly used vegetables grown throughout the year. The time of harvest of okra seed crop determines the seed quality, often, okra seed is harvested before the seed reaches optimal maturity, because of several reasons which include incidental rains, production of multiple pods, their maturity and harvest at different times. In addition, many cultivars of okra do not mature uniformly throughout the field due to indeterminate growth habit, resulting in poor quality of the harvested seed. Thus, poor seed vigor results in faster loss of germination during storage, poor field emergence and inadequate plant stand establishment. Therefore, delayed or poor field emergence may reduce the yield at harvest, but the direct effect of seed vigor on plant growth and yield in the absence of population differences is controversial (Ellis, 1992). Innumerable vigor tests have been attempted; unfortunately most procedures used for vegetable seed vigor testing are usually those that are recommended for field crop species (Matthews, 1980). Hence, the present study was undertaken to find out the effect of seed vigor on field performance and seed yield.

2. Materials and Methods

Fresh hybrid seeds (*Uphar*) okra having 91% germination subjected to accelerated ageing (AA) at 40±1°C and 90±5% relative humidity for periods of 4, 8, 12 and 16 days in order to obtain different seed vigor levels in terms of germination.

The resultant seed lots exhibited four vigor levels of germination with 82, 74, 65 and 57% respectively while the same for control was 91%. The seeds were used to study the effect on initial seedling quality in laboratory and seed vigor, field performance and yield under field conditions. The accelerated aged seed lots were subjected to standard germination tests (ISTA, 1999) and observations on initial seed quality parameters such as germination (%) seedling length and dry matter content were recorded. The vigor index I and II were computed as per Abdul Baki and Anderson (1973) (Table 1a & b).

The seed okra lots of four vigor levels together with the control were sown in the field in a Completely Randomized Block Design (CRBD) with four replications during *Rabi* (winter), 2008-09 at Department of Seed Science and Technology, College of Agriculture, Rajendranagar, Hyderabad. The crop was raised by following recommended package of practices of the region and need based plant protection measures were taken. The following observations from field studies were recorded namely, field emergence (10 DAS), days to 50% flowering, plant height, dry weight of plant, leaf area per plant, number of green fruits per plant, green fruit yield plant^{-1}, number of seeds fruit^{-1} and seed yield. The leaf area was measured from leaves of five randomly selected plants using leaf area meter and expressed in cm^2. Days to 50% flowering were recorded on plot basis, while observations for yield and other parameters were recorded in ten randomly selected plants in each replication of each treatment. The quality of the seed harvested from each plot was tested as per the standard procedure (ISTA, 2004). The results of laboratory and field studies were statistically analyzed as per the standard procedures (Panse and Sukhatme, 1985).

3. Results and Discussion

The analysis of variance indicated highly significant to significant effect of different treatments (control and four vigor levels) for all the characters except for days to first picking and per cent of germination after seed harvested from each plot. It clearly indicated that the accelerated ageing of seeds caused difference in seed vigor levels in terms of germination percentage (Table 1c & d). Although, the seed vigor levels significantly influenced all the parameters in the present study, the vigor of the seed was high in fresh seed lots in terms of germinability (91%), seedling length (23.12 cm), seedling dry matter (2.20 g) and seed vigor index (2098.5) (Table 2). Duration of accelerated ageing had a significant influence in declining the seed vigor in okra hybrid. The germination decreased from 91 to 57 % with increase in days of accelerated ageing from 4 to 16 days. The drastic reduction in germination (65 and 57 %) after 12 and 16 days of accelerated ageing may be attributed to seed deterioration as a result of loss in initial seed vigor in *Uphar* hybrid. Lipid peroxidation and the loss of membrane phospholipids are major causes of seed ageing under accelerated ageing conditions (Mc Donald, 1999). Reduction in seed germination due to accelerated ageing was earlier reported in other crops like soybean (Rao et al., 1994) and green gram (Bishnoi and Santos, 1997). Further, Arunkumar et al. (2007) found that the germination, seedling vigor, seedling dry weight and field emergence decreased with increased period

Table 1(a, b, c, d): ANOVA for seedling quality and field performance parameters in okra hybrid *Uphar*

a. sov	df	Germination (%)	Seedling length (cm)	Seedling dry weight (g)	SVI-I[a]	SVI-II[b]	Germination on exhaustive vigor test (%)
Trt	4	718.750**	50.552**	0.387**	1097635.000**	8442.852**	170.712**
Err	15	0.450	0.800	0.004	224.557	50.298	1.179

b. sov	df	Field emergence index	Days to 50% flowering	Plant height (cm)	Fresh weight (g)	Dry weight (g)	leaf area plant^{-1} (cm^2)
Rep	3	0.911	0.608	0.088	1.414	0.082	0.149
Trt	4	727.638**	2.950	583.432**	12514.060**	245.737**	6950.785**
Err	12	0.880	1.265	0.439	1.545	0.120	0.206

c. sov	df	DFP	NPGF	TNGFP	TGFYP (g)	FYPP (kg)	NSDF	DFW (g)	NFP	SI (g)	SYP (g)
Rep	3	0.471	0.183	1.108	7.261	0.798	1.138	0.035	1.433*	0.013	0.165
Trt	4	3.925	6.425**	70.114**	10006.050**	177.183**	102.805**	3.130	20.325**	1.656**	251.139**
Err	12	2.627	3.933	0.366	6.083	1.485	0.494	1.036	0.381	0.079	0.248

d. sov	df	Germination (%)	Seedling length (cm)	SVI-I[a]	SVI-II[b]
Trt	4	1.200	3.331**	641577.600**	5.469**
Err	15	3.333	0.159	80.168	0.690

sov: Sources of variation; df: Degrees of freedom; Rep: Replication; Trt: treatments; Err: error; [a]: Seedling length basis; [b]:Seedling dry weight basis; DFP: Days to first picking; NPGF: Number of pickings of green fruits; TNGFP: Total number of green fruits plant^{-1}; TGFYP : Total green fruit yield plant^{-1}; FYPP: Fruit yield plot^{-1}; NSDF: No. of seeds dry fruit^{-1}; DFW: Dry fruit weight; NFP: No. of fruits plant^{-1}; SI: Seed Index (100 Seed weight; SYP: Seed yield plant^{-1}; *: p=0.05; **: p=0.05

Table 2: Effect of seed vigour levels on seed quality parameters of okra hybrid *Uphar* in the laboratory

Trt	G (%)	SL (cm)	SDW (g)	SL basis	SDW basis	EVT (%)
T_1	91	23.12	2.20	2098.5	199.65	39.00
T_2	82	20.90	2.03	1713.75	168.33	35.00
T_3	74	18.10	1.81	1340.05	134.09	30.25
T_4	65	15.92	1.64	1027.00	106.26	25.75
T_5	57	14.00	1.44	794.52	81.70	22.25
Mean	73.8	18.40	1.824	1394.75	138.00	30.45
SEm±	0.60	0.21	0.018	17.7	1.81	0.53
CD*	1.71	0.65	0.057	54.74	5.58	1.64

T_1 : Without accelerated ageing (control); T_2: Accelerated ageing for 4 days at 40 ± 1^{0}C and 85 ± 5% RH; T_3: Accelerated ageing for 8 days at 40 ± 1^{0}C and 85 ± 5% RH; T_4: Accelerated ageing for 12 days at 40 ± 1^{0}C and 85 ± 5% RH; T_5: Accelerated ageing for 16 days at 40±1^{0}C and 85 ± 5% RH; G: Germination; SL: Seedling length; SDW: Seedling dry weight (g); EVT: Exhaustive vigour test (%); $^*p$=0.05

of accelerated aging in okra. These seed lots with low initial germination exhibited low initial seed quality as evidenced by their decreased seedling length (23.12 to 14.00 cm), reduced dry weight of seedling (2.20 to 1.44 g) and low seedling vigor index (2099 to 795). Thus the reduction in seedling length and dry matter accumulation was directly proportional to reduction in germination levels. The decline in seedling length, dry matter and vigor index was more in seed lots having lesser (65 and 57 %) germination as compared to the lots with high vigor levels with 91, 82 and 74 germination percentage. The reduction in seedling length, dry matter and vigor index may be due to loss of membrane integrity of cellular membranes, leaching of solutes and intercellular disorganization and also impairing the growth of seedling by slowing down the metabolic activity McDonald, 1999). The accuracy of this vigor test confirmed previous results of Panobianco and Marcos-Filho (2001) for tomato seeds. A valuable vigor test for the seed industry must reveal different performance levels from high and low physiological potential seed lots, since the identification of intermediate vigor is almost impossible as values frequently overlap higher and/or lower quality lots, as reflected for seed germination and seed vigor level (Table 2). Similar findings of reduction in seed quality parameters were reported in maize (Hussaini et al., 1988). The laboratory studies clearly indicated that the vigor levels in okra influenced the seed quality parameters.

The field performance (field emergence, plant height, fresh weight, dry weight, leaf area, days to 50% flowering and pod yield), crop growth and yield parameters of okra hybrid *Uphar* were significantly influenced by the seed vigor levels (Table 3). A significant reduction in field emergence index (from 79.36 to 47.45 units) was noticed with the decrease in vigor levels. A significant positive association between germination and field emergence index (r=0.96*) was observed. Similar results were also obtained by Gray and Steckel (1983) in carrot. This variation in field emergence was mainly due to the difference in seed vigor levels. It is not uncommon that low vigor seed may emerge in the field but, the seedlings emerging from such seed may be inefficient to overcome the compactness of soil especially under sub optimal conditions (Mc Donald, 1980). In the present study, the time taken for flower initiation and 50% flowering increased with the decrease in seed vigor. The delay in flowering was more pronounced in plants developed from seed lots with low germination, decreased seedling length and field emergence than those from seed lots with high germination, increased seedling length and high field emergence. These results are in conformity with the earlier reports of Camargo and Vaughan (1973) in sorghum. Plant growth in terms of plant height (87.42 to 56.83 cm) and leaf area (353.22 to 245.24 cm^2) were also affected by seed vigor levels. The plants having high vigor showed increased plant height and leaf area, which might be due to early emergence, rapid seedling growth and uniform crop growth. Similar observations were made by Paramesh et al. (2002). The growth characters viz., plant height and leaf area showed a concomitant effect on dry matter production. The total dry matter production drastically decreased in low vigor seed lots (31.42 g) as compared to high vigor seed lots

Table 3: Effect of seed vigor levels on field performance in okra hybrid *Uphar*

Trt	FEI	DFF	PH (cm)	FW (g)	DW (g)	LAP (cm^2)
T_1	79.36	41.00	87.42	369.86	50.55	353.22
T_2	73.24	41.25	78.72	338.14	45.98	317.59
T_3	63.32	41.75	70.02	295.51	38.06	290.44
T_4	52.09	42.50	62.76	260.64	35.30	271.35
T_5	47.45	43.00	56.83	232.23	31.42	245.24
Mean	62.71	41.90	69.15	299.27	40.26	295.57
SEm±	0.43	0.059	0.40	3.76	0.37	3.44
CD*	1.33	0.162	1.24	11.6	1.16	10.60

T_1 : Without accelerated ageing (control); T_2: Accelerated ageing for 4 days at 40 ± 1^{0}C and 85 ± 5% RH; T_3: Accelerated ageing for 8 days at 40 ± 1^{0}C and 85 ± 5% RH; T_4: Accelerated ageing for 12 days at 40 ± 1^{0}C and 85 ± 5% RH; T_5: Accelerated ageing for 16 days at 40±1^{0}C and 85 ± 5% RH; FEI: Field emergence index; DFF: Days to 50% flowering; PH: Plant height ; FW: Fresh weight; DW: Dry weight; LAP: leaf area plant $^{-1}$; $^*p$=0.05

Table 4: Effect of seed vigor levels on field performance in okra hybrid *Uphar*

Trt	DFP	NPGF	TNGFP	TGFYP (g)	FYPP (kg)	NSDF	DFW (g)	NFP	SI (g)	SYP (g)
T_1	43.00	17.50	32.75	325.78	30.05	46.50	5.83	11.75	9.71	33.92
T_2	43.25	17.00	28.75	282.15	24.77	43.50	5.15	10.00	9.22	29.02
T_3	43.75	16.50	26.75	254.13	21.07	39.75	4.48	8.50	8.74	25.32
T_4	44.50	15.00	24.25	231.29	16.70	37.50	4.03	7.25	8.45	19.07
T_5	45.00	14.25	21.50	194.25	13.22	33.75	3.63	5.75	8.16	13.94
Mean	43.90	16.05	26.8	257.52	21.61	40.20	4.62	8.15	8.67	24.25
SEm±	0.19	0.30	0.51	3.61	0.45	0.50	0.053	0.23	0.056	0.83
CD*	0.61	0.95	1.27	11.15	1.39	1.54	0.16	0.71	0.18	2.57

T_1 : Without accelerated ageing (control); T_2: Accelerated ageing for 4 days at 40 ± 1^{0}C and 85 ± 5% RH; T_3: Accelerated ageing for 8 days at 40 ± 1^{0}C and 85 ± 5% RH; T_4: Accelerated ageing for 12 days at 40 ± 1^{0}C and 85 ± 5% RH; T_5: Accelerated ageing for 16 days at 40±1^{0}C and 85 ± 5% RH; DFP: Days to first picking; NPGF: Number of pickings of green fruits; TNGFP: Total number of green fruits plant $^{-1}$; TGFYP : Total green fruit yield plant $^{-1}$; FYPP: Fruit yield plot $^{-1}$; NSDF: No. of seeds dry fruit $^{-1}$; DFW: Dry fruit weight; NFP: No. of fruits plant $^{-1}$; SI: Seed Index (100 Seed weight; SYP: Seed yield plant^{-1}; *: p=0.05

(50.55 g) at 90 DAS. Hence, it is evident from the present findings that any improvement in seed vigor ultimately influences the crop yield. The present investigation revealed that the influence of seed vigor levels on field performance, yield and its contributing parameters were more pronounced during the initial crop growth stages and declined gradually as the crop reached maturity (Table 4). Ellis (1992) also mentioned that the influence of seed vigor on plant performance in the field occurs during the initial development and diminishes over time as plants reach subsequent growth stages.

Yield in crop plants is a complex quantitative trait and is largely influenced by a number of its component characters. The present study revealed a significant variation in the yield and yields components namely, number of green fruits plant $^{-1}$ (32.75 to 21.50), number of seeds fruit^{-1} (46.50 to 33.75) and seed yield plant^{-1} (33.92 to 13.94 g) due to different seed vigor levels (Table 4). Seed lots with low seed vigor and poor germination exhibited reduced plant size, less number of fruits plant^{-1}, seeds fruit^{-1} and low fruit weight as compared to those having high seed vigor. This might be due to the cumulative influence of seed vigor and quality on the time taken for field emergence and subsequent crop growth. Similar observations were recorded in rice (Rao, 1990) and sunflower (Ravinder, 1990).

The laboratory studies to assess the quality of harvested seed revealed non- significant impact of seed vigor levels on germination, seedling length and vigor index of harvested seed in okra hybrid *Uphar* (Table 5).

Similarly, Ellis (1992) found that the seed vigor exhibited influence only during the plant performance and yield in the field and it had no impact on the quality of subsequently harvested seed. Therefore it indicates, that the initial seed quality and field performance as measured by plant growth and green pod yield parameters were influenced by initial seed vigor levels in okra. Thus, the use of high vigor seed lots is justifiable to ensure adequate stand establishment under different environmental conditions, as emphasized in seed vigor definition (Marcos Filho, 1999).

Table 5: Effect of Seed vigour levels on seedling quality of the harvested seed in okra hybrid *Uphar*

Trt	G (%)	SL (cm)	SVI I SL basis (units)	SVI II DW basis (units)
T_1	84	23.30	1995.72	27.08
T_2	84	23.07	1937.88	24.76
T_3	85	22.50	1912.50	26.17
T_4	84	21.40	1797.60	26.64
T_5	85	21.45	1823.25	25.38
SEm±	2.06	0.56	74.16	0.65
CD*	NS	NS	NS	NS

T_1 : Without accelerated ageing (control); T_2: Accelerated ageing for 4 days at 40 ± 1^{0}C and 85 ± 5% RH; T_3: Accelerated ageing for 8 days at 40 ± 1^{0}C and 85 ± 5% RH; T_4: Accelerated ageing for 12 days at 40 ± 1^{0}C and 85 ± 5% RH; T_5: Accelerated ageing for 16 days at 40±1^{0}C and 85 ± 5% RH; FEI: Field emergence index; DFF: Days to 50% flowering; PH: Plant height ; FW: Fresh weight; DW: Dry weight; LAP: leaf area plant $^{-1}$; *p=0.05

4. Conclusion

Relatively seed with high vigour seed (more than 75% germination) should be used to have early emergence, uniform growth and field performance and improve the yield potential.

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