Advances in Research

11(1): 1-8, 2017; Article no.AIR.35500
ISSN: 2348-0394, NLM ID: 101666096

Effect of Relative Storability on Primed Seed Lots of Fenugreek (*Trigonella foenum-graecum* L.)

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Authors' contributions

This work was carried out in collaboration between all authors. Author SK designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author OSD guided all the authors during whole period of study and article writing. Author PS managed the analyses of the study. Author VSM managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AIR/2017/35500
Editor(s):
(1) Magdalena Valsikova, Horticulture and Landscape Engineering, Slovak University of Agriculrure, Nitra, Slovakia.
Reviewers:
(1) Rocky Thokchom, Uttar Banga Krishi Viswavidyalaya, India.
(2) Thaise Gerber, Concórdia College, Brazil.
(3) Jose Luis Martinez, Universidad de Tabasco, Mexico.
(4) Lokesh, G. Y., University of Agricultural Sciencess, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/20535

Original Research Article

Received 16th July 2017
Accepted 14th August 2017
Published 18th August 2017

ABSTRACT

The present research was carried out on two genotypes of fenugreek viz. HM-57 and HM-103 with two seed lots of each genotype including fresh and one year old seed lot were stored under ambient condition and the observations were recorded at the interval of 3 months. In this experiment, both seed lots of two genotypes were tested for various physiological and biochemical basis for loss in viability and vigour. The hydration (6 h) and dehydration at room temperature followed by dry dressing with thiram (0.25%) recorded significantly maximum germination over the treatments throughout the storage period in both varieties and seed lots showed higher improvement in all laboratory and field parameters followed by hydration-dehydration treatment. Lot (L_2) seeds showed better improvements over lot (L_1) for standard germination, root length, shoot length, vigour indices, viability, Electrical conductivity. Whereas L_1 seed lots showed better improvement in test weight, seed density, seedling dry weight. The variety HM-57 showed higher improvement in test weight, seed density, standard germination, root length, vigour index-I, whereas HM-103 showed higher improvement in shoot length, seedling dry weight, vigour index-II.

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Keywords: Fenugreek; seed lots; storability; priming.

1. INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is an annual herbaceous multipurpose crop grown during winter season in North India. The seed is mainly used as condiment and in the pharmaceutical industry especially in preparation of ayurvedic medicines, while young plants are used as a vegetable and forage. Seed is an important component and availability of viable and vigorous seed at the planting time is important for achieving increase agricultural productivity because good quality seed acts as a catalyst for realizing the potential of other inputs. Main objective of the seed storage is to preserve the seed quality and to prolong the self life under different sets of storage conditions. The knowledge of the relative storability of seed lots/varieties also helps in making certain decisions during storage to maintain its vigour and viability.

Seed quality plays an important role in the crop establishment and overall performance of the crop. Availability of viable and vigorous seeds at the planting time is important for achieving targets of agricultural production because good quality seed acts as a catalyst for realizing the full potential of other inputs. Since the total cultivable area is decreasing due to over growing population, the increased agricultural productivity is the only option. Good seed in good land yield abundant. The good quality seed is pre-requisite to enhance the production and productivity. Seed is an important component and the quality seed plays a crucial role in agricultural production as well as in national economy. Use of quality seeds increased productivity of crop by 15-20% Sidhawani [1].

Plant breeders have developed a number of high yielding varieties and to harvest their potential, quality seed has been recognized as an important and cheapest input. The quality of seed is mainly measured by its genetic purity and capacity to develop into a healthy plant. The unfavorable environment (especially exposure to rains just for one week) during the post maturation, pre-harvest environment can greatly accelerate the seed ageing phenomenon, resulting in 20 to 30% loss of seed viability. The seed of particular harvest cannot be used immediately for sowing the following crop because of the time required for processing and for seed certification prior to the marketing of seeds. Therefore, the fresh seeds have to be stored for 6-8 months after harvest and under uncontrolled storage conditions.

2. MATERIALS AND METHODS

The present study was conducted during 2013-14 at the laboratories and research farm area of Seed Science & Technology Section CCS Haryana Agricultural University. Hisar. Seed material comprised of two varieties viz. HM-57, HM-103 of fenugreek crop was procured from the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar. Two seed lots of each variety include – L_1= Standard germination above Indian minimum seed certification standards (>70%), L_2 = Standard germination below Indian minimum seed certification standards (<70%) and each seed lot of both varieties was invigorated with following priming treatments prior to lab and field study.

- T_0 Untreated (control)
- T_1 Hydration (6 h.) and dehydration at room temperature
- T_2 2% $CaCl_2$ (6 h) at room temperature and surface drying at room temperature
- T_3 Hydration with 50 ppm GA_3 (6 h.) and surface drying at room temperature
- T_4 As in T_1 followed by dry dressing with thiram @ 0.25% (6 h.) and surface drying at room temperature
- T_5 0.5% KNO_3 hydration (6 h.) and dehydration at room temperature

After each treatment seed were dried back to original moisture content under shade and observations on following parameters were recorded:

2.1 Laboratory Parameters

2.1.1 Standard germination (%)

One hundred seeds of each lot in three replicates were placed in between sufficient moistened rolled towel papers (BP) and kept at 20℃ 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 [2]).

2.1.2 Root length (cm)

Five normal seedlings were selected randomly at the time of final count of standard germination and average length of five root lengths was measured in centimeters.

2.1.3 Shoot length (cm)

Five normal seedlings were selected randomly at the time of final count of standard germination and average length of five shoot length was measured in centimeters.

2.1.4 Seedling dry weight (mg)

Seedling dry weight was assessed after the final count in the standard germination test (14 days). Ten seedlings of each lot replicated thrice were taken. Seedlings were dried in a hot air oven for 24 hrs at 80±1℃. The dried seedlings of each replication were weighed and average seedling dry weight of each variety was calculated.

2.1.5 Seedling vigour indices

Seedling vigour indices were calculated according to the method suggested by Abdul-Baki and Anderson [3].

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

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

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

   Vigour index–II =Standard Germination (%) × seedling dry weight (mg)

2.1.6 Electrical conductivity (µS/cm/seed)

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℃ for 24 h. The electrical conductivity of the seed leachates was measured using a direct reading conductivity meter and expressed in µS/cm/seed.

The primed seed lots were stored under ambient condition and following observation were recorded at the interval of 3 months. The data was collected on standard germination (%), root and shoot length (cm), seedling dry weight (g), seed vigour Index- (I & II) and electrical conductivity (µS/cm/seed). The factorial experiment in completely randomized design (CRD) as well as in randomized block design (RBD) was conducted for laboratory and field parameters, respectively.

3. RESULTS AND DISCUSSION

3.1 Standard Germination (%)

The results revealed that standard germination percentage decreased significantly as period of storability increased in both varieties and lots recorded significantly maximum germination over the treatments throughout the storage period in both varieties and seed lots. At the end of storage period (9 months) maximum seed germination (76.00) was in variety HM-103 with T_4 treatment in lot L_1 while minimum germination (49.30) was recorded in variety HM-103 with T_3 treatment of lot L_2 (Table 1). Selvarani [4] treated onion seeds with water (hydropriming) and salts of KNO_3 revealed that priming treatments increased the speed of germination, seedling length, protein content and enzyme activity but lower the electrical activity of seeds when compared to control. Seed stored for zero, one, two, and three year under ambient conditions (kalsa [5]). Similar results were observed on onion by Kumar [6]; on sweet pepper by Kaewnaree [7], Kumar [8]; Kumar [9]; on Entada pursaetha by Priya [10]; in tomato by Perez-Camacho [11]; on soybean by Mohammadi [12]; on ksauri methi by Sherawat [13] and on papper and tomato by Valsikova [14]. It is concluded that storage has adverse effect on germination.

3.2 Root Length (cm)

After 9 month of storage period, the maximum root length (9.72 cm) was in HM-57 treated with T_4 in lot L_1 while minimum (6.01 cm) in HM-57 with T_2 in lot L_2 (Table 2). Similar finding was reported in coriander by Kumar (8) and Kumar (9); in turnip by Khan [15]; in wheat by Singh [16].

3.3 Shoot Length (cm)

The maximum shoot length (18.06 cm) was recorded in HM-57 with T_4 in lot L_1 while minimum (8.35 cm) shoot length in HM-57 with T_0 in lot L_2 (Table 3). The increase in seedling length by various pre-sowing treatments can be due to the beneficial effect in quick and uniform germination, due to intensified hydrolytic process, better uptake of nutrient and moisture and imparting stimulation for better establishment of seedling. All the physiological parameters viz., germination percentage, viability, root length, shoot length, and consequently the vigour index in all varieties of chickpea were significantly decreased with accelerated ageing Kapoor [17].

Table 1. Effect of priming on standard germination (%) during storage period

Treatment	HM -57							
	0 month		3 months		6 months		9 months	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
T_0	83.00 (65.62)	65.30 (53.91)	80.00 (63.41)	62.30 (52.12)	77.00 (61.33)	61.70 (51.73)	72.70 (58.47)	59.30 (50.36)
T_1	85.00 (67.21)	72.00 (53.03)	79.70 (63.20)	70.00 (56.77)	77.00 (61.33)	68.30 (55.74)	75.30 (60.22)	65.00 (53.71)
T_2	81.30 (64.37)	68.00 (55.54)	77.70 (61.79)	65.30 (53.91)	76.00 (60.66)	63.70 (52.91)	74.30 (59.55)	62.00 (59.55)
T_3	84.00 (66.40)	69.30 (56.36)	79.70 (63.18)	65.70 (54.12)	76.70 (61.10)	63.00 (52.52)	74.00 (59.32)	61.70 (59.32)
T_4	86.00 (68.01)	73.30 (58.90)	83.30 (65.91)	70.00 (56.77)	80.00 (63.43)	68.00 (55.54)	74.70 (59.77)	65.00 (59.78)
T_5	80.00 (63.43)	63.70 (52.92)	77.30 (61.55)	61.00 (51.35)	75.30 (60.22)	59.30 (50.37)	72.70 (58.46)	55.70 (58.46)
	HM-103							
T_0	82.70 (65.40)	65.00 (53.72)	77.00 (61.33)	63.00 (52.51)	74.30 (59.54)	61.00 (51.34)	70.00 (56.77)	58.70 (49.97)
T_1	84.30 (66.69)	70.30 (56.99)	79.70 (63.23)	67.70 (55.33)	77.00 (61.33)	64.70 (53.51)	74.70 (59.78)	60.70 (51.44)
T_2	80.30 (63.68)	69.70 (56.58)	77.30 (61.55)	66.70 (54.72)	74.70 (59.76)	64.00 (53.11)	72.30 (58.25)	61.30 (51.54)
T_3	77.30 (61.62)	61.70 (51.73)	76.00 (60.67)	57.70 (49.39)	73.70 (59.11)	57.70 (49.39)	71.30 (57.61)	49.30 (44.60)
T_4	86.00 (68.01)	72.00 (58.05)	82.00 (64.91)	65.30 (53.91)	79.00 (62.70)	63.70 (52.91)	76.00 (60.65)	62.70 (52.31)
T_5	80.00 (63.47)	63.30 (63.47)	77.30 (61.57)	61.70 (51.73)	76.70 (61.10)	59.70 (50.55)	73.70 (59.11)	57.70 (49.39)

C.D. (P = 0.05); V = 1.007; L = 1.007T = 1.744; V X L X T = N.S.

Table 2. Effect of priming on root length (cm) during storage period

Treatment	HM -57							
	0 month		3 months		6 months		9 months	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
T_0	9.41	6.56	9.08	6.28	8.52	6.18	8.23	6.01
T_1	10.07	6.98	9.65	6.62	9.44	6.28	9.29	6.08
T_2	10.01	6.73	9.62	6.45	9.27	6.22	9.10	6.06
T_3	9.64	6.87	9.41	6.50	9.22	6.36	9.08	6.19
T_4	10.59	7.76	10.25	7.44	10.01	7.15	9.72	6.94
T_5	10.16	7.17	10.06	7.05	9.75	6.91	9.54	6.70
	HM-103							
T_0	8.88	7.08	8.55	6.85	8.35	6.51	8.15	6.27
T_1	9.43	7.54	9.26	7.3	9.18	7.14	9.05	6.97
T_2	9.2	7.33	9.13	7.15	8.96	7.06	8.81	6.92
T_3	9.48	7.53	9.25	7.33	9.16	7.15	9.05	7.02
T_4	9.76	7.88	9.46	7.57	9.27	7.41	9.25	7.17
T_5	9.26	7.57	9.23	7.41	9.21	7.24	9.08	7.10

C.D. (P = 0.05); V = 0.073; L = 0.073T = 0.126; V X L X T = N.S.

3.4 Seedling Dry Weight (mg)

Seedling dry weight decreased as period of storability increased in both variety and seed lots. T_4 recorded significantly maximum seedling dry weight over the other treatments throughout the storage period in both varieties and lots. At the end of storage period the maximum seedling dry weight (7.35 mg) was in variety HM-57 with T_4 in lot L_1 while minimum seedling dry weight (6.00 mg) was in HM-103 with T_0 in lot L_2 (Table 4). Nagarajana [18] observed that increasing period, the dry weight of seedling was decreased in okra. Samriti [19], effect of organic seed pelleting on seed storability and quality seedling production in biofuel tree species.

3.5 Vigour Index-I

After 9 months of storage, the maximum seed vigour index–I (2073.7) was in HM-57 with T_4 in lot L_1 while minimum seed vigour index–I (799.2) in HM-103 with T_3 in lot L_2 (Table 5). Reduction in vigour index was observed as the storage period increased. This may be due to reduction in seedling length. These results are same in accordance with Nagarajana [18] in okra.

Table 3. Effect of priming on shoot length (cm) during storage period

Treatment	HM -57							
	0 month		3 months		6 months		9 months	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
T_0	15.93	9.82	15.61	9.15	15.51	8.75	15.22	8.35
T_1	17.47	10.17	17.45	9.8	17.39	9.35	17.04	9.12
T_2	17.9	10.42	16.94	9.94	16.38	9.76	16.15	9.45
T_3	17.45	10.33	16.74	9.79	16.49	9.53	16.25	9.24
T_4	18.4	11.12	18.31	10.72	18.15	10.38	18.06	10.14
T_5	18.03	10.4	17.85	10.41	17.54	10.14	17.23	9.96
	HM-103							
T_0	16.54	9.77	15.34	9.57	15.15	9.24	14.93	9.08
T_1	18.13	10.39	15.85	9.63	15.56	9.4	15.22	9.19
T_2	17.28	10.57	15.94	9.98	15.67	9.73	15.39	9.45
T_3	18.25	10.83	16.6	9.76	16.12	9.38	16.25	9.18
T_4	18.93	11.51	17.48	10.76	17.51	10.32	17.27	9.98
T_5	17.65	11.01	17.44	10.18	17.17	9.81	17.05	9.76

C.D. (P = 0.05); V = 0.073; L = 0.073T = 0.127; V X L X T = 0.253

Table 4. Effect of priming on seedling dry weight (mg) during storage period

Treatment	HM -57							
	0 month		3 months		6 months		9 months	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
T_0	7.35	6.37	7.17	6.35	7.10	6.27	7.01	6.15
T_1	7.41	6.54	7.54	6.40	7.27	6.38	7.12	6.27
T_2	7.53	6.59	7.60	6.41	7.32	6.31	7.15	6.23
T_3	7.59	6.44	7.36	6.43	7.24	6.31	7.11	6.17
T_4	8.04	6.81	7.87	6.46	7.57	6.41	7.35	6.31
T_5	7.70	6.54	7.75	6.34	7.49	6.18	7.25	6.12
	HM-103							
T_0	7.23	6.37	7.18	6.25	7.18	6.19	7.06	6.00
T_1	7.33	6.62	7.31	6.48	7.31	6.28	7.17	6.12
T_2	7.47	6.54	7.36	6.36	7.36	6.28	7.18	6.11
T_3	7.53	6.72	7.29	6.39	7.29	6.31	7.11	6.22
T_4	7.94	6.98	7.64	6.50	7.64	6.44	7.29	6.27
T_5	7.54	6.69	7.43	6.46	7.43	6.33	7.12	6.17

C.D. (P = 0.05); V = 0.038; L = 0.038T = 0.065; V X L X T = 0.130

3.6 Vigour Index-II

Similarly maximum seed vigour index–II (539.6) was in HM-57 with T_4 in lot L_1 while minimum seed vigour index–II (326.5) was in HM-103 with T_3 in lot L_2 (Table 6). Basu [20] studied that vigour index- I, and Vigour index- II decreased as duration of storage period increased in maize.

3.7 Electrical Conductivity (µS/cm/seed)

After 9 month, the minimum electrical conductivity (285.6) was in HM-57 with T_4 in lot L_1 while maximum electrical conductivity (425.1) in HM-57 with T_1 in lot L_2 (Table 7). Similar increase in electrical conductivity of seed leachates was observed during natural ageing on turnip by Khan [15]; on fenugreek by Singh [21]; on onion by Kumar [6]; On coriander by Kumar [8]; on wheat by Singh [16]; On soybean by Mohammadi [12]. The good quality seed (fresh seed lot) will release less leachates as compare to old seed lots. Kaewnaree [7] on sweet pepper demonstrated that cell membrane damage decrease ability of carrier proteins and cause to increase electrolyte leakage in sweet pepper after accelerated ageing.

Table 5. Effect of priming on vigour index-I during storage period

Treatment	HM -57							
	0 month		3 months		6 months		9 months	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
T_0	2104.1	1070.3	1975.1	961.9	1849.4	920.2	1704.5	851.7
T_1	2340.6	1234.0	2158.7	1149.4	2066.2	1067.9	1984.1	988.1
T_2	2270.3	1165.3	2062.9	1070.7	1949.5	1017.3	1877.1	961.4
T_3	2276.1	1193.4	2083.3	1069.2	1970.8	1001.0	1874.9	951.5
T_4	2493.6	1383.6	2379.2	1271.4	2253.0	1192.1	2073.7	1110.0
T_5	2255.4	1117.6	2158.4	1064.6	2055.9	1011.5	1945.9	927.5
HM-103								
T_0	2101.0	1095.5	1839.8	1034.5	1747.6	986.5	1615.5	931.0
T_1	2324.3	1262.2	2000.3	1145.4	1904.9	1069.7	1811.9	1012.8
T_2	2127.8	1247.8	1938.9	1142.3	1838.9	1074.5	1750.3	1003.8
T_3	2145.0	1131.8	1964.5	985.4	1861.8	865.1	1805.1	799.2
T_4	2467.9	1395.8	2209.0	1197.3	2115.6	1104.5	2015.4	1006.4
T_5	2154.1	1176.8	2062.8	1084.9	2022.4	1017.7	1924.7	972.5

C.D. (P = 0.05); V = 23.852; L = 23.852T = 40.893; V X L X T = N.S.

Table 6. Effect of priming on vigour index-II during storage period

Treatment	HM -57							
	0 month		3 months		6 months		9 months	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
T_0	610.28	415.8	573.6	395.6	546.4	386.8	514.7	383.1
T_1	629.5	471.2	600.7	448.2	560.1	427.2	537.1	400.6
T_2	612.4	448.2	590.4	419.0	556.4	399.3	536.6	380.8
T_3	637.7	446.4	586.1	422.1	555.3	405.0	535.3	395.6
T_4	691.1	499.2	655.9	452.0	605.7	405.7	539.6	384.5
T_5	616.1	416.9	599.4	387.0	564.0	434.8	519.4	387.1
HM-103								
T_0	597.4	414.4	552.8	394.0	533.7	381.3	502.3	363.9
T_1	618.1	465.4	582.4	438.7	551.6	404.3	542.4	361.8
T_2	600.2	455.1	569.4	424.0	547.2	387.5	507.6	358.2
T_3	582.5	414.3	554.3	368.6	544.1	353.4	528.8	326.5
T_4	682.6	502.7	626.7	424.8	580.2	386.9	538.9	384.8
T_5	603.2	423.6	574.7	398.5	511.8	421.7	495.5	382.2

C.D. (P = 0.05); V = 8.155; L = 8.155T = 14.125; V X L X T = N.S.

Table 7. Effect of priming on electrical conductivity (µS/cm/seed) during storage period

Treatment	HM -57							
	0 month		3 months		6 months		9 months	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
T_0	274.9	390.1	279.4	404.6	295.1	411.9	312.4	425.0
T_1	254.7	369.4	270.9	401.0	284.6	415.9	294.5	425.1
T_2	265.4	370.3	281.6	381.8	288.4	393.8	293.5	412.9
T_3	267.2	374.4	272.8	386.0	284.7	405.1	292.7	420.0
T_4	241.3	345.2	264.3	386.2	270.7	397.8	285.6	408.8
T_5	253.4	376.1	277.6	386.8	290.2	410.0	297.2	417.9
	HM-103							
T_0	289.0	379.5	299.5	387.7	316.6	409.6	327.6	423.9
T_1	266.6	355.5	297.3	388.7	306.8	412.9	331.5	424.4
T_2	278.3	372.4	298.9	390.6	314.7	395.2	331.6	421.0
T_3	279.8	377.5	302.2	392.8	312.1	410.2	320.0	422.5
T_4	252.3	346.4	276.9	374.5	303.5	391.3	310.3	406.7
T_5	271.8	370.6	278.9	388.6	231.1	405.3	323.7	423.6

C.D. (P = 0.05); V = 3.925; L = 3.925T = 6.799; V X L X T = 13.597

4. CONCLUSION

From present study, it is evident that Lot L_1 (marginal lot) showed better improvement in standard germination as compared to lot L_2 (good quality) because seeds of good quality were already close to optimum performance, naturally the possibility of improving seed quality is limited as compared to seeds of lower quality The quality of seed (in terms of germinability and field performance) can be improved by applying pre-sowing seed soaking treatment in both the seed lots and more so in the marginal quality seeds indicating that these treatments are more effective in low quality seeds. It is concluded from this study that the germination level of marginal/sub standard seed lots in fenugreek can be improved by using pre-sowing seed treatments. This practice may prove beneficial in this crop since a slight (4-5%) improvement in germination can save lakh of rupees.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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