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Incidence of seed borne mycoflora of brinjal when stored at different temperatures

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Abstract
Brinjal seeds with 12% moisture content were stored at room temperature for nine months at 5, 15, 25 and 35^{0}C. The observations were recorded after three months interval on incidence of seed borne mycoflora and seed quality parameters. The maximum percent incidence of *Alternaria alternata*, *Aspergillus flavus*, *Curvularia lunata*, *Aspergillus niger*, and *Rhizopus stolonifer* (5.60, 41.60, 16.00, 12.80 and 36.80 respectively) were recorded after nine month of storage. The highest prevalence of fungi in brinjal was recorded in seeds stored at 35^{0}C and least in 5^{0}C. Decreased of percent seed borne fungi were observed with increased of storage period at cold temperature storage condition. The maximum germinabilty and vigour index were 94.40% and 1107.50 respectively after one month of storage and the minimum were 43.20 and 262.69 after nine months of storage at 35^{0}C. Germination and vigour index of seeds were decreased with increased of storage time and fungal infection.

Keywords: Brinjal, seed mycoflora, temperature, germination, vigour index, root length and shoot length

Introduction
Seed health is crucial to crop production. Seed is an important exchange material for farming, seed production, and research at national, regional, and international levels. Seed borne pathogens are a continuing problem and may even be responsible for the re-emergence of diseases of the past as well as the introduction of diseases into new areas (Gitaitis and Walcott, 2007) [6]. Moisture and temperature are the two factors which affect on germination of seed, besides affecting mold growth and mycotoxin production (Bullerman *et al*., 1984) [1]. Tariq *et al*. (2005) [12] reported that moisture and temperature increase the infection of *A. flavus* and decrease germination of soy bean seed. The storage life of seeds is controlled by two factors which are seed moisture and temperature. For each rise of 01 percent on seed moisture content and for each rise of 5 ^{0}C in storage temperature, the storage life of seeds is halved (Harrington, 1973). High temperature promotes both fungal growth and insect development. Germination of seeds declines rapidly during storage if temperature is not monitored properly (Terkony *et.al*. 1993). The basic objective of the storage is to keep the storage temperature below the usual ambient temperatures, thereby minimizing the biochemical reactions, which leads to the maintaince of physiological quality and prevents insects and fungi development.
Focussing on these aspects the study was carried out to determine optimum storage conditions to maintain viability during storage to protect the shelf life of brinjal seeds.

Materials and methods
Locally grown seeds were collected from farmers and kept in transparent polythene bag. Moisture content of seeds was determined by oven dry method. The seeds were stored at four different levels of temperature such as 5 ^{0}C, 15 ^{0}C, 25 ^{0}C and 35 ^{0}C upto 9 months. Seeds with an original moisture content of about 8-12% and was adjusted at 12% moisture levels by adding the required amount of sterilized distilled water to seed and kept in glass jar. Seed samples were removed at 30 days and after 90, 180 and 270 days of incubation to study the germination, root length, shoot length, Mean germination time, Vigour index and seed borne mycoflora using Standard blotter method as recommended by ISTA (ISTA,1993). Fungi growing on seeds were identified after reference to (Ellis, 1971, Nelsen *et.al*. 1983, Domsch *et al*. 1980, Raper and Fanell, 1965) [4, 9, 3, 10]. The data was subjected to analysis following the procedure as given by (Gomez and Gomez, 1984) [7].

Testing of seeds
To assess seed vigour four hundred seeds each were retrieved from each of four temperature storage regimes of 5, 15, 25 and 35 ^{0}C in interval of three months, starting from 0 days to 270 days and tested for vigour. Seeds were sown on moistened three layers of filter paper in 9cm

petridish and then incubated in germination chamber set at alternating temperatures 20/30 ^{0}C. Light was applied for 8h/d during the warm temperature phase (ISTA, 1999) [8]. A seed was considered as normally germinated when the radicle protruded by 2–3cm. Germinated seeds were scored daily for up to 7days.Seed germination percentage, Mean germination percentage, Shoot length and Root length were computed.

Results and discussions

The results of the experiment indicated that in brinjal seeds five fungal species *i.e. Alternaria solani, Aspergillus flavus, Aspergillus niger, Curvularia lunata* and *Rhizopus stolonifer* were observed when stored at 5 ^{0}C, 15 ^{0}C, 25 ^{0}C and 35 ^{0}C.

Prevalence of fungi at 5 ^{0}C

Significantly, highest percent incidence of *Alternaria alternata, Aspergillus flavus, Curvularia lunata, Aspergillus niger* and *Rhizopus stolonifer* were 0.80, 1.60, 0.80, 1.60 and 2.40 respectively after one month of storage. These pathogens were statistically at par. At the end of storage period *Curvularia lunata* (0.80%) was found associated with the brinjal seeds. The lowest percent infection of these fungi was recorded after nine months of storage period. These pathogens were statistically at par upto nine months of storage period.

Prevalence of fungi at 15 ^{0}C

The highest percent incidence of *Alternaria alternata, Aspergillus flavus, Curvularia lunata, Aspergillus niger* and *Rhizopus stolonifer* were 2.40, 20.00, 7.20, 8.80, 17.60 respectively after nine month of storage at 15^0 C. The lowest statistically significant pathogen *A.alternata* was recorded when storage period is nine month at 15^0 C. The lowest percent infection of these fungi was found 0.80, 1.60, 0.00 and 2.40 respectively one month after storage period. Prevalence of these fungi was statistically at par. Three months after storage period it is indicated that significant lowest pathogen *A.niger* was isolated.

Prevalence of fungi at 25 ^{0}C

Likewise, the highest percent incidence of *Alternaria alternata, Aspergillus flavus, Curvularia lunata, Aspergillus niger* and *Rhizopus stolonifer* were 4.00, 35.20, 13.60, 13.60, 13.60 and 31.20 respectively after nine month of storage whereas the lowest percent infection of these fungi were found 0.80, 5.60, 0.80, 1.60 and 3.20 after one months of storage period. Prevalence of *Alternaria alternata, Aspergillus niger, Curvularia lunata* and *Rhizopus stolonifer* were at par.

Prevalence of fungi at 35 ^{0}C

Similarly, the maximum percent incidence of *Alternaria alternata, Aspergillus flavus, Curvularia lunata, Aspergillus niger,* and *Rhizopus stolonifer* were 5.60, 41.60, 16.00, 12.80 and 36.80 respectively after nine month of storage. The lowest percent infection of these fungi was found 2.40, 8.80, 1.60, 4.80 and 9.60 respectively after one months of storage period. Statistically *Alternaria alternata, Aspergillus flavus, Aspergillus niger*and *Curvularia lunata* were at par.

The highest prevalence of fungi in brinjal was recorded in seeds stored at 35 ^{0}C and followed by 25 ^{0}C and 15 ^{0}C and least in 5^{0}C. The percent infection of *A. alternata* ranges from 0.60 to 3%, *A.flavus* 0.8 to 26.20%, *C.lunata* from 0.8 to 6.80%, *A. niger* from 1 to 8% and *R. stolonifer* from 1.20 to 24.60%.

Germinability and Vigour index

The reduction in germination percentage and vigour index was observed with the increased in seed infection, storage temperature and storage time upto nine months. The germination percentage and vigour index decreases with the increased of storage periods upto nine months. The maximum germinabilty and vigour index were 94.40% and 1107.50 respectively after one month of storage and the minimum were 69.60% and 611.39 after nine months of storage at 5 ^{0}C. Likewise, at 15 ^{0}C, seed germinability and vigour index were highest (89.60% and 950.70 respectively) after one month of storage and the least was recorded (59.20% and 448.45) after nine months of storage. Seed germinability and vigour index was found highest (81.60% and 810.59) after one month of storage and the least (50.40% and 354.98) at 25 ^{0}C. Similarly, at 35^{0}C, seed germination and vigour index was the highest (77.60% and 710.44) after one of storage and lowest (43.20% and 262.69) after nine months of storage. The root and shoot length were statistically significant.

Root and Shoot length

The data clearly indicated that in root and shoot length of brinjal seeds the longest was 4.36cm and 6.42cm respectively after one month of storage and the shortest was 3.12cm and 4.71cm respectively after nine months of storage at 5^0 C. Again, at 15^0 C, the maximum was 4.20cm and 6.02cm respectively after one month of storage and the shortest was 2.99cm and 4.17cm after nine months of storage. The maximum root and shoot length was 4.07cm and 5.91cm respectively after one month of storage and the shortest was 2.58cm and 3.95cm after nine months of storage at 25^0 C. Likewise, at 35^0 C the maximum root and shoot length was 3.72cm and 5.08cm respectively after one month of storage and the shortest was 2.02cm and 3.09cm after nine months of storage at 35 ^{0}C.

The findings are in close proximity with Singh and Singh (1981) [11] who studies the effects of methods and duration of storage on seed germination and seedling vigour in papaya *(Carica papaya* L.). They found that cold stored papaya seeds maintained significantly higher germination and better seedling vigour than the room stored seeds. With the increase in the duration of storage, seeds germination decreased after 20 months at room temperature whereas it declined marginally during the same period when kept in the cold storage.

Similar result was recorded in sunflower seeds stored at low temperature which registered maximum germination than the seeds stored in ambient condition by Corbinean *et al*. (2002) [2]. The present result is accordance with Fabiana *et al*. (2008) [5] the higher the moisture content and temperature the higher the fungi incidence while lower seed moisture decrease the incidences by 25%. Storage conditions below 30 ^{0}C and 13% moisture appear suitable to preserve common bean seed in relation to viability and health, up to 8 month period.

Table 1: Percent incidence of Brinjal seeds with seed associated pathogens when stored under different temperatures

Pathogen Associated (C)	Stored Temperature (T)																			
	5⁰C					15⁰C					25⁰C					35⁰C				
	Storage Period (in months) (P)					Storage Period (in months) (P)					Storage Period (in months) (P)					Storage Period (in months) (P)				
	1	3	6	9	Mean	1	3	6	9	Mean	1	3	6	9	Mean	1	3	6	9	Mean
Alternaria alternata	0.80	0.80	0.80	0.00	0.60	0.80	1.60	1.60	2.40	1.60	0.80	1.60	2.40	4.00	2.20	2.40	1.60	2.40	5.60	3.00
	(5.69)	(5.69)	(5.69)	(4.05)	(5.28)	(5.69)	(7.33)	(7.33)	(8.97)	(7.33)	(5.69)	(7.33)	(8.97)	(12.24)	(8.56)	(8.97)	(7.33)	(8.97)	(14.12)	(9.85)
Aspegillus flavus	1.60	1.60	0.00	0.00	0.80	1.60	4.80	16.80	20.00	10.80	5.60	12.80	29.60	35.20	20.80	8.80	20.80	33.60	41.60	26.20
	(7.33)	(7.33)	(4.05)	(4.05)	(5.69)	(7.33)	(11.79)	(24.55)	(26.91)	(17.64)	(14.12)	(21.35)	(33.25)	(36.67)	(26.35)	(17.69)	(27.46)	(35.71)	(40.44)	(30.32)
Curvularia lunata	0.80	1.60	0.80	0.00	0.80	0.00	0.00	3.20	7.20	2.60	0.80	1.60	5.60	13.60	5.40	1.60	4.80	4.80	16.00	6.80
	(5.69)	(7.33)	(5.69)	(4.05)	(5.69)	(4.05)	(4.05)	(10.61)	(16.00)	(8.68)	(5.69)	(6.63)	(14.12)	(22.00)	(12.11)	(7.33)	(12.49)	(11.79)	(23.96)	(13.89)
Aspergillus niger	1.60	1.60	0.00	0.80	1.00	0.00	0.00	4.80	8.80	3.40	1.60	4.80	6.40	13.60	6.60	4.80	7.20	7.20	12.80	8.00
	(7.33)	(7.33)	(4.05)	(5.69)	(6.10)	(4.05)	(4.05)	(13.18)	(17.32)	(9.65)	(7.33)	(13.18)	(15.06)	(22.00)	(14.39)	(12.49)	(16.00)	(16.00)	(21.35)	(16.46)
Rhizopus stolonifer	2.40	2.40	0.00	0.00	1.20	2.40	4.80	10.40	17.60	8.80	3.20	10.40	27.20	31.20	18.00	9.60	17.60	34.40	36.80	24.60
	(8.97)	(8.97)	(4.05)	(4.05)	(6.51)	(8.97)	(12.49)	(19.20)	(25.14)	(16.45)	(10.61)	(19.20)	(31.73)	(34.25)	(23.94)	(18.45)	(25.14)	(36.19)	(37.62)	(29.35)

Factors	T	P	C	T X P	T X C	P X C	T X P X C
C.D. (P=0.05)	0.91	0.91	1.02	1.83	2.04	2.04	4.09
S.Em. (±)	0.33	0.33	0.37	0.66	0.73	0.73	1.47
S.Ed. (±)	0.46	0.46	0.52	0.93	1.04	1.04	2.08

Note: Arcsine transform values in parentheses

Table 2: Effect on percent germination and vigour index of Brinjal seeds when stored at different temperatures. (^{0}C)

Stored Temp. (T)	Percent Germination					Vigour Index				
	Storage period (in months) (A)					Storage period (in months) (A)				
	1	3	6	9	Mean(A)	1	3	6	9	Mean(A)
5	94.40	86.40	79.20	69.60	82.40	1107.50	990.99	835.01	611.39	886.22
	(76.48)	(68.38)	(62.86)	(56.53)	(66.06)	(33.29)	(31.49)	(28.89)	(24.74)	(29.61)
15	89.60	77.60	68.00	59.20	73.60	950.70	794.10	664.70	448.45	714.49
	(71.24)	(61.75)	(55.53)	(50.28)	(59.70)	(30.85)	(28.19)	(25.78)	(21.19)	(26.50)
25	81.60	72.80	61.60	50.40	66.60	810.59	671.78	562.70	354.98	600.01
	(64.60)	(58.55)	(51.69)	(45.21)	(55.01)	(28.49)	(25.94)	(23.70)	(18.86)	(24.25)
35	77.60	64.80	53.60	43.20	59.80	710.44	579.33	438.05	262.69	497.63
	(61.75)	(53.59)	(47.05)	(41.07)	(50.87)	(26.67)	(24.09)	(20.86)	(16.24)	(21.96)
Mean(T)	85.80	75.40	65.60	55.60		894.81	759.05	625.12	419.38	
	(68.52)	(60.57)	(54.28)	(48.27)		(29.82)	(27.43)	(24.81)	(20.26)	

Factors	A	T	A X T	A	T	A X T
C.D. (P=0.05)	0.94	0.94	NS	0.55	0.55	NS
S.Em. (±)	0.33	0.33	0.66	0.20	0.20	0.39

Note: Figures in parentheses arcsine transform values (Germinaton percentage)
Figures in parantheses squareroot values (Vigour index)

Table 3: Effect on root length, shoot length and mean germination time of Brinjal seeds when stored at different temperatures (0C)

Stored Temperature (T)	Root length (cm)					Shoot length (cm)					Mean Germination Time				
	Storage period (in months) (A)					Storage period (in months) (A)					Storage period (in months) (A)				
	1	**3**	**6**	**9**	**Mean**	**1**	**3**	**6**	**9**	**Mean**	**1**	**3**	**6**	**9**	**Mean**
5	4.36	4.03	3.83	3.12	3.84	6.42	6.02	5.80	4.71	5.74	4.23	4.32	4.41	4.51	4.37
15	4.20	3.91	3.51	2.99	3.66	6.02	5.98	5.45	4.17	5.41	4.35	4.50	4.53	4.64	4.51
25	4.07	3.62	3.13	2.58	3.35	5.91	5.21	5.00	3.95	5.02	4.40	4.58	4.60	4.72	4.58
35	3.72	3.47	3.01	2.02	3.05	5.08	5.00	4.18	3.09	4.34	4.64	4.73	4.75	4.79	4.73
Mean	4.09	3.76	3.37	2.68		5.86	5.55	5.11	3.98		4.41	4.53	4.58	4.67	
Factors	A		T		A X T	A		T		A X T	A		T		A X T
C.D. (P=0.05)	0.09		0.09		0.18	0.05		0.05		0.11	0.03		0.03		0.07
S.Em. (±)	0.03		0.03		0.06	0.02		0.02		0.04	0.01		0.01		0.02

Conclusion

The result of the experiment revealed that storage conditions have great impact on the quality of the seeds in storage. Seeds stored at 5^0C maintained better quality than ambient condition. This is due to temperature is lower in controlled condition resulting slow rate of deterioration of seeds under controlled condition it was higher under ambient condition. Seeds of brinjal stored in 5^0C were found to have the highest germination, vigour index, root and shoot length in the nine months storing with lesser infection from different fungi.

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