International Journal of Plant & Soil Science

33(19): 63-70, 2021; Article no.IJPSS.72674
ISSN: 2320-7035

Seed Health of Chickpea as Influenced by Different Packaging during Storage

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Authors' contributions

This work was carried out in collaboration between both authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2021/v33i1930601
Editor(s):
(1) Prof. Marco Trevisan, Catholic University of the Sacred Heart, Italy.
Reviewers:
(1) T. Amose, Madurai Kamaraj University, India.
(2) Sittal Thapa, Punjab Agricultural University, India.
(3) Salar Monajjem, University of Guilan, Iran.
Complete Peer review History: https://www.sdiarticle4.com/review-history/72674

Original Research Article

Received 06 August 2021
Accepted 10 September 2021
Published 11 September 2021

ABSTRACT

A storage experiment was conducted to know the influence of cloth, gunny, high density polythene (HDPE), and vacuum packed bags on the seed health of chickpea for 18 months. To investigate, chickpea seeds were packed in all the bags and were kept in ambient conditions. During the storage period, there was a lot of fluctuation in moisture content of the seeds based on the relative humidity in cloth, gunny, and HDPE bags due to the pervious nature of packaging materials whereas, there was no moisture fluctuation in vacuum packed bags due to lower water vapor and oxygen transmission rate and higher thickness of polythene bag used for vacuum package. After 8 months of storage period, there was bruchids infestation to the seeds stored in cloth, gunny, and HDPE bags whereas, no bruchids infestation were seen to vacuum packed bag even after 18 months of storage but germination, root length, shoot length, seedling vigour index, seedling dry weight has reduced and mean germination time, electrical conductivity of seed leachates has increased due to seed aging. Hence, vacuum packaging technology can be effectively used for storage of chickpea seeds for longer period without any aid of chemicals.

Keywords: Bruchids; chickpea; seed health; vacuum packaging.

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1. INTRODUCTION

Chickpea (*Cicer arietinum* L.), is one of the leguminous crops cultivated and consumed worldwide and it was originated in southern Turkey [1]. It is the most popular food legume, as it is a good source of protein, minerals, vitamins, fiber, and energy [2]. Moreover, it is cultivated in around 57 nations under a wide range of climatic conditions [3]. So, due to its higher diversity, at the global level, it is second in the area (15.3 %) and third in production (15.4 %). India is the largest producer of chickpea in the world, as it covers 65% of the total production (9.07 million tonnes) [4]. As it is a seasonal crop, seeds must be stored for regular availability without altering the quality. Therefore, suitable storage practice plays an important role in reducing losses and preserving the seeds for further processing [5]. Reducing postharvest losses, particularly in developing countries, might be a long-term strategy for boosting food supply, reducing hunger, and improving farmer livelihoods [6].

During the storage period, chickpea seeds are susceptible to insect attack, particularly by *Callosobruchus sps.* In many parts of the globe, storage pest control measures generally rely on the use of synthetic insecticides and fumigants [7] [8]. Although effective, they have an adverse effect on other insect species and non-target organisms and may be harmful to the environment and human health. The ban of methyl bromide since 2015 in developing countries and 2005 in developed countries [9] and insect resistance to phosphine [10] have addressed the need of developing effective alternatives to various chemicals for insect pest management in legumes with minimal impact on quality of produce. In addition to these synthetic chemicals, botanical insecticides are used but they are generally more expensive than synthetic insecticides; the challenges to the utilization of botanical pesticides have been well-reviewed by Rajashekar *et al.* [11].

In this view, to enhance the availability of grain legumes for human consumption and for agriculture purposes, it is necessary to reduce pest-associated storage losses by storing them in proper conditions in a chemical-free environment. With this above background, an experiment has been conducted by storing the chickpea seeds in a chemical-free environment with the use of different packaging materials under ambient conditions.

2. MATERIALS AND METHODS

A seed storage experiment was conducted under ambient storage conditions at University of Agricultural Sciences, Dharwad, Karnataka, India for 18 months i.e. from 15 November 2019 to 15 May 2021. Average data related to temperature (ºc) and relative humidity (%) that prevailed in store house during the first 15 days of every alternate month were recorded with anemometer and presented in Table 1. For storage, healthy seeds of chickpea (Var. BGD-103) were used.

Table 1. Average temperature and relative humidity of store house

Months	Temperature (ºC)	Relative humidity (%)
January-2020	21.3	68.6
March-2020	24.3	54.6
May-2020	28.5	67.2
July-2020	22.8	86.9
September-2020	22.7	85.4
November -2020	22.1	63.1
January-2021	20.9	74.1
March-2021	24.8	51.7
May-2021	26.6	67.8

2.1 Experimental Set Up

The seeds (3 kgs) were packed in the cloth, gunny, and high density polythene (HDPE) bag (Fig.1) and replicated 5 times. However, in the case of vacuum packaging, 1 kg of seeds were packed and such 9 bags were packed and replicated 5 times and finally, all bags were kept under the ambient condition (Table 1.) in the laboratory for 18 months to assess the seed health as influenced by different packaging and most importantly in storage stacking of bags were not done, so that all the bags are equally exposed to prevailing environmental conditions. The characteristics of polythene bag used for vacuum packaging are presented in Table 2. The machine used for vacuum packaging different seeds was an OLPACK 501/V manufactured by INTERPRISE–BRUSSELS S.A., BRUXTAINER DIVISION, Belgium.

2.2 Observation Recorded

Before storage, seed health parameters such as germination (%), root length (cm), shoot length (cm), seedling vigour index, mean germination time, seedling dry weight, electrical conductivity of seed leachates (µS cm^{-1}), and moisture content (%), were recorded and packed. Again, on the 15th of every alternate month, representative samples were drawn from all treatments and all the above-mentioned seed health parameters were recorded up to 18 months.

a) Germination %, root length (cm), shoot length (cm) and seedling vigour index: The germination test was conducted by following between paper method. The numbers of normal seedlings in each replication were counted on the final day count, i.e., on the 8^{th} day. The germination was calculated based on the number of normal seedlings and expressed in percentage [12]. From the above germination test, 10 normal seedlings were randomly selected from each treatment on the final day to measure root and shoot length and are expressed in centimeters. Further, Seedling vigour index was calculated by multiplying total seedling length and per cent germination [13].

b) Seedling dry weight: The ten normal seedlings used for measuring root and shoot length were taken in butter paper and dried in a hot-air oven maintained at 70^{o}C temperature for 24 h. Then, the seedlings were removed and allowed to cool before weighing. The average weight was calculated and expressed in milligram.

c) Electrical conductivity of seed leachates (µS cm^{-1}): Digital conductivity meter (ELICO) was used to measure the electrical conductivity and mean values are expressed in µS cm^{-1}.

Fig. 1. Different packaging used for chickpea storage

Note: Observations in cloth, gunny and HDPE bag treatments have been stopped due to bruchids infestation after 8 months of storage

Table 2. Specifications of the multi layer polythene bag used for vacuum packaging

S. No.	Characters	Unit	Results	Tested as per (Guidelines of)
1	Thickness (Microns)	Microns	149.40	IS: 2508
2	Water vapor transmission rate	g/m^2/24 hrs at 38ºC and 90.0 % Relative humidity	0.95	ASTM F 1249
3	Oxygen transmission rate	cc/(m^2 × day × atm)	0.91	ASTM D 1434-15

d) Mean germination time: Mean germination time was calculated based on the following formula [14]. A lower mean germination time indicates faster germination for a particular crop.

$$\text{Mean germination time} = \frac{(\text{n1} \times \text{d1}) + (\text{n2} \times \text{d2}) + \cdots \ldots.}{\text{Total number of seeds germinated}}$$

Where,
n: number of seeds germinated on each day
d: number of days

e) Moisture content (%): It was calculated on a dry weight basis as per the procedure described by the International Seed Testing Association, 2013.

2.3 Data Analysis

Completely Randomized Design (CRD) was used to test the significance of various variables and results are presented in graphical format.

3. RESULTS AND DISCUSSION

Chickpea seeds with 94.0 per cent germination, root length (18.7 cm), shoot length (23.3 cm), seedling vigour index (3935.2), mean germination time (1.43), seedling dry weight (2625.0 mg) electrical conductivity of seed leachates (590.1 µS cm^{-1}), and moisture content (8.60 %) were stored in cloth, gunny, HDPE and vacuum packed bag. After 2 months, there was no significant difference in all the parameters tested except moisture content (Figs. 2.1 and 2.2). There was an increase in moisture content of seeds in cloth, gunny, and HDPE bags and this is due to the pervious nature of packaging materials in which seeds are stored. Moreover, seeds being hygroscopic in nature absorb and desorbs moisture based on surrounding environmental conditions. Similar results of an increase in moisture content in pervious packaging material have been reported by Shankar *et al.* [15] in blackgram; [16] in gardenpa; [17] in cucumber.

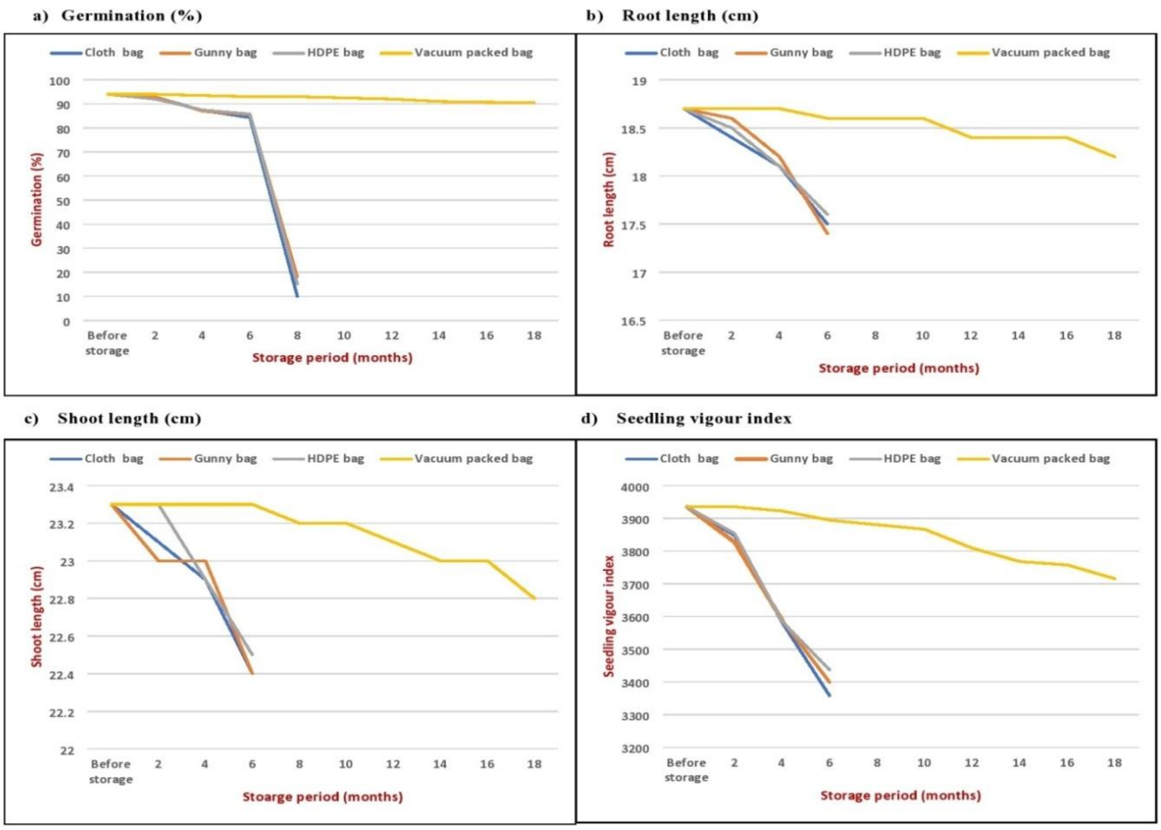

Fig. 2.1. Germination (%), root length (cm), shoot length (cm) and seedling vigour index of chickpea seeds as influenced by different packaging at different time intervals of storage
Note: Observations in cloth, gunny and HDPE bag treatments have been stopped due to bruchids infestation after 8 months of storage

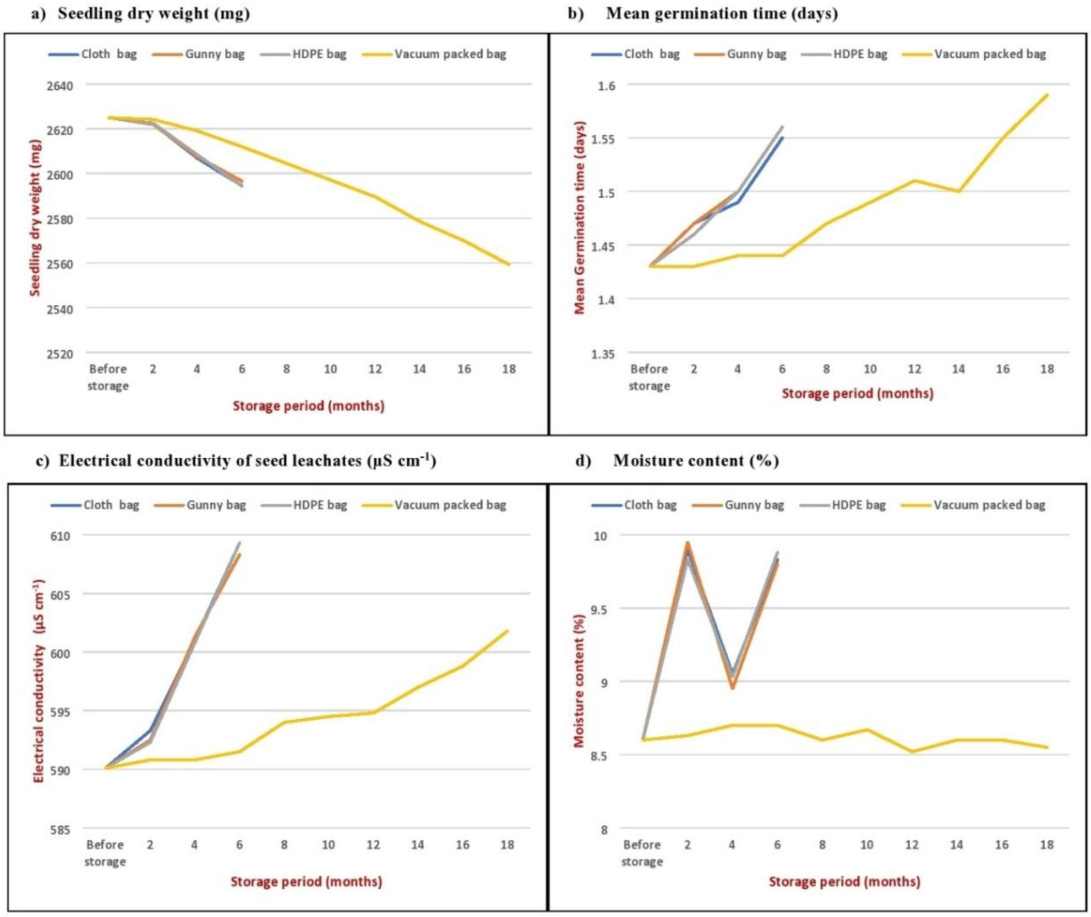

Fig. 2.2. Seedling vigour index, mean germination time, seedling dry weight (mg), electrical conductivity of seed leachates (µS cm^{-1}) and moisture content of chickpea seeds as influenced by different packaging at different time intervals of storage

Note: Observations in cloth, gunny and HDPE bag treatments have been stopped due to bruchids infestation after 8 months of storage

There was no variation in moisture content of the seeds in vacuum packed bag and this is due to lower oxygen and water vapor transmissions rate and also due to higher thickness of packaging material (Table 2) in which seeds are stored and this character has led to a minimal gas exchange between seeds and surrounding environment and there by maintained constant moisture irrespective of change in surrounding environmental conditions. Similar results of no variation of moisture content when seeds are vacuum packed has been reported by Chetti et al. [18] in chilli; Khanna et al. [19] in chickpea; Meena et al. [20] in soybean.

As the storage period progressed, there was a decline in germination, root length, shoot length, seedling vigour index, seedling dry weight meanwhile, there was an increase in mean germination time, and electrical conductivity of seed leachates in cloth, gunny, and HDPE bag but not in vacuum packed bags due to differential rate of seed deterioration (Fig.2.1 and 2.2). After 8 months of storage, there was bruchids infestation to the seeds stored in cloth, gunny, and HDPE bags to the extent of more than 80 per cent (Fig. 3). Due to bruchids infestation, there was a decrease in germination (Fig. 4) and other seed health parameters of seeds as they completely deteriorated and this compete deterioration is due to the internal feeding behaviour of bruchid larvae, which causes heavy losses and seeds become unsuitable for consumption and for sowing purpose also [21]. Similar results of decrease in seed health parameters due to bruchids infestation in pervious packaging materials have been reported by Charjan *et al*. [22] in arhar; [23] in greengram; [24] in black gram, greengram, and redgram.

Fig. 3. View of different packaging used for chickpea storage (8 months after storage)

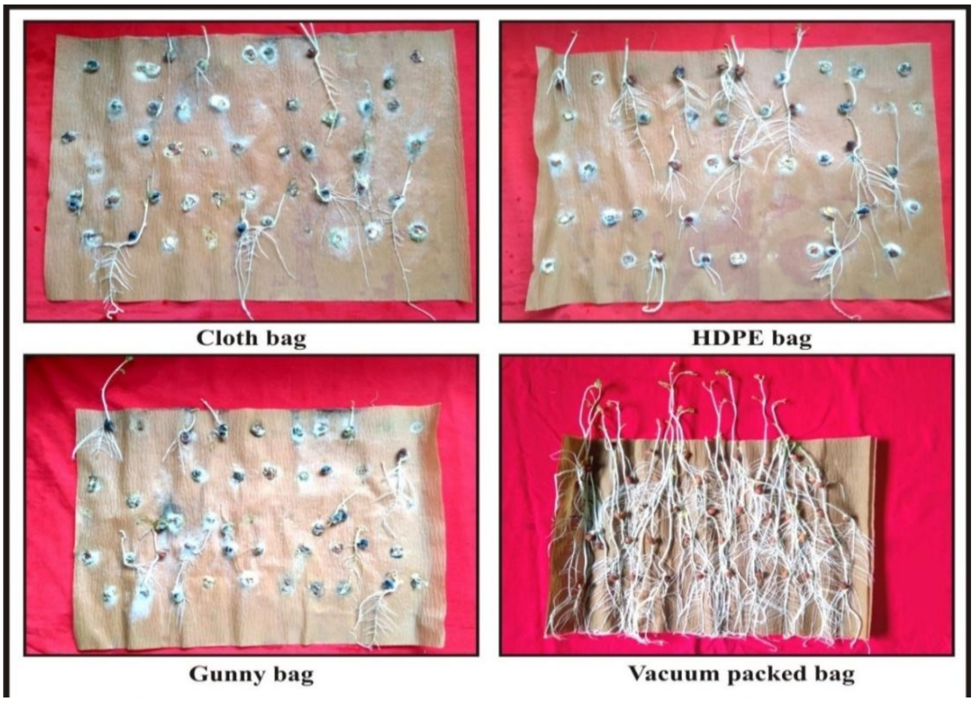

Fig. 4. Germination of chickpea seeds after 8 months of storage

Due to bruchids infestation in conventional packaging materials *viz.,* cloth, gunny and HDPE bags, germination was reduced to below 20.0 per cent and it was much lower than the standards described by the central Seed Certification Board, Department of Agriculture & Co-operation, Ministry of Agriculture, Government of India the minimum seed germination for chickpea is 85 %. Hence, further observations in these treatments have been stopped. Further, the bruchids infestation were not seen in vacuum packed bag even after 18 month of storage period and this is due to the type of packaging was done. But, as the storage period progressed, there was a little variation in seed health parameters due to the aging of seeds (Fig. 2.1

and 2.2). Our results are in accordance with the findings of [25] in onion; [20] in soybean; [19] in chickpea; [26] in onion, as they reported that, due to vacuum packaging, seeds can be stored for a longer period without much deterioration.

4. CONCLUSION

From our investigation, it can be concluded that, vacuum packaging technology can be effectively used for the long-term storage of chickpea seeds without any aid of chemicals. Hence, along with maintaining seed health for longer time, a threat to environment is completely avoided.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/72674