The Pharma Innovation Journal 2021; 10(1): 336-347

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2021; 10(1): 336-347

www.thepharmajournal.com
Received: 25-10-2020
Accepted: 07-12-2020

Bhanu Vijay Shanker
Research Scholar, Deprtment of Agriculture. Engineering, Faculty of Engineering and Technology MGCGV, Chitrakoot, Dist. Satna, Madhya Pradesh, India

Mishra K.P.
Prof. Department of Agriculture Engineering, Faculty of Engineering and Technology, MGCGV, Chitrakoot, Satna, Madhya Pradesh, India

Pandey Anjaney
Dean, Faculty of Engineering and Technology, MGCGV, Chitrakoot, Satna, Madhya Pradesh, India

Ashwani Duggal
Prof., Head Agriculture Engineering, Faculty of Engineering and Technology, MGCGV, Chitrakoot, Satna, Madhya Pradesh, India

Corresponding Author:
Bhanu Vijay Shanker
Research Scholar, Deprtment of Agriculture. Engineering, Faculty of Engineering and Technology MGCGV, Chitrakoot, Dist. Satna, Madhya Pradesh, India

Impact of environment, Storage time and packaging materials on seeds viability of paddy seeds

Bhanu Vijay Shanker, Mishra K.P., Pandey Anjaney and Ashwani Duggal

Abstract
Seeds is one of the vital input of agriculture crop cultivation and it vigor and germination was noted highest at the time of crop harvest from the field and it go on deteriorate with respect to duration of it storage. Quantum of deterioration depends upon number of factors like seeds moisture contain, type of package in it store, hygiene of structure it store, ambient condition etc. Seed being store in package for keeping it in safe storage, easy handling, better distribution to users etc. Packages of a few packaging materials were taken for conducting this study. Seeds at different levels of moisture content were packed in packages and kept in ventilated storage structure in ambient condition for the period of one year. Moisture content and viability of seeds analyzed after an interval of every three months. It is observed from this study that the minimum seed certification standards of germination percentage in case of Paddy seed were maintained in all types of packages used for study up to 9 months at 12% Initial Moisture Content (IMC) level and seed certification standard of germination percentage was maintained up to one year of paddy seeds stored in T-4 (0.23 mm thick) type HDPE package at 12% IMC level.

Keywords: Viability, germination percentage, vigor index, energy of germination, emergence rate, moisture content

Introduction
Agriculture is the backbone of Indian economy and plays a vital role in building Gross Domestic Product (GDP) of India. Seed is the most important input component for the success of agriculture. Seed has a crucial role in advancement of Agricultural Productivity and Production in India. The organized seed industry of the country is just fifty years old and whole emphasis so far has been to increase the productivity through breeding programmers to bring out productive varieties. Agricultural input of all the agricultural inputs, seed hold the key to continued improvement in production and productivity. Seed is having a living embryo, grow in agricultural production in different agro-climate conditions.

During the past 5 years the Indian seed has been growing at a Compound Annual Growth Rate (CAGR) of 12% of the total compared to Global Growth of 6-7%. The Indian Seeds Market is further expected to grow at a CAGR of 14.3% during 2018-2023, reaching a value of more than US$ 8 Billion by 2023. In value terms the major growth has come from the adoption of BT cotton hybrids, single cross crop hybrid and hybrid vegetable.

Storage condition and duration of seeds are important factors affecting germination parameters. But before the impact on germination is visible lot of deterioration take place in terms of reduction in vigor. The recommendation of packaging of these seeds mainly base on experience in the absence of credible scientific study. Seed vigor is used as a measure of accumulated damage in seed as viability declines. The decline of germination is much more acute under tropical conditions. These environmental conditions make very difficult to maintain its viability during the period of storage (Mahjabin etc -2015) [11]. Different periods of seed storage, as well as ageing conditions adversely affected the seed viability. It concluded that seed viability gradually decreased (Bharat K. Pradhan., 2012) [10].

Seed Vigor is an important factor that affects seedling establishment and crop growth and ultimately production rate. Each biotic or non-biotic factor that affect seed vigor and germination during seed's development, subsequently will affect production especially when seeds produced under stress conditions. The vigor of seeds decreases rapidly by increasing seed storage period. The short terms storage under bad and unfavorable conditions affect seedling vigor more than germination and seed vigor decreases more than germination ability. The storage duration or unfavorable conditions during storage may cause that loss of seed membrane selective properly and therefore seed vigor decreases (Abdul-Baki AA etc.1973) [1].

Seed lost their germ inability, vigour and viability progressively with aging treatment (M. Mumtaz Khan etc. 2004) [12].

Packaging is essential for distribution of most commodities in units of convenient size. Seed as a live material are vulnerable to deterioration throughout storage. The most important function of a seed package is protection against climatic factors and injuries during handling, transport and distribution. The physical properties and storage potential of seed are influenced by moisture content, which in turn is controlled by the relative humidity of the atmosphere surrounding the seed. A suitable packaging material should reduce or eliminate the transport of water vapour and oxygen through the package into the seed environment. The choice of packaging material for climatic protection will depend on the ability of particular kind of seed that can withstand the surrounding temperature and relative humidity conditions (M.K. Garg. 1995) [13].

In view of the above mentioned considerations, this study is proposed to be undertaken with following specific objectives:

1. To study moisture content and viability of Paddy seeds packed in different Packaging Materials of various Thicknesses at different Moisture Levels at staggered storage period.
2. To find out co-relation between packet's properties and seeds viability during storage.
3. To suggest suitable type of Packaging Materials of a particular thickness in respect of storage period for storage of Paddy seeds.

Materials and Methods

This section includes details of various experiments and analyses those were conducted to meet the objectives of this study. The entire experimental study were divided in three stages. The first stage was to measure the physical properties of all types of packages before used in this study, second stage to measure the influence of seeds stored in different types packages on the Moisture Content & Viability of seeds under ambient condition and third stage to record the Ambient Temperature & Relative Humidity of Inside and outside of study room during the period of seed storage.

Selection of Materials

Seeds

Source of procurement of seeds those were used in conducting this study was freshly harvested seed of Paddy (Variety MTU-1064, harvested in the month of Nov-2015) was obtained from NSC, Warangal. While paddy seeds having poor storability, delicate & sensitive seeds which requires to be handled with care to maintain its viability till forthcoming planting season. The requirement of such seeds are in bulk because such crops are being cultivated over huge area in the country.

Packaging Material of Package: Packing materials selected of different fabrics and different thickness those were commonly used in seeds industry for preparing packages for storage of seeds during conducting this study. Such fabrics having different water vapour transmission rates. Water vapour transmission rates influences the Moisture Content of seeds stored in packages during period of storage. Seeds viability ultimately get affected from Moisture Content in seeds.

As per availability in the local market, suitable types & thickness of fabrics of packaging materials were procured. Required numbers of Packages of 20x30 cm size of each type has got prepared. Type of fabrics namely HDPE, Nonwoven, Cotton & Jute and four different thickness of each fabric were used in preparation of packages for conducting this study, pictures of such packages are shown as below in Fig. No. 1.0 (A) to 1.0 (D).

Fig 1A: HDPE Package

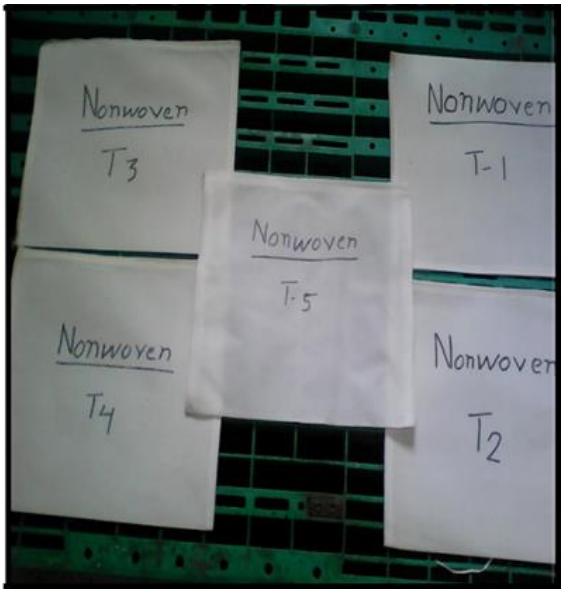

Fig 1B: Nonwoven Package

Fig 1C: Jute Package

Fig 1D: Cotton Package

Fig 1: Packages of Fabrics used in study

Experimental techniques

Measurement of physical properties of packaging material of packages: The physical properties were measured of all types packages used in this study. Testing of sample were carried out in the Lab of Department of Textile Engineering, Indian Institute of Technology Delhi. Properties were measured of packages of all thickness of all types of fabric. Package's properties were tested at Initial stage (Before) in this study. Representative samples were drawn of each type of package those used in this study. Representative samples in replicates were considered of each type packages for conducting test of physical properties. The methodology & instruments those were used to measure the physical properties of packages were as under:

Thickness through thickness tester

Determination of thickness of fabric samples in laboratory was carried out with the help of a precision thickness gauge. In this equipment, the fabric whose thickness was determined kept on a flat anvil and a circular pressure foot was pressed on to it from the top under a standard fixed load. The Dial Indicator directly gave the Thickness in mm.

Principle to measure the fabric thickness is the precise measurement of the distance between two plane parallel plates separated by the cotton when a known pressure is applied and maintained on the plates.

Weight through Arial density testing (Weight in GSM)

The GSM of fabric is one kind of specification of fabric. 'GSM' means 'Gram per Square Meter' that is the weight of fabric in gram per one square meter. By this we can compare the fabrics in unit area which is heavier and which is lighter.

Measurement of Water Vapour Permeability (WVP) through MMT Tester

MMT (Moisture Management Tester)

While performance fabrics require the typical standard tests of other fabrics, they also require an extra level of specialized testing to assure their engineering properties. The MMT® (Moist, and classifying liquid management properties of fabrics. AATCC Test Method 195 and GB 21655.2 were developed based on the MMT.

B. Measurement of Water Vapour Permeability (WVP) through WVTR tester

B.1 Water Vapour Transmission rate

Determined water vapour transmission rate of flexible barrier materials used in packaging. Key factors to understand material permeation include thickness of the material and environmental factors such as Relative Humidity and Temperature.

Seed Moisture Content & Seeds Viability study

The packaging study was conducted to observe the changes in Moisture Content and Viability of Paddy seeds during storage in packages under ambient conditions over a period of twelve months. Moisture Content and Seeds Viability of seeds were measured after the end of each quarter during the period of study conducted. The methodologies of this study conducted are described in detail as under:

Experimental design

Paddy seeds having three different initial moisture content levels were selected for conducting this study. These seeds were packed in packages made from four different fabrics of four various thicknesses of each fabric. Packages were stored in a ventilated experimental (study) room under ambient conditions for a period of 12 months and it taken out in phase manners as per experimental design from the experimental room at the intervals of three months (quarter). Samples those were drawn from experimental room were taken in seeds testing labs for conducting analysis. The nos of packages required for conducting this study were work out as indicated in experimental design in fig. 2.

Seed			
Paddy			
Moisture Contents			
M1	M2		M3
Types of Package			
HDPE	JUTE	NONWOVEN	COTTON
(T1-T4)	(T1- T4)	(T1-T4)	(T1-T4)
Replications			
1	2		3
Durations			
3 months (Q1)	6 months (Q2)	9 months (Q3)	12 months (Q4)

Fig 2: Experimental design for conducting study in Package Storage

Seeds Packages

A. Random Sampling

A representative samples were prepared as per experimental design of each experimental parameter in replicates. All sampling plans presume that each packet has an equal likelihood of being selected. A number was assigned to each

package. One hundred forty four packages of each quarter were prepared for conducting this study.

B. Packing and Storing of Seeds

1000 g (Approx.) quantity of seeds were filled in each package, number of packages were prepared as per the experimental design. The mouth of packages were closed with the help of package closer and it stacked over plastic pallets inside the experimental (study) ventilated room. The room was situated at 1st floor in the corporate office of National Seeds Corporation, Beej Bhawan, IARI, Pusa Campus, and New Delhi. Seeds in packages were stored inside the experimental room at ambient conditions. Required Numbers of Packages for all four quarters were stacked separately over plastic pallets for conducting this study inside the study room. Arrangement of samples of each quarter inside the ventilated room is shown as below:

Fig 3: Arrangement of paddy samples inside Experimental room.

Experiment Period

Seed viability and Moisture Content of paddy seeds were studied at interval of quarterly basis over a period of one year. Schedule of putting in and drawing out the packages of seeds from the study room of respective quarters were planned, which is shown as under

Table 1: Schedule Period of Storage of Seeds Samples under different quarters

Quarter	Date on Packages Put	Date on Packages Drawn
First		21.11.2016
Second	22.08.2016	21.02.2017
Third		21.05.2017
Fourth		21.08.2017

Storage Environment

The Packages of seeds were stored inside the ventilated room under ambient conditions. Daily Maximum and Minimum Temperatures & Relative Humidity of inside the study room were recorded with the help of Humidity and digital temperature meter since August 2016 to August 2017. The study room was in corporate office of NSC, New Delhi, which was situated inside the IARI, Complex, New Delhi. Temperature and Relative Humidity data of outside the study room of above period were obtained from the Division of Agricultural Physics, IARI, New Delhi.

Seeds Quality Tests

For full filled the purposes of objectives of this study, the following seed quality tests were planed and conducted. Once a package was opened, it was not reused for further storage.

Measurement of seeds Moisture Content

Moisture contents of the seeds samples were determined using standard oven drying method as recommended by International Seed Testing Association (Anon, 1985) [5] and American Society of Agricultural Engineers (Anon, 1988) [6] in a seeds testing lab of NSC, New Delhi. Samples of about 5 g were oven dried at 130 °C +10 °C for 16 hours. Samples of Seeds were coarsely ground in a non-absorbing, non-corrosive grinder before drying. Initial and final weights of seed samples (before and after drying) were obtained to calculate moisture percentage upto two decimal place on the dry weight basis as given below (Anon, 1985) [5].

$$\text{Moisture content (M)(db)} = \frac{M_2 - M_3}{M - M} \times 100 = \frac{\text{Weight Loss} \times 100}{\text{Initial weight of seeds}}$$

Where

M = Seed Moisture Content.

M1 = weight of moisture dish along with its cover

M2 = weight of moisture dish with its cover + seed sample before drying
M3 = weight of moisture dish with its cover + seed sample after drying

The Moisture Content was measured in replicate and the arithmetic mean was reported as Moisture Content of the seeds.
The Moisture Content of seeds stored in each package was determined experimentally by adopting the procedure as outlined above.
The Moisture Content was measured of seeds stored in packages those taken out from study room at the end of each quarter up to the period of 12 months. Seeds samples in replicates were drawn from each package. Samples were tested in the lab and average Moisture Content of replicates sample of seeds of each package was recorded in the table.

Measurement of seeds germination
Germination test was conducted by using 100 seeds of each sample in three replications of each package by the Between Paper (BP) method (Anon, 1985) [5], Germination of a seed in a laboratory test is the emergence and development of the seedling to a stage where the aspects of its essential structure indicate whether it or not it is able to develop further into a satisfactory plant under favorable conditions in soil.
The test was conducted in walk in germinator in two stages, first sample was kept in a walk in germinator where temp kept to maintain at 30 °C and saturation Relative Humidity for 5 days of samples and further it shifted to another walk in germinator where temp kept to maintain at 20 °C and near saturation Relative Humidity for 9 days of samples of Paddy seeds. At the end of 14 days of samples of Paddy seeds, the number of normal seedlings of each sample was counted and the percentage of seeds germinated of each sample was calculated. Averages of replications of samples were reported in the table. The complete process of conducted seed viability experiment in the seeds testing lab, NSC, New Delhi is shown below in Fig. No. 4.

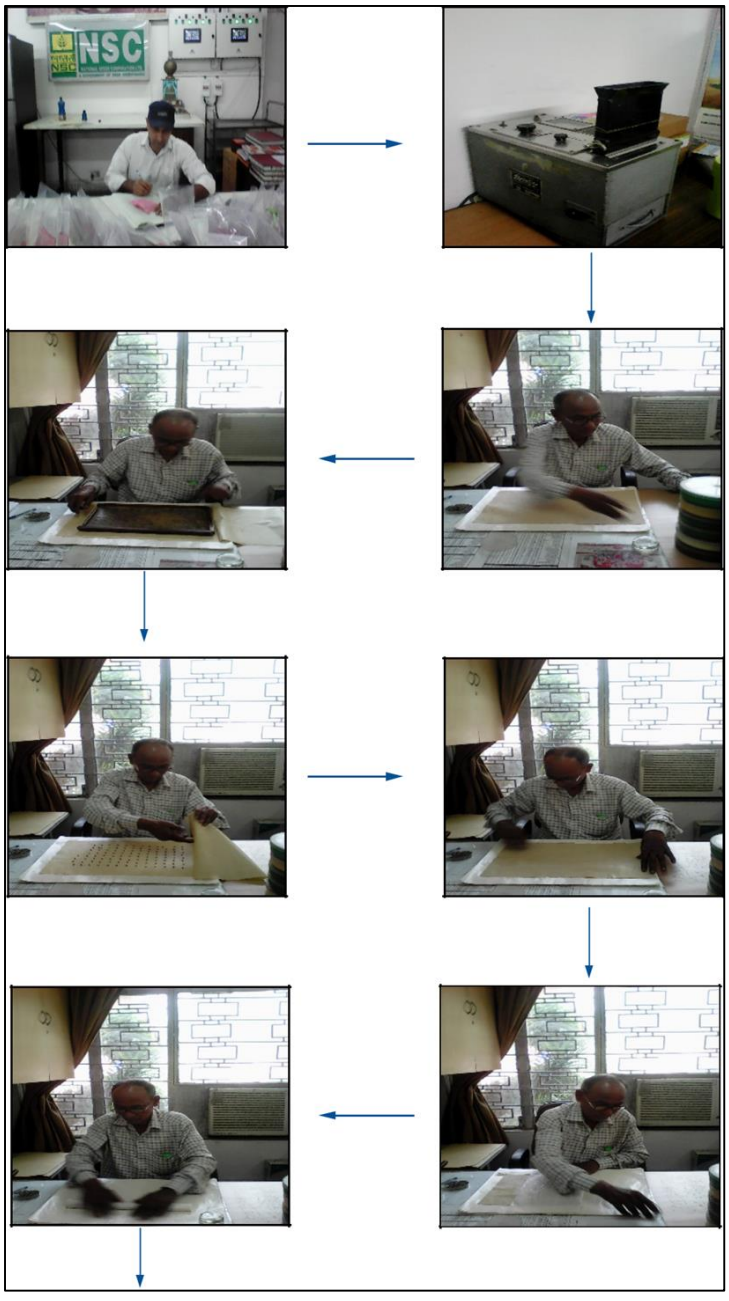

Fig 4: Seeds Viability Test in NSC's Seed Testing Lab.

Measurement of Seeds Energy of Germination

One hundred seeds of each sample in three replications of each package were planted in paper substratum for measurement the Energy of Germination of seeds. Samples of seeds in replicates of each package were planted in paper substratum. The substratum were kept in walk in germinator and maintained recommended Temperature & Relative Humidity for seeds. Number of seedlings emerged after Six days of paddy seeds counted from date of planting the seeds in the germinator. Thereafter an average of Energy of Germination of all samples of replicate of each package recorded in the table.

Measurement of Seeds Emergence Rate

One hundred seeds of each sample of replicate of each package were planted in paper substratum for computing Emergence Rate of seeds. The substratum of all samples were kept in walk in germinator and maintained recommended Temperature & Relative Humidity. The Emergence Rate was calculated by a half of the sum of the number of seeds lings emerged after seven days & ten days in case of paddy seeds from day of planting the seeds in germinator. Thereafter an emergence rate of each sample was computed by using the following formula.

$$\text{Emergence Rate} = \frac{\text{No of seed emerged after (7 days +10 days)}}{2}$$

Average of replication of each package reported in the table.

Measurement of Seeds *Vigour*

Seed vigour is an important quality parameter, ISTA Congress (1977) [14] adopted the definition of seed vigour as "The sum total of those properties of seed which determine the level of activity and performance of the seed or seed lot during germination". Ten normal seedlings were taken at random from each replication of the standard germination test and the lengths of root and shoot of each seedlings were measured. Average values of all three replications of seeds of each package reported in the table. Vigour Index of each sample (Baki and Anderson, 1973) [9] in whole number was calculated as follows:

Vigour Index = Germination Percentage x Total mean length (root + shoot) of seedling in cm

Measurement of Seeds Infestation

During the experiment, none of seed of paddy crop was observed insect infested and not seen living insects in sample. However, time to time seeds protection practice from insect infestation was adopted. To measure the infestation level in different packages, samples were drawn and presence of living insects, it's stage and external insect- injury was examined through visual observation with the help of magnifying glass (10 X) aided with light but none of beetle, moth larva etc. and seeds damaged by insects were seen in the samples. Experimental set up for measurement of insect infestation is shown as in Fig. No. 5

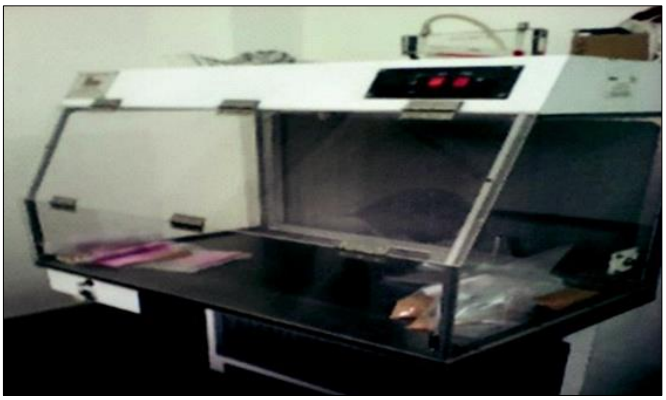

Fig 5: Seed Infestation Test in NSC's Seeds Testing Lab.

Results and Discussion

Experiments were conducted to observe environmental effects on physical properties of packages, Viability & Moisture Content of seeds and seed storage behavior in different packaging materials under ambient conditions.

The results of this study presented and discussed in this chapter under the following main headings:

Air Temperature and Relative Humidity in the Storage Space: The seed, after packing in different packages, were stored on plastic carrots in a well-ventilated room situated at 1st floor in the corporate building of NSC, New Delhi. Since storage environment effects the Moisture Content and Viability of the stored seed, reliable meteorological data is required to simulate the process of seed storage. Relevant parameters of the storage environment, air temperature and relative humidity, were measured as explained earlier.

The storage space used in this study was RCC structure which roof was covered with GI Sheet, wooden ceiling and all four sides surrounded with brick walls having adequate no of door, ventilators & windows. The space was well ventilated, full of natural light, damp & rat proof. Data logger (LICOR 1000) was used for measurement of inside maximum & minimum Temperature and maximum & minimum Relative Humidity values on daily basis, daily mean highest Relative Humidity for the room air in the month of June-17 during the period of study was recorded 54.75%, while daily mean Relative Humidity of the outside air on that month was 65.60%. The difference in value of mean Relative Humidity of inside and outside was only 10.85%. It was, therefore, assumed that monthly mean Relative Humidity of outside and inside air had about the same values except in afew month i.e. from November 16 to April -17, June-17 & July-17 there were slightly wide difference in inside & outside Relative Humidity ranging Minimum 4.61% and Maximum 10.85%, detailed is shown in Table No. 2.

The monthly mean air temperatures outside and inside the room of seed package stored was recorded and shown in the Table No. 3. The monthly outside mean ambient air temperature was noted lower than inside monthly mean air temperature in different months by 0.75 to 6.60 C.

Table 2: Comparison of outside and inside ambient Relative Humidity during Year 2016-17.

Month 1	RH Outside (%)			RH Inside (%)			RH Difference (%)
	Max(Mean) 2	Min(Mean)3	Average4	Max5(Mean)	Min(Mean)6	Average7	Col (4)- Col (7)8
Aug.16	89.60	71.50	80.55	86.76	73.18	79.97	+0.58
Sep.-16	86.70	56.7	71.70	85.00	61.69	73.34	-1.64
Oct.-16	86.50	38.40	62.45	84.50	47.30	65.90	-3.45
Nov.-16	88.30	39.00	63.65	71.20	46.20	58.70	+4.95
Dec.-16	93.60	50.30	71.95	73.60	60.60	67.10	+4.85
Jan.-17	94.10	58.20	76.15	73.00	60.90	66.95	+9.20
Feb.-17	91.30	48.80	70.05	74.40	50.40	62.40	+7.65
Mar.-17	84.10	43.90	64.00	75.90	37.50	56.70	+7.30
April-17	70.50	40.90	55.70	61.40	37.10	49.25	+6.45
May-17	69.40	42.80	56.10	67.00	48.00	57.50	–1.40
June-17	77.00	54.20	65.60	62.00	47.50	54.75	+10.85
July-17	86.30	68.60	77.45	84.00	61.69	72.84	+4.61
Aug-17	90.40	72.30	81.35	87.00	80.75	83.87	-2.52

Table 3: Comparison between outside and inside ambient Temperature during Year 2016-17**.**

	Temp Outside (degree C)				Temp Inside (degree C)		Temp (degree C)
Month 1	Max (Mean) 2	Min (Mean) 3	Average4	Max (Mean) 5	Min(man) 6	Average7	Difference Col (4) Col (7) 8
Aug-16	33.40	24.10	28.75	32.84	30.29	31.56	-2.81
Sep-16	34.20	22.60	28.40	33.19	30.30	31.74	-3.34
Oct-16	33.90	16.00	24.95	33.10	27.40	30.25	- 5.30
Nov-16	29.00	9.00	19.00	27.70	22.00	24.85	- 5.85
Dec.16	23.20	5.20	14.20	22.90	18.70	20.80	- 6.60
Jan.-17	20.20	7.70	13.95	20.50	16.60	18.55	- 4.60
Feb.- 17	24.10	9.80	16.95	21.90	21.90	21.90	- 4.95
Mar-17	29.70	13.80	21.75	27.90	25.30	26.70	- 4.95
Apr-17	38.10	20.70	29.40	30.80	29.50	30.15	- 0.75
May-17	39.50	29.40	34.45	39.80	31.00.	36.90	-2,45
June -17	36.80	25.20	31.00	38.80	29.90	34.35	-3.35
July-17	34.20	26.20	30.20	33.30	30.19	34.74	- 4.55
Aug-17	33.80	25.90	29.85	32.48	28.83	30.65	-0.80

The information presented in these tables indicates that higher average air temperatures are accompanied by lower average air Relative Humidity and vice versa except in the month of August-16 to October-16 & July -17 to August -17 being month of rainy season, April and May months had the lowest average air Relative Humidity while the months of November to February had the lowest average air temperatures inside the experimental (study) room.

Physical properties of packaging materials

Required numbers of Packages of 30 × 20 cm size of all types of package as per experimental design were got made for conducting this study. The physical properties of Packages of all types of fabrics like thickness, substance weight, bursting strength and Water Vapour Permeability were measured before used them in conducting this study. These tests were carried out in the laboratory of IIT Delhi (Department of Textile Engineering) and averages of replications of each test

of above properties of all type of packages before use were reported in Table No. 4

Package Thickness

It was observed from table No. 4 that mean thickness of HDPE fabric packages comparatively less than thickness of other packages made with fabrics like cotton, Nonwoven and Jute those were used in this study. Thickness of jute fabric Packages were noted thickest among thickness of other fabrics packages used in this study. The mean thickness of HDPE fabric packages was found 3.72 times lesser than mean thickness of Jute fabric packages used in this study.

Package Weight

As per table No. 4, it was observed that HDPE packages lighter in weight as compared to weight of packages made from other fabrics like Nonwoven, Cotton and Jute used in conducting this study. The minimum variation in weight was noted in packages made with fabric like Cotton and Nonwoven. Mean weight of Jute packages was found 4.91 times heavier in weight than mean weight of HDPE packages used in this study. Ideally, a packaging material should be as light as possible, but at the same time, it must have sufficient strength for handling and holding the seed.

Package Bursting Strength

It was observed from table No. 4 that bursting strength not same of all packages and it varied fabric to fabric. The maximum bursting strength was found in Jute packages and found the bursting strength in decreasing order in other packages used in this study like HDPE, Cotton and Nonwoven

Table 4: Physical Properties of Packages before conducting study.

Fabric Thickness	Thickness (mm)			Weight (g)			Bursting Strength (Kg/sq cm)			Water Vapor Permeability g/ (cm2 Day)		
HDPE												
	Avg.	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min**
T-1	0.06	0.07	0.05	5.47	5.48	5.46	7.51	7.52	7.50	2339.34	2339.36	2339.32
T-2	0.17	0.18	0.16	11.25	11.26	11.24	11.85	11.86	11.84	2182.99	2183.01	2182.97
T-3	0.24	0.26	0.22	11.48	11.50	11.46	13.74	13.76	13.72	1777.88	1777.90	1777.86
T-4	0.25	0.27	0.23	16.0	16.02	15.98	15.57	15.59	15.55	1611.34	1611.36	1611.32
Jute												
T-1	0.80	0.79	0.81	59.75	59.74	59.76	14.60	14.80	14.40	6056.43	6056.45	6056.41
T-2	0.83	0.84	0.82	64.95	64.96	64.94	15.96	15.98	15.94	5653.36	5653.38	5653.34
T-3	0.87	0.89	0.85	68.16	68.18	68.14	17.59	17.61	17.57	5563.34	5563.36	5563.32
T-4	0.91	0.90	0.92	68.66	68,68	68.64	19.37	13.39	13.35	5379.34	5379.36	5379.32
Cotton												
T-1	0.21	0,20	0.22	17.66	17.67	17.65	5.65	5.67	5.63	6953.15	6953.17	6116.04
T-2	0.22	0.22	0.22	18.12	18.14	18.10	6.30	6.32	6.28	6609.15	6609.17	5702.23
T-3	0.26	0.28	0.24	22.65	22.64	22.66	6.87	6.89	6.85	6430.97	6430.99	5679.70
T-4	0.27	0.28	0.26	23.77	23.65	23.90	7.13	7.15	7.11	5827.21	5827.23	5634.59
Nonwoven												
T-1	0.42	0.43	0.41	15.62	15.63	15.61	4.33	4.35	4.31	6116.06	6116.08	6953.13
T-2	0.49	0.48	0.50	18.24	18.26	18.22	4.79	4.81	4.77	5702.25	5702.27	6609.13
T-3	0.53	0.55	0.51	19.95	19.96	19.94	4.87	4.89	4.85	5679.70	5679.90	6430.95
T-4	0.57	0.58	0.56	23.29	23.30	23.28	5.27	5.29	5.25	5634.61	5634.63	5827.19

Water Vapour Permeability

The water vapour permeability of packages of different fabric used in this study were measured through using the suitable instrument as per fabric. The lowest water vapour permeability was found in packages of HDPE fabric. In other packages, Magnitude of water vapour permeability was observed more or less of similar range. The maximum water vapour permeability was noted in packages of Cotton fabric. The mean water vapour permeability of Cotton packages was found 3.26 times more than mean water vapour permeability of HDPE packages.

Seeds Moisture Content and Seeds Viability evaluation

During evaluation of Seeds Viability, test like Seed Moisture Content, Energy of Germination, Seed Emergence Rate, Germination and Vigour Index of Paddy Seeds were conducted at a quarterly intervals basis over a period of one year. Infestation Percentage in Paddy Seeds was also measured. The results of all such parameter are discussed and described in detailed as under:

3.1 Seeds Moisture Content

Moisture Contents in Paddy Seeds was observed fluctuated during the period of storage with seasonal changes in temperature and relative humidity of air. Changes of Moisture Content in seeds also affected due to store in type of packages. Moisture Content in seeds during packages storage also depends upon factors like initial moisture content level of seeds, type of fabric of package and thickness of fabric of package. High Relative Humidity and low Temperature in air was observed during in month of November-February (Table. 2 & Table. 3). A fall in Relative Humidity and increase in Temperature in air was noted with the onset of dry summer months because of experienced maximum air Temperature and minimum air Relative Humidity values.

There was no major significant effect either gained or lost of Moisture Content observed in paddy seeds stored at all initial Moisture Content levels in all types of package. Minimum mean gained or lost the magnitude of Moisture Content was found of Paddy Seeds stored in HDPE packages and the magnitude of Moisture Content was noted in increasing order of Paddy Seeds stored in Nonwoven, Cotton and Jute Package of seeds stored at all levels of Moisture Content, all package thicknesses and stored for the period of all quarters in mean storage.

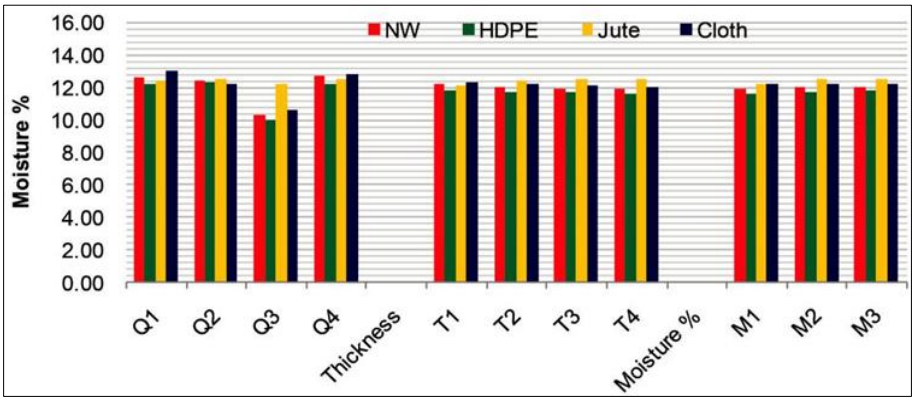

Fig 6: Effects of Parameters used under study on Seeds Moisture Content (%) during different periods of storage-Paddy Seeds.

Seeds Energy of Germination

The maximum mean Energy of Germination in Paddy seeds were found of seeds stored in HDPE packages and magnitude of mean Energy of Germination of seeds was noted in declining order of seeds stored in Jute, Nonwoven and Cotton packages in mean storage of seeds stored in all packages thicknesses at all levels of Moisture Content during period of storage of all quarters.

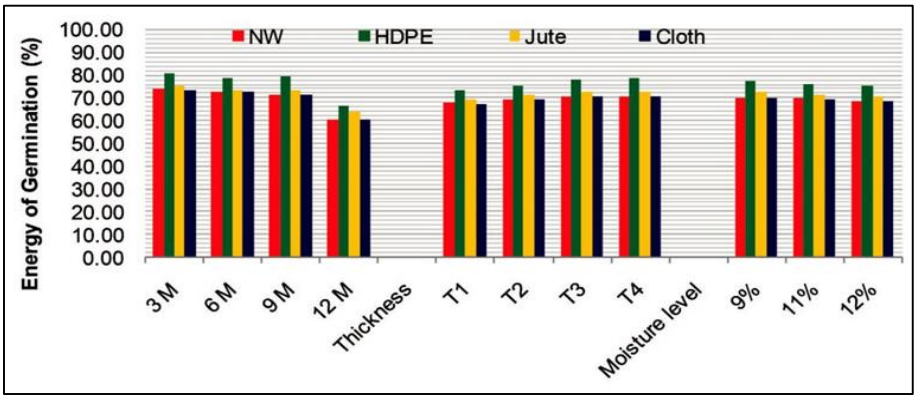

Fig 7: Effects of Parameters used under study on Energy of Germination (%) in different periods of storage – Paddy Seeds.

Seeds Emergence Rate

The maximum mean Emergence Rate of Paddy Seeds was found maintained of seeds stored in HDPE packages during the entire period of storage under this study and found magnitude of mean Emergence Rate went on decline with respect to period of storage of Paddy Seeds stored in Cotton, Nonwoven and Jute packages in mean storage of seeds stored at all levels of Moisture Content during period of storage of all quarters

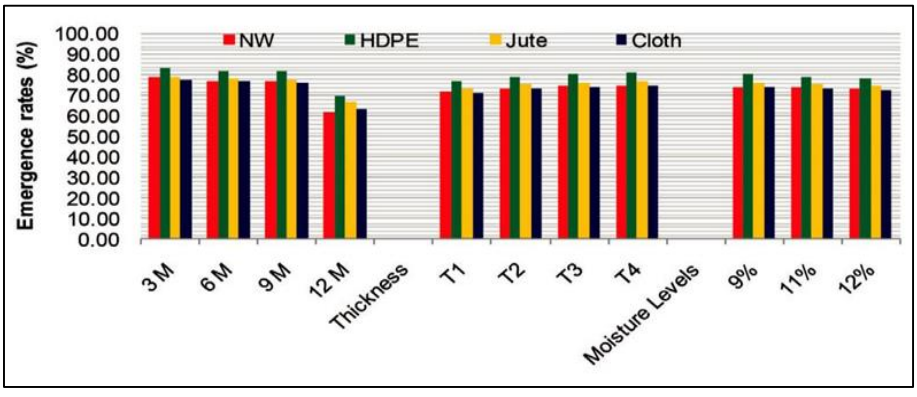

Fig 8: Effects of Parameters used under study on Seed Emergence Rate (%) during different periods of storage-Paddy Seeds.

Seed Germination Percentage

The experimental evidence for the range of parameters studied and suggests that germination of Paddy Seeds not much dependent on seed Moisture Content up to 12% to any significant extent to maintain minimum seed certification level (80%) for a period of one year in T-4 HDPE Package (0.23 mm thick). Further, Paddy seeds could be stored in all other type of packing materials like Jute, Nonwoven and Cotton up to 9 months at initial Moisture Content level up to 12% without sacrificing minimum seed certification Germination Capability (80%) for plantation in nest forthcoming season.

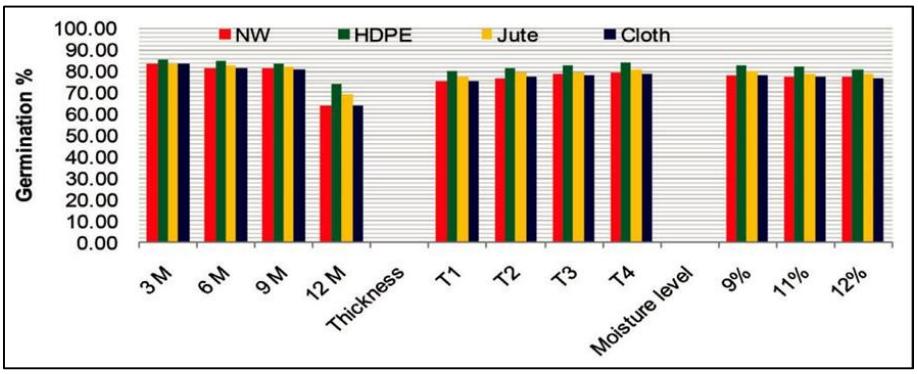

Fig 9: Effects of Parameters used under study on Seed Germination% during different periods of storage – Paddy Seeds.

Seeds Vigour

It is concluded from this study that mean Vigour Index of seeds was found highest in seeds stored in HDPE packages as compared to mean vigour index of seeds stored in other packages used in this study like cotton, Nonwoven & Jute packages in mean storage of all packages thickness stored at all initial Moisture Content levels during storage periods of all quarters.

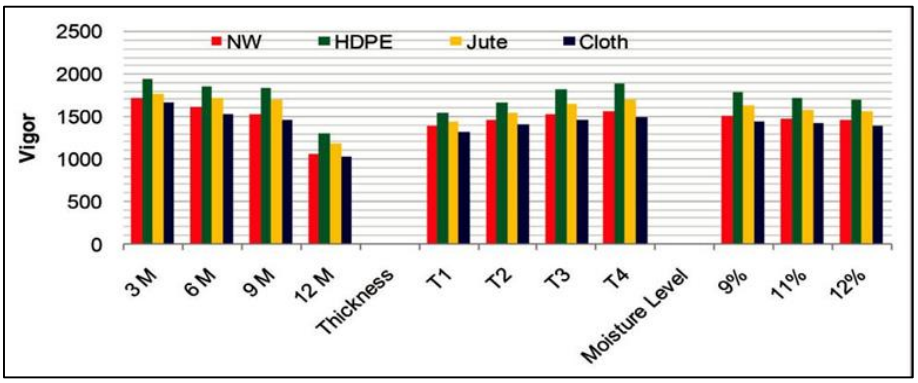

Fig 10: Effects of Parameters used under study on Seed Vigour Index during different periods of storage-Paddy Seeds.

Insect Infestation of Seeds during Storage:

Insect Infestation was not noticed in sample Package during the period of study. Apparently, the seed at the time of initial packing had no Infestation and the Infestation level remained constant till the end of the experiment. As per previous study clearly indicated that Moisture Content as well as packaging materials has an effect on insect infestation of seeds during storage. The Infestation Percentage increased with the increased in initial Moisture Content level. Since insects need oxygen to survive, the lack of oxygen eliminated the possibility of insect development. It has also been reported that any Infestation in seed at the time of packaging it into store, would soon die when the oxygen in container is depleted below 3%.

It is concluded from this study that Infestation percentage in seeds depends upon initial Moisture Content level in seeds and type of packages used for seeds storage under stable ambient condition.

Co-relation between package's physical properties and seeds viability during storage under ambient condition

Table 5: Co-relation between packages' Physical Properties & Seeds Viability of paddy seeds.

Character	Thickness (mm)	Weight (gm)	Bursting strength (kg/sq.m)	Water vapour permeability g/ (cm2 Day)	Germination%	Vigor Index
Thickness (mm)	1.000	0.927**	0.607**	0.366*	0.085	0.102
Weight (gm)		1.000	0.716**	0.375*	0.004	0.046
Bursting Strength (kg/sq. m)			1.000	-0.302*	0.223	0.388**
Water Vapour Permeability g/ (cm2 Day)				1.000	-0.296*	-0.414**
Germination%					1.000	0.930**
Vigour Index						1.000

Co-Relation between package's Thickness and Seeds Viability:

The experiments & analysis indicates that as thickness of the package increased, the package weight & bursting strength were also went on increased up to more than significant level 0.5 and water vapour permeability of packages increased too up to the significant level below 0.5. The positive impact of increased of package's thickness was observed on seeds Germination & Vigor Index in case of Paddy seeds stored in package.

Co-Relation between packages Weight and Seeds Viability: The effects of package's weight on paddy Seeds shown in Table No. 10. As weight increased, the bursting strength of package also went on increased up to the significant level more than 0.5 and water vapour permeability

of packages increased too up to the significant level below 0.5 and observed it positive impact on seeds Germination &Vigor Index in Paddy Seeds stored in package.

Co-Relation between packages Bursting Strength and Seeds Viability

The effects of package's Bursting Strength shown in the Table No. 10 of Paddy Seeds, as package's Bursting Strength increased, its water vapour permeability was observed went decreased. Its positive effect was observed on Seeds Germination & Vigor Index but significant impact was noted on Vigour Index of seeds stored in package storage.

Co-Relation between packages Water Vapour Permeability and Seeds Viability

The effects of package's, water vapour permeability shown in the Table No. 10 as package's water vapour permeability increased, the Seeds Germination and Vigor Index of seeds went on decreased significantly up to negative level below 0.5 of seeds stored in package storage.

It was observed from this study that Germination% & Vigour Index of Paddy seeds were influenced from package's physical properties during it stored in package. Seed Viability of seeds stored in package was observed affected from each of package's physical property. Package's water vapour permeability has got significant impact on seed viability. The effects of package's water vapour permeability was found inversely proportional to Seeds Viability.

Suitable type & Thickness of Package for storage of Paddy & Soybean seeds to maintain minimum seeds certification standard of Moisture Content & Germination% with respect to storage period under ambient condition.

Suitable fabric of Package for storage of Paddy Seeds to maintain safe Moisture Content level with respect to Storage Period under ambient condition:

It concluded from study that Moisture Content (MC) of Paddy Seeds was better maintained up to safe storage level, stored in HDPE fabric packages, compared to seeds stored in packages used of other fabrics during study with respect to period of storage under ambient condition.

S. No.	Name of Crop	Suitable fabric's rank for safe seeds storage			
		HDPE	JUTE	NONWOVEN	COTTON
1	Paddy	No.-1	No.-4	No.-2	No.-3

Suitable type and Thickness of Package for storage of Paddy Seeds to maintain Germination% with respect to Storage Period:

S. No.	Name of Crop	Safe Storage in type of package			
		3 Months	6 Months	9 Months	12 Months
1	Paddy	Seeds stored in all types package used during study at12% IMC			Seeds stored in HDPE Package (0.23 mm thick) at12% IMC

It concluded from the study that minimum seeds certification standard of Germination Percentage (80%) of Paddy Seeds can be maintained up to one year of seeds stored in T-4 type (0.23 mm) thick HDPE package at 12% Initial Moisture Content (IMC) level.

Summary and Conclusion

1. The packaging material as well as thickness of package and type of seed stored in the package affect Water Vapour Permeability of the package. Since beginning of September up to Jan-Feb, depending upon initial moisture content level, there was observed an increase in Moisture Content of varying magnitude of seeds stored in all types of packages of all thicknesses. A fall in magnitude of seed Moisture Content was noted with the onset of dry summer months of April and May.
2. The minimum seed certification standards of Germination Percentage (80%) in case of Paddy seed were maintained in all types of packages used for study up to 9 months at 12% Initial Moisture Content (IMC) level and seed certification standard of Germination Percentage was maintained up to one year of paddy seeds stored in T-4 (0.23 mm thick) type HDPE package at 12% IMC level.
3. HDPE Package proved to be the best in maintaining high levels of Germination of Paddy Seeds. The packaging material which minimized the moisture absorption and flow of oxygen during storage was able to maintain Seed Viability for the longest period.
4. No insect infestation was observed in seeds because of seeds stored at adequate initial moisture content level as well as used suitable packages under safe storage condition. The infestation percentage in seeds increase with the increase in moisture content. HDPE packages are most suitable packages for storage of seeds to protect from insect infestation due to having low permeability to oxygen and Moisture thus, not creating favorable conditions for insect survival.
5. The Physical Properties of package influenced the Seeds Viability and Moisture Content of seeds. An effect of Water Vapour Permeability of package was noted inversely proportional to Seed Viability & Moisture Content of seeds and other properties of packages also observed to influence Seeds Viability positively.

Acknowledgement

We are grateful of National Seeds Corporation ltd, New Delhi for providing facility of storage and seeds testing in conducting of this study.

References

1. Abdullah M, Abdullah Alsadon A, Safwat khalid O, Mohamood Wahb-Allah A, Mahran El Nagar and Abdullah A Ibrahim 2011.
2. Agrawal PK, Dadlani M. Techniques in Seed Science and Technology. South Asian Publishers, New Delhi 1992.
3. Alam A, Gene C. Hygroscopicity and thermal properties of soyabean. Transactions of the ASAE 1973;16(4):707-709.
4. Anderson RB. Modifications of the Brunauer, Emmet and Teller equation. J. Am. Chem. Soc 1946;68(4):686-691.
5. Anonymous, International rules foe seed testing. Seed Sci. Technol 1985;13(2):307-520.
6. Anonymous. Agricultural Engineers Yearbook of Standards. Published by Am. Soc. Agric. Engrs 1988.
7. Anonymous. Indian minimum seed certification standards. Central Seed Committee, Dept. of Agril., Ministry of Food, Agril., Community Development & Co-operation, New Delhi 1988.
8. ASHRAE Handbook of Fundamentals. Am. Soc. of

Heating, Refrigerating and Air-Conditioning Engineers, Inc., New York 1977.
9. Baki AAA, Anderson JD. Relationship between decrboxylation of glutamic acid and vigour in soybean seed. Crop Sci 1973;13(2):227.
10. Bharat Pradhan K. "Effect of Storage Condition "Scientific world Journal, 2012, Art I D128105.
11. Mahjabin etc 142015"Physiological and Biological changes during Seeds Deteioration "A Review International Research of resent Scientific Research, PP3416-3422. 6, 4.
12. M Mumtaj Khan etc. International Journal of Agriculture and Biology 2004;6(4):708-711.
13. Garg MK. "Prediction of Viability of Seedsstored in different packaging Materials", Ph.D Thesis, Division of Agril. Enineering, Indian Agril. Research Institute, New Delhi, India, 1995.