The Pharma Innovation Journal 2021; 10(2): 614-620

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2021; 10(2): 614-620

www.thepharmajournal.com
Received: 21-11-2020
Accepted: 07-01-2021

Vijay Shanker Bhanu
Faculty of Engineering and Technology, Mahatma Gandhi Chitrakoot Gramodhya Vishwavidhyalaya, Chitrakoot, Satna, Madhya Pradesh, India

KP Mishra
Professor, Faculty of Engineering and Technology, Mahatma Gandhi Chitrakoot Gramodhya Vishwavidhyalaya, Chitrakoot, Satna, Madhya Pradesh, India

Dr. Anjaney Panday
Faculty of Engineering and Technology, Mahatma Gandhi Chitrakoot Gramodhya Vishwavidhyalaya, Chitrakoot, Satna, Madhya Pradesh, India

Ashwani Duggal
Professor, Faculty of Engineering and Technology, Mahatma Gandhi Chitrakoot Gramodhya Vishwavidhyalaya, Chitrakoot, Satna, Madhya Pradesh, India

Corresponding Author:
Vijay Shanker Bhanu
Faculty of Engineering and Technology, Mahatma Gandhi Chitrakoot Gramodhya Vishwavidhyalaya, Chitrakoot, Satna, Madhya Pradesh, India

Impact of environment, storage time and packaging materials on seeds viability of soybean seeds

Vijay Shanker Bhanu, KP Mishra, Dr. Anjaney Panday and Ashwani Duggal

Abstract
This study was conducted on seeds of Soybean crop which is very sensitive and delegate to maintain its Seeds certification standard during storage till it's plantation for forthcoming season. Soybean crop is being cultivated during kharif season in large cultivation area of the country and it is known as a cash crop in Madhya Pradesh. The main objective of conducting this study was to find out suitable type of package for its storage to maintain certification level of germination percentage and safe level of moisture content up to period it cultivate in forthcoming season. Study was conducted on certified seeds of soybean crop and it stored in packages of four different fabrics of four various thicknesses of each fabric for period of one year. Seeds viability and moisture content of seeds stored in each package and effect of Package's physical properties on seeds viability were studied in detail at the interval of every three months up to the period of one year. During study it was noted that seeds Viability go on deteriorate with respect to storage time. Package's physical properties in seeds stored has got significant impact on seeds viability. Package of HDPE fabric was found most suitable to store of Soybean seeds among packages of other fabrics used for conducting this study. Soybean seeds at 12% moisture content can store in HDPE packages up to period more than six months under ambient condition in ventilated package store. HDPE package are cheaper in cost among package of all other fabrics which reduce the seed cost and support to farmers in getting seeds at cheaper rate.

Keywords: Moisture content, seeds viability, germination, vigour, seeds infestation

Introduction
Seeds is the most important input component for the success of agriculture. Seeds has a crucial role in advancement of Agricultural Productivity and Production in India. Efforts are being made in the country since 1928 for production and distribution of good quality seeds.
National Seeds Corporation was set up in 1963 with the basic objective of developing a sound seeds industry in the country. The Tarai Development Corporation and State Farms Corporation of India were established in 1969 for producing seeds on their own farms. To meet the growing demand for quality seed, the National Seeds Projects (NSP) I, II and III were launched in 1977-78, 1978-79 and 1990-91 with financial support of World Bank to upgrade the efficiency and infrastructures of the Public Sectors like NSC, SFCI, SSCs, Research stations of ICAR, Agricultural Universities as well as Seeds Certification Agencies and central and state Seeds Testing Laboratories.
The organized seeds industry of the country is just fifty years old and whole emphasis so far has been to increase the productivity through breeding programs to bring out productive varieties. Though the economics to play role and have a larger consideration on the fact that at what rate the seeds are made available to farmers, the associate cost factor have not been investigated thoroughly, so far so find alternative and equally good way of packaging and storing the seeds at lesser cost. Packaging is essential for distribution of most commodities in units of convenient size. Seeds 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 Viability and Vigour potential of seeds are influenced by moisture content, which can be controlled by the relative humidity of the atmosphere surrounding the seeds. A suitable packaging material should reduce or eliminate the transport of water vapour and oxygen through the package into the seeds 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. In view of the above mentioned considerations, this study is undertaken with following specific objectives:

1. To study Moisture Content and Viability of Soybean 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 Soybean Seeds.

Materials and Methods

This section contained various experiments and analyses to meet the objectives of this study.

Selection of materials

Seeds

Certified Seeds of Soybean crop Variety J S -135, harvested in the month of November-2016 was procured from Arihant Agro Seeds, Ujjain.

Packaging materials for package

Most commonly being used packaging materials in seeds industry like HDPE, Nonwoven, Cotton & Jute of four different thicknesses of each fabric were used for conducting this study.

Experimental techniques

Measurement of physical properties of packaging material of package

Physical properties of all types package were tested before used for conducting experiment. Testing was conducted in the lab at two stages i.e. initial stage (Before) and final stage (After) used of package during study. The methodology & instruments those were used to measure the physical properties of package were as under:

a) Thickness through Thickness Tester: Thickness of fabric's samples was determined 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.

b) 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.

c) Bursting Strength through Diaphragm Bursting Tester: Bursting Strength is a method of measuring strength in which the material is stressed in all the directions at the same time and is therefore more suitable for materials such as knitted fabrics, lace or non-woven. Fabrics used in parachute, filters, sacks and nets are simultaneously stressed in all the directions during service. In service, a fabric is more likely to fail by bursting than by a straight tensile fracture.

d) Measurement of Water Vapour Permeability (W V P) 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 (Moisture Management Tester) provides this by measuring, evaluating, and classifying liquid management properties of fabrics. AATCC Test Method 195 and GB 21655.2 were developed based on the MMT.

Seed moisture content and seeds viability study

The packaging study was conducted to observe the changes in Moisture Content and Viability of seeds of Soybean crop during storage in packages. Seeds packages were stored under ambient conditions in ventilated store over a period of twelve months and Moisture Content and Viability of seeds were measured quarterly basis during the period of study. The methodologies adopted for conduct the experiments described in detail as under:

Experimental design

Soybean seeds of three different initial moisture content levels were taken and packed in packages. Packages were made of commonly used in seeds industry four different fabrics of readily available four various thicknesses of each fabric. Seeds packages were stored in a ventilated experimental room which was situated in corporate building of office of National Seeds Corporation, New Delhi under ambient conditions. This study was carried out for a period of 12 months and seeds samples drawn quarterly basis as per experimental design. Samples were taken in seeds testing labs for conducting Test and analysis. Total nos of 144 Seeds packages of each crop for each quarter were required for conducting this study as per experimental design as shown as in fig. No.1 below:

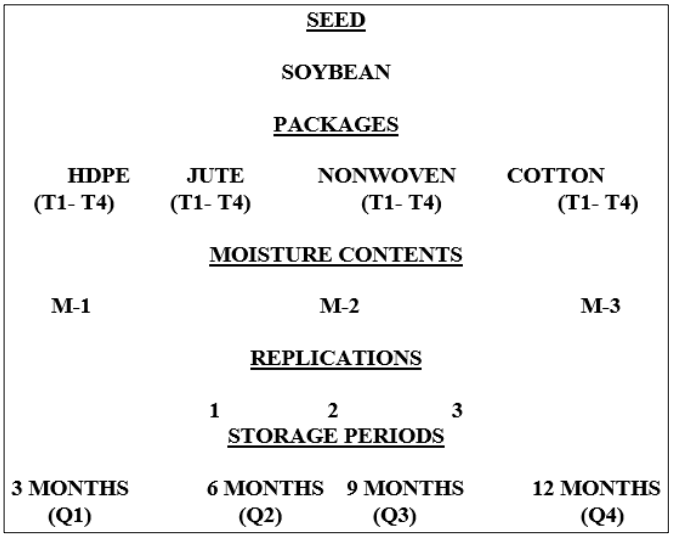

Fig 1: Experimental design for conducting seeds viability study in package storage

Seeds quality tests

Methodology of experiments conducted for measurement of Moisture Content & seed viability tests for fullfillment the purposes of objectives of this study discussed in detailed as below. A seeds package which was opened once 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, 6, 7] and American Society of Agricultural Engineers (Anon, 1988) [5, 6, 7] in a seeds testing lab. Samples of about 25 g were oven dried at 103 °C for 72 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 M

$$\text{Moisture content (M) (db)} = \frac{M_2 - M_{3\,x100}}{M2 - M1} = \frac{\text{Weight Loss} \times 100}{\text{Initial weight of seeds}}$$

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 of each seeds sample in replicate of each package was measured and the arithmetic mean was reported as moisture content of a seeds package.

Seed viability test

Measurement of seeds energy of germination

One hundred seeds of each sample of replication of each seeds package were planted in paper substratum for measurement the Energy of Germination of seeds. The substratum were kept in walk in germinator and maintained recommended temperature & relative Humidity same as germination test. Number of seedlings emerged after four days from date of planting the seeds in the germinator is measurement of Energy of Germination.

Measurement of seeds emergence rate

One hundred seeds of each sample of replication of each seeds package were planted in paper substratum. The substratum of all samples were kept in walk in germinator and maintained recommended temperature & relative humidity same as germination test. The Emergence Rate was calculated by a half of the sum of the number of seeds lings emerged after five days & eight days from day of planting the seeds in germinator.

$$\text{Emergence Rate} = \frac{\text{No of seed emerged after (5 days + 8 days)}}{2}$$

Measurement of seeds germination

Germination test was conducted by using 100 seeds of each replicate sample of a seeds package by the Between Paper (BP) method (Anon, 1985) [5, 6, 7], The test was conducted in walk in germinator in two stages, first sample was kept in a walk in germinator where temperature 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 temperature kept to maintain at 20 °C and near saturation relative humidity for 3 days. At the end of 8 days the number of normal seedlings of each sample counted and the percentage of seeds germination was calculated.

Measurement of seeds vigour

Seed Vigour is an important quality parameter, 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 seedling were measured and vigour index was calculated as shown as below:

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

Measurement of seeds infestation

During the experiment, none of seeds were observed insect infested and not seen living insects in sample. To measure the infestation level in different seeds 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.

Storage under ambient conditions

Seeds stored in experimental room (under ambient conditions) will not normally be exposed to constant temperatures or relative humidity. Accurate prediction of seed deterioration under changing environmental conditions would be of great value to seed Producers. In the present case, it is considered that the storage environment remains constant over a month period. Since most of the climatologically data available in the literature is on monthly basis.

Results and Discussion

Experiments were conducted to observe environmental effects on Viability & Moisture Content of seeds and Co-relation between package's property & seeds Viability under ambient conditions. The results of this study presented and discussed under the following main headings:

Air temperature and relative humidity in the storage space

The seeds, after packing in different packages, were stored over plastic pallets in a well- ventilated room situated at 1st floor in the corporate office building of NSC, New Delhi. Since storage environment effects the Moisture Content and Viability of the seeds stored in package, reliable meteorological data is required to simulate the process of seed storage. Relevant parameters of the storage environment like Air Temperature and Relative Humidity, were measured.

With the help of a data logger (LICOR 1000) inside maximum & minimum Temperature and maximum & minimum Relative Humidity values measured on daily basis. It is observed from the table No.1 that mean highest Relative Humidity of the room air was recorded 72.90%, in the month of January-18 while during same month outside air monthly mean Relative Humidity was 84.50% and found difference in mean air Relative Humidity during Jan-2018 only 11.60 %. It is observed from the table that monthly mean Relative Humidity of outside and inside air had about the same values except in a few months i.e. from January-17 to April-17, June-17 & Jan-18 there were slightly wide difference in Relative Humidity observed ranging minimum 4.85% and maximum 11.60%.

The monthly mean air temperatures of outside and inside the experimental room was recorded and shown in the Table No.2. This is observed from table that difference of 0.75 to 6.60 degree C was noted between monthly outside mean ambient air temperature and monthly inside mean air temperature in different months.

Table 1: Comparison of outside and inside ambient relative humidity during years 2016-17 and 2017-18

Month 1	RH outside (%)			RH inside (%)			RH difference (%)
	Max (Mean) 2	Min (Mean) 3	Average 4	Max (Mean) 5	Min (Mean) 6	Average 7	Col (4) - Col (7) = 8
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
Sep.-17	91.20	61.80	76.50	86.76	73.18	79.97	–3.47
Oct.-17	92.10	41.00	66.55	86.50	47.00	66.75	–0.20
Nov-17	90.10	49.80	69.95	79.20	46.20	62.70	+7.25
Dec-17	80.40	57.00	68.70	73.60	50.00	61.80	+6.90
Jan-18	99.00	70.00	84.50	80.40	65.40	72.90	+11.60

Table 2: Comparison between outside and inside ambient temperature during years 2016-17 and 2017-18

Month 1	Temp outside degree (C)			Temp inside degree (C)			Temp difference degree (C) Col (4) - Col (7) = 8
	Max (Mean) 2	Min (Mean) 3	Average 4	Max (Mean) 5	Min (Man) 6	Average 7	
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	- 1.55
Aug.-17	33.80	25.90	29.85	32.48	28.83	30.65	-0.80
Sep.-17	33,40	23.80	28.60	32.84	24.99	31.56	-2.96
Oct.-17	33.90	17.10	25.50	33.10	27.40	30.25	- 4.75
Nov-17	26.80	10.50	18.65	22.00	22.00	22.00	- 3.35
Dec-17	23.00	6.80	14.90	22.90	18.10	20.50	- 5.60
Jan.-18	25.00	7.50	16.25	22.30	17.00	19.65	- 3.40

Seeds moisture content and seed viability evaluation

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

Seeds moisture content

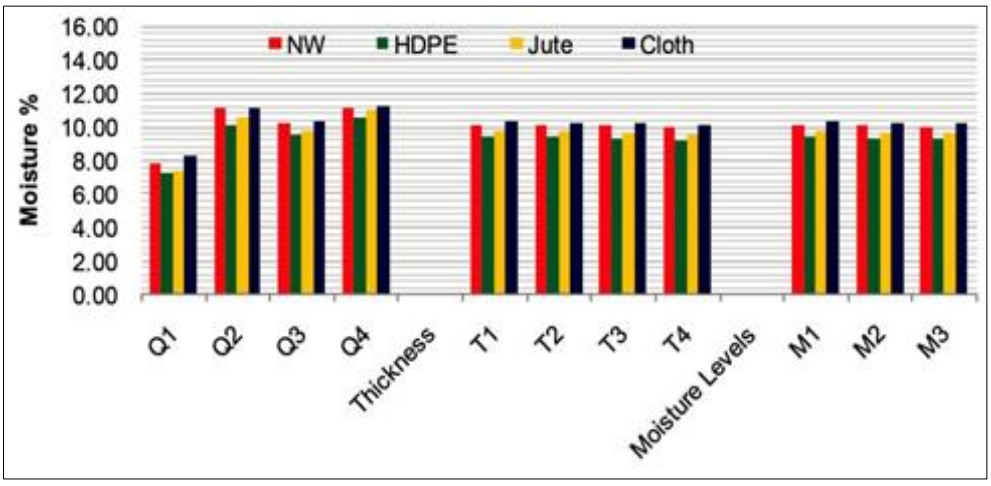

Fig 2: Effects of parameters used under study on seeds moisture content (%) during different periods of storage – soybean seeds

In case of Soybean seeds, minimum mean gained or lost of moisture content was found in seeds stored in package of HDPE & Jute fabrics and the magnitude of Moisture Content found in increasing order of seeds stored in other packages of fabrics like Cotton & Nonwoven at all levels of moisture content, all package thicknesses and for the storage period of all quarters in mean storage.

Seeds energy of germination

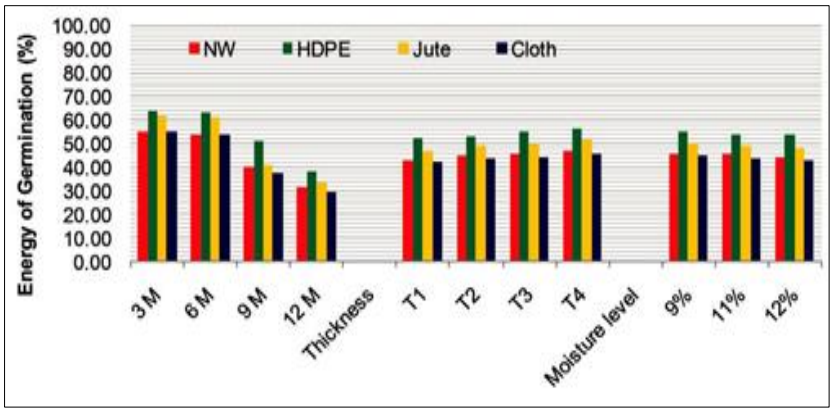

Fig 3: Effects of parameters used under study on energy of germination (%) during different periods of storage – soybean seeds

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

Seeds emergence rate

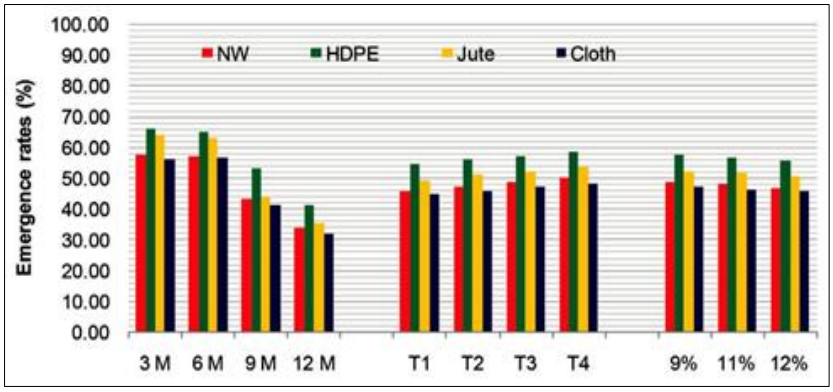

Fig 4: Effects of parameters used under study on seeds emergence rate (%) during different periods of storage – soybean seeds

The maximum mean Emergence Rate of Soybean seeds was found maintained of seeds stored in package of HDPE fabric during the entire period of storage under this study and found magnitude of mean Emergence Rate went on declined with respect to period of storage of Soybean seeds stored in other packages of fabrics namely Cotton, Nonwoven and Jute of all thicknesses at all levels of Moisture Content during period of mean storage of all quarters.

Seed germination percentage

The minimum seed certification level of germination is 70% for Soybean Seeds.

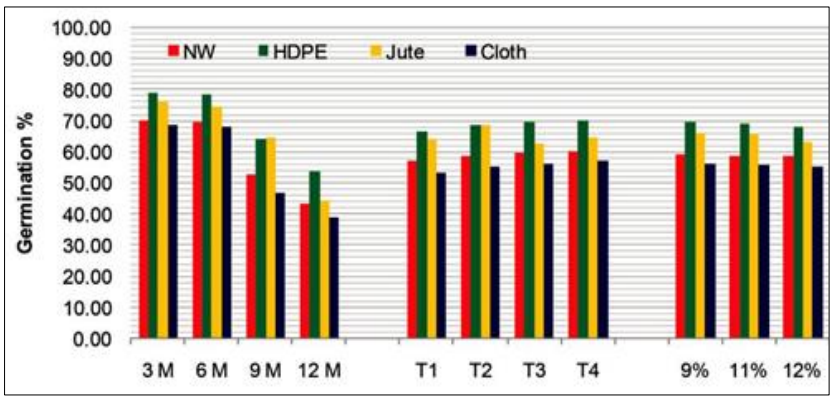

Fig 5: Effects of parameters used under study on seed germination % during different periods of storage-soybean seeds

The experimental evidence for the range of parameters studied and suggests that mean germination % of soybean seeds dependent on seed moisture content up to 9% to maintain minimum seed certification level (70%) for a period of one year in T-4 HDPE Packages (0.23 mm thick). Further, Soybean seeds could be stored in packages of all others fabric like jute, Nonwoven & Cotton up to 6 months at initial Moisture Content level below 12% without sacrificing

minimum seed certification level germination capability (70%) for plantation in nest forthcoming season stored in mean storage.

Seeds vigor

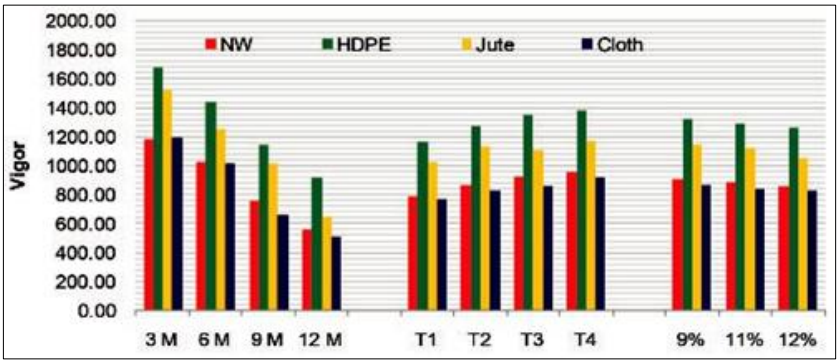

Fig 6: Effects of parameters used under study on seed vigor index during different periods of storage-soybean seed

It is concluded from this study that mean Vigor Index of Soybean seeds were found highest in seeds stored in HDPE package as compared to mean Vigor Index of seeds stored in other packages of fabrics used in this study like cotton, Nonwoven & Jute of all thicknesses at all initial Moisture Content levels during mean storage period of all quarters.

Insect infestation of seeds during storage

Insect infestation was not noticed in sample package during the period of study. Apparently, the seeds at the time of initial packing had no infestation and the infestation level remained constant till the end of the experiment. Since insects need oxygen to survive, the lack of oxygen eliminated the possibility of insect development.

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

Correlation between package's physical properties and viability of seeds during mean storage were studied. The parameters those were considered for the co-relation study like Thickness, Weight, Bursting Strength & Water Vapor Permeability of package's physical properties and seeds viability i.e. Germination Percentage & Vigor Index of soybean seeds. Effects of each package's property on other package's properties and seeds viability were studied. Effects are shown in below Table.

Table 3: Co-relation between package's physical properties and seeds viability of soybean seeds

Character	Thickness (mm)	Weight (gm)	Bursting strength (kg/sq.m)	Water vapour permeability g/(cm^2.Day)	Germination %	Vigour index
Thickness (mm)	1.000	0.927**	0.607**	0.366**	0.107	0.107
Weight (gm)		1.000	0.716**	0.375**	0.066	0.062
Bursting Strength (kg/sq.m)			1.000	-0.302*	0.283*	0.412**
Water vapour permeability g/(cm^2.Day)				1.000	-0.307*	-0.471**
Germination %					1.000	0.947**
Vigor 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 increase up to more than significant level 0.5 and water vapour permeability of packages decreased too up to the significant level below 0.5. The positive impact of increased of package's thickness was observed on s Germination & Vigor index of seeds stored in package.

Co-relation between packages weight and seeds viability

As weight increased, the bursting strength of packages also went on increase up to the significant level more than 0.5 and water vapour permeability of packages decreased too up to the significant level below 0.5 and observed its positive impact on Germination & Vigor index of seeds of Soybean crop stored in package.

Co-relation between packages's bursting strength and seeds viability

The significant effects of package's bursting strength on water vapour permeability was observed and found it went on decrease up to negative level below 0.5. The significant positive effects of Package's bursting strength was noted on seeds Germination & Vigor Index of seeds of soybean crop stored in package.

Co-relation between packages water vapour permeability and seeds viability

Water Vapour Permeability of package increased, the seeds Germination and Vigor Index of soybean seeds went on decrease significantly up to negative level below 0.5 of seeds of soybean crop stored in package.

It was observed from this study that Germination % & Vigor Index of seeds of Soybean crop stored in packages was influenced from package's Physical Properties. Seed viability of seeds of soybean crop stored in package was observed affected from each package's physical property those considered for this study. Package's Water Vapour Permeability has got significant impact on seeds Viability. The effects of package's Water Vapour Permeability was found inversely proportional to seeds Viability.

Suitable type and thickness of package for storage of soybean seeds to maintain minimum seeds certification standard of moisture content and germination % with respect to storage period under ambient condition

Study was conducted on Storage of seeds of Soybean crop in package. Package of various fabrics in different thicknesses were used to store seeds having different levels of initial Moisture Content. Seeds were stored in packages over plastic pallets in ventilated room under ambient conditions. Impact on seeds Viability and Moisture Content of seeds were studied up to a period of one year at the interval of each quarter. Test results of various experiments those conducted during study were recorded. Based on study, suitable packages which able to maintain minimum seeds certification standard of Moisture Content and Germination Percentage for storing of Soybean seeds with respect to storage period are recommended as under:

Suitable type and thickness of package for storage of soybean seeds to maintain safe moisture content level with respect to storage period under ambient condition

It concluded from this study that Moisture Content up to safe storage level (>-12%) of seeds of Soybean crop stored in package of HDPE fabric was better maintained as compared to seeds stored in packages used of other fabrics in this study with respect to storage period under ambient condition.

Suitable type and thickness of package for storage of seeds of soybean crop to maintain seeds certification level of germination % with respect to storage period

It concluded from this study that minimum seed certification standard of Germination Percentage (70%) can be maintained up to one year of seeds of Soybean crop stored in T-4 type (0.23 mm thick) HDPE package at 9% initial moisture content level under Ambient condition.

The Germination Percentage (70%) can be maintained up to the period of six months of seeds of Soybean crop stored in packages used of all fabrics at 12% Moisture Content level under ambient condition in package storage.

Conclusion

1. The minimum seed certification standard of Germination Percentage of seeds of soybean crop was maintained in all types of package used in study up to 6 months at not more than 12% initial Moisture Content (IMC) level and required certification standard of germination percentage of soybean seeds was maintained up to one year in T-4 (0.23 mm thick) type packages of HDPE fabric at 9% (IMC) level. Packages of HDPE fabric proved to be the best in maintaining high level of germination of seeds of Soybean crop because it minimized the moisture absorption and flow of oxygen during storage was able to maintain seed Viability for the longest period.
2. No insect infestation was observed in seeds of soybean crop 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. Packages of HDPE fabric is most suitable package 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.
3. The Moisture Content of stored seed increased and Germination Percentage decreased with an increased in Water Vapour Permeability. An increase in package film thickness reduced its Water Vapour Transmission rate and, thus, helped in maintaining the low initial Moisture Content and better Viability.
4. The Physical Properties of packages influenced the seeds Viability and Moisture Content of seeds. An effect of Water Vapour Permeability of packages was noted inversely proportional to seed Viability & Moisture Content of seeds and other properties of packages also observed to influence seeds Viability positively.

References

1. Abdullah M, Abdullah Alsadon A, Safwat khalid O, Mohamood Wahb-Allah A, Mahran El Nagar, Abdullah Ibrahim A 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. ArtID128105 2012.
11. Mahjabin etc. Physiological and Biological changes during Seeds Deteioration. A Review International Research of resent Scientific Research 6(4):3416-3422.
12. Mumtaj Khan M. International Journal of Agriculture and Biology 2004;6(4):708-711.
13. Garg MK. Prediction of Viability of Seeds stored in different packaging Materials, Ph.D Thesis, Division of Agril. Enineering, Indian Agril. Research Institute, New Delhi, India 1995.
14. International Seeds Testing Association (ISTA) held in Madrid 1977.