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ASSESSMENT OF PACKAGING MATERIALS FOR STORAGE EFFICIENCY AND SEED QUALITY OF GROUNDNUT PODS (*ARACHIS HYPOGEA* L.)

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ABSTRACT

This study aimed to assess the impact of different packaging materials for groundnut pods on seed quality parameters. The research was conducted at the Department of Seed Science and Technology, Seed Research and Technology Centre, Professor Jayashankar Telangana State Agricultural University, Hyderabad, India. Groundnuts from normal harvesting window with 8 % seed moisture content were collected in pod form were subjected to ambient storage for one year in various packaging materials. These pods were shelled monthly before conducting the seed quality tests, the resulting kernels were subjected to seed quality assessments, including seed moisture content, germination percentage, seedling dry weight, seed vigour index II, field emergence, and electrical conductivity, were performed using three replicates of 100 seeds each. Results revealed that seeds stored in polypropylene bags exhibited the highest germination rate, maintaining 75% after one year, whereas those stored in gunny bags (control) showed the lowest germination rate at 65% under similar conditions. The study found significant variation in germination rates across different packaging materials.
***Keywords*:** Groundnut, seed quality, packaging material, ambient storage

Introduction

Groundnut (*Arachis hypogaea* L.), also known as earthnut or monkey nut, is a tetraploid, self-pollinating legume belonging to the Fabaceae family. Often referred to as the "poor man's cashew nut," it is rich in oil (40–48%), protein (22–26%), carbohydrates (26%), fats (3%), minerals (such as calcium, phosphorus, magnesium, zinc, and iron), vitamins (E, K, and B-complex), antioxidants, and digestible fiber. Additionally, it provides around 30 other essential nutrients (Biswas and Bhattacharjee, 2019). Groundnut ranks as the second most cultivated oilseed crop in India, following mustard. In Telangana, major groundnut-growing districts include Nagarkurnool, Nalgonda, Wanaparthy, Gadwal, and Vikarabad, with a total cultivated area of 0.83 lakh hectares, a production of 1.98 lakh tonnes, and a productivity of 2,383 kg per hectare (Indiastat, 2023–24).

Seeds harvested in March and April experience a rapid decline in viability, with over 50% losing their viability within 4–5 months of storage (Radhakrishnan *et al.*, 2022). As groundnut is primarily grown as a Rabi season crop for seed purposes, it is vital to ensure the multiplication, storage, and timely availability of quality planting material for the next Rabi season. Preserving seed quality from harvest to the subsequent planting season is essential to maintain high germination rates and achieve economically viable seed production. Factors such as biological and environmental conditions, along with the timing and method of harvesting, significantly affect seed longevity. Furthermore, storage conditions including seed moisture content, initial seed quality, storage infrastructure, and packaging materials are critical for maintaining seed viability and quality (Dadlani, 2023).

Currently, groundnut seeds are typically stored in pod form in accordance with the Indian Minimum Seed Certification Standards (IMSCS), which involves bulk handling and necessitates large storage facilities. This storage approach, while standard, can limit the shelf life of the seeds, and any effort to extend the duration of seed viability would mark a significant step forward in reducing the cost of cultivation by ensuring a reliable, continuous supply of high-quality seeds.

The rate at which seed moisture content fluctuates, whether it decreases or increases, is heavily influenced by the type of storage container used. This, in turn, has a direct impact on the seed's longevity. For groundnut seeds, which are typically stored for 6 to 8 months before planting, the packaging material used plays a crucial role in preserving seed quality. Seed vendors often use a variety of packaging materials that vary in permeability *i.e.,* from fully permeable to completely impermeable. These variations significantly affect how the seeds retain moisture and air, influencing their overall storability, germination potential, and quality at the time of sowing.

In Telangana, groundnut seeds purchased from the open market often experience a decline in germination rates due to inadequate storage conditions. To address this challenge, an experiment has been designed to explore effective solutions. The primary objective of this experiment is to develop strategy that protects the viability of groundnut seeds, improving germination rates for those shelled prior to sowing. By evaluating different packaging materials in ambient conditions, the aim is to minimize losses in seed storability, ensure better seed quality and ultimately help improve crop yields. This research will provide valuable insights into the most effective packaging materials to enhance the longevity and viability of groundnut seeds in Telangana's agricultural sector.

Material and Methods

Experimental material, site and design

The study was carried out at the Department of Seed Science and Technology, Seed Research and Technology Centre, Professor Jayashankar Telangana State Agricultural University, Hyderabad, India. Bulk seed samples of the groundnut variety Kadiri Lepakshi (K-1812), with a moisture content of 8%, were freshly harvested from farmers' fields in the Nagarkurnool district of Telangana during the Yasangi (post-rainy) season. These samples were promptly procured and separately packed in different packaging materials for use in the experiment designed during *Kharif* 2021-2022 in Completely Randomized Block Design.

Treatments: 6

T1: Polypropylene bag

T2: Polylined gunny bag

T3: Triple layer PICS bag (Outer woven sack made up of Polypropylene & two 80µm thick inner liners made up of HDPE)

T4: Modified PICS bag (Outer woven sack made up of Polypropylene & one 80µm thick inner liner made up of HDPE)

T5: Malathion treated gunny bag

T6: Gunny bag (Control)

Seed Quality Parameters Recorded

The study on seed quality parameters was conducted following standard methods, with the parameters recorded as outlined below:

Seed Moisture Content (%)

Seed moisture content was determined using the oven-drying method for kernels, based on the dry weight approach (ISTA, 2021). Moisture content was calculated by measuring the weight loss of seeds after drying. A sample of 10 intact seeds weighing 10 g was subjected to a constant temperature of 103°C for 17 hours. The weight before and after drying was recorded, and the moisture content was calculated using the following formula:

$$\text{Moisture content (\%)} = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

M_1 = Weight of the metal container with lid (grams)

M_2 = Weight of the metal container with lid and sample before drying (grams)

M_3 = Weight of the metal container with lid and sample after drying (grams)

Germination (%)

Germination tests were conducted on 300 randomly selected seeds per treatment using the 'Between Paper Method' according to ISTA rules (ISTA, 2021). Seeds were placed on paper towels, rolled, and positioned vertically in a seed germinator set at 25 ± 1°C with a relative humidity of 95 ± 2%. On the 10th day, the number of normal seedlings (those with proper shoot and root development) was recorded. Germination percentage was calculated using the formula:

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds sown}} \times 100$$

Seedling Dry Weight (mg)

On the final day of germination testing, 10 seedlings were randomly selected from each replication, enclosed in butter paper covers, and dried in a hot air oven at 100 ± 1°C for 24 hours. The dried seedlings were then cooled in a desiccator for 30 minutes before being weighed on an electronic balance. The average weight was expressed in milligrams.

Seed Vigor Index II (SVI-II)

Seed Vigor Index II was calculated as per Abdul-Baki and Anderson (1973), using germination percentage and seedling dry weight with the formula:

Seedling vigor index II = Germination (%) x Seedling dry weight (mg)

Field Emergence (%)

Field emergence was assessed using 300 seeds per treatment across replications. The seeds were sown at a depth of 2.5-3.0 cm, covered with soil, and watered as needed. On the 10th day after sowing, the number of seedlings emerging 3 cm above the soil surface was recorded. Field emergence percentage was calculated using the formula:

$$\text{Field Emergence (\%)} = \frac{\text{Number of seedlings emerged}}{\text{Total number of seeds sown}} \times 100$$

Electrical Conductivity ($dSm^{-1}g^{-1}$)

Electrical conductivity was measured following ISTA (2020) guidelines. A random sample of 25 seeds was selected and weighed to two decimal places. The seeds were completely immersed in 50 ml of deionized water in beakers, which were then covered with aluminum foil. These beakers were placed in an incubator maintained at a temperature of 20±1°C for 24 hours. After incubation, the seed leachate was collected in a separate beaker, and the electrical conductivity was measured using a digital conductivity meter. The results were expressed in $dSm^{-1}g^{-1}$.

$$\text{Electrical Conductivity } (dSm^{-1}g^{-1}) = \frac{\text{Conductivity reading } (dSm^{-1}) \text{ - Background reading}}{\text{Weight of the replicate (g)}}$$

Statistical Analysis

The experiment was conducted in Factorial Completely Randomized Block Design (Gomez and Gomez, 1984) with three replications for the present investigation. The standard error of difference was calculated for each treatment effect, and the Critical Difference (CD) at a 5% probability level was determined to compare the mean differences among treatments. The data for parameters expressed as percentages were transformed into arcsine values prior to statistical analysis for all objectives in the study (Snedecor and Cochran, 1956).

Results and Discussion

Seed Moisture Content (%)

The data on seed moisture content influenced by different packaging materials for groundnut pods, presented in Table 1, are discussed here. The seed moisture content showed a gradual decline from 1 (7.86 %) to 12 (5.88 %) months after storage (MAS). Among the packaging materials evaluated, the lowest mean seed moisture content was recorded in the polypropylene bag (T1) at 6.86 %, followed by the polylined gunny bag (T2) at 6.89 %. The highest moisture content was observed in the triple-layer PICS bag (T3) at 7.40 %, followed by the modified PICS bag (T4) at 7.28 %, which were statistically at par with each other, and subsequently in the control, the gunny bag (T6), at 7.20 %. The interaction effect between packaging material and storage period was found to be statistically significant.

Germination (%)

Table 2 illustrates the impact of packaging materials on the germination percentage of groundnut pods. The mean germination percentage declined steadily as the storage duration increased, from 85 % at 1 month after storage (MAS) to 49 % at 12 MAS.

Among the packaging materials tested, the polypropylene bag (T1) demonstrated the highest mean germination percentage (75 %), significantly surpassing the Indian Minimum Seed Certification Standards (IMSCS) and showing a notable advantage over the control (gunny bag, T6), which recorded the lowest germination percentage at 65 %.

Among the other treatments, the triple-layer PICS bag (T3) and modified PICS bag (T4) exhibited germination percentages of 71 % and 70 %, respectively. The malathion-treated gunny bag (T5) and the control gunny bag (T6) followed with germination percentages of 67% and 65 %, respectively. Importantly, the interaction effects between packaging material and storage period were found to be statistically significant.

All treatments demonstrated an improvement in germination over the control, with the highest percentage increase (15 %) observed in seeds stored in the polypropylene bag (T1). This was followed by the triple-layer PICS bag (T3) at 9 %, the modified PICS bag (T4) at 8 %, the polylined gunny bag (T2) at 5 %, and the malathion-treated gunny bag (T5) at 3 %. These results clearly indicate that the polypropylene bag is the most effective packaging material for preserving groundnut seed germination (Table 3).

Seedling Dry Weight (mg)

The data in Table 3 highlight the impact of different packaging materials on the seedling dry weight of groundnut seeds stored in pod form. A gradual and significant reduction in mean seedling dry weight was observed as the storage period increased from 1MAS (383 mg) to 12 MAS (219 mg). The seedling dry weight ranged between 146 mg and 432 mg across the treatments.

Among the packaging materials tested, the polypropylene bag (T1) recorded the highest mean seedling dry weight (350 mg), whereas the lowest (228 mg) was observed in the control, the gunny bag (T6). Other treatments showed significant differences, with the triple-layer PICS bag (T3) at 339 mg, followed by the modified PICS bag (T4) at 316 mg, the polylined gunny bag (T2) at 308 mg and the malathion-treated gunny bag (T5) at 266 mg. The interaction effects between packaging material and storage duration were statistically significant, emphasizing the influence of both factors on seedling dry weight.

Seed Vigor Index II (SVI-II)

Table 4 presents the impact of different packaging materials on the seed vigour index II of groundnut pods. A gradual decline in mean seed vigour index II was observed as the storage period increased, decreasing from 32,393 at 1MAS to 10,799 at 12 MAS.

Among the packaging materials tested, the polypropylene bag (T1) recorded the highest mean seed vigour index II (25,986), followed by the triple-layer PICS bag (T3) at 24,603, the modified PICS bag (T4) at 22,589, and the polylined gunny bag (T2) at 21,479. The lowest mean vigour index II was observed in the control, the gunny bag (T6), at 15,285. The latter treatments were statistically similar. The interaction effects between packaging materials and storage duration were statistically significant, indicating a notable influence of both factors on seed vigour index II.

Field Emergence (%)

The data in Table 5. depict the percentage field emergence of groundnut pods as influenced by packaging materials. A gradual decline in mean field emergence was observed as the storage duration increased, dropping from 83 % at 1 MAS to 51 % at 12 MAS.

Across the packaging materials evaluated, seeds stored in polypropylene bags (T1) exhibited the highest mean field emergence (71 %), followed by the triple-layer PICS bag (T3) at 70 % and the modified PICS bag (T4) at 69 %. These treatments were significantly superior to the polylined gunny bag (T2), which recorded 68 %. The lowest mean field emergence was observed in the control, the gunny bag (T6), at 63 %. The interaction effects between packaging material and storage duration were statistically significant, emphasizing the combined influence of these factors on field emergence.

Electrical Conductivity ($dSm^{-1}g^{-1}$)

Table 6 presents data on the electrical conductivity (EC) of groundnut pods stored in different packaging materials over time. A steady increase in EC values was observed as the storage duration progressed, with the lowest mean EC recorded at 1 MAS (0.69 $dSm^{-1}g^{-1}$) and the highest at 12 MAS (1.64 $dSm^{-1}g^{-1}$).

Among the packaging materials evaluated, seeds stored in polypropylene bags (T1) exhibited the lowest mean EC (0.93 $dSm^{-1}g^{-1}$), followed by the triple-layer PICS bag (T3) at 1.00 $dSm^{-1}g^{-1}$. This was succeeded by the modified PICS bag (T4) at 1.15 $dSm^{-1}g^{-1}$, the polylined gunny bag (T2) at 1.20 $dSm^{-1}g^{-1}$, and the malathion-treated gunny bag (T5) at 1.30 $dSm^{-1}g^{-1}$. The highest mean EC was observed in the control, the gunny bag (T6), at 1.43 $dSm^{-1}g^{-1}$. The interaction effects between packaging material and storage duration were statistically significant, highlighting the combined influence of these factors on electrical conductivity.

The selection of packaging materials for groundnut storage can be guided by the intended storage duration and quality requirements (Xiaoji *et al.,* 2018). Consistent with these findings, Sharanappa *et al.* (2018) observed that seeds stored in gunny bags exhibited lower quality parameters, which were attributed to fluctuations in moisture content. These moisture variations were identified as a key factor accelerating seed deterioration. Similarly, Sharanappa (2018) also emphasized the importance of packaging materials, noting that groundnut pods stored in Purdue Improved Crop Storage (PICS) bags demonstrated superior performance in terms of germination percentage, seedling vigor, and reduced seed infection. Furthermore, seeds stored in pod form exhibited significantly lower mean moisture content and seed infection compared to those stored as kernels.

Seeds with 8 % moisture content were deemed suitable for medium-term storage (up to 9 months), while seeds with moisture levels of 4 % or below were found appropriate for longer storage periods, as reported by Sudini *et al.* (2014). The proportional increase in dry weight of germinating seedlings serves as an indicator of their future growth potential, as noted by Woodstock and Comb (1964). Low-vigor seeds showed reduced field emergence values, with aging and decreased vigor linked to factors such as lipid peroxidation, mitochondrial dysfunction, and diminished ATP production. Kapoor *et al.* (2010) further demonstrated that aging-induced seed deterioration resulted from biochemical changes.

The elevated electrical conductivity (EC) of seed leachate reflects increased cell membrane permeability, indicating higher respiration rates and metabolic activity essential for maintaining vigor during storage (Bhanuprakash *et al.,* 2010). Among the packaging materials tested in the present study, polypropylene bags exhibited the lowest EC, likely due to their semi-impermeable nature. These findings align with Vijayalakshmi *et al.* (2020), who reported that PICS bags recorded a low EC value (0.208 dS/m) during the initial month of storage in pod form, compared to the higher EC value (0.765 dS/m) observed in kernels stored in gunny bags after eight months, a difference attributed to variations in moisture permeability.

Conclusion

The study highlights the significant influence of packaging materials on the preservation of seed quality parameters in groundnut pods over varying storage durations. Among the packaging materials evaluated, those with semi-permeable and impermeable properties, such as polypropylene bags and triple-layer PICS bags, consistently demonstrated superior performance across multiple parameters, including seed germination, seedling vigor, field emergence, and reduced electrical conductivity. These materials effectively minimized moisture fluctuations, delayed seed deterioration, and preserved overall seed quality. Conversely, conventional materials like untreated gunny bags were less effective in maintaining seed quality over extended storage periods.

These findings also emphasize the importance of selecting appropriate packaging materials to optimize seed storage conditions and enhance seed longevity, particularly in tropical and subtropical climates. This research contributes valuable insights for seed storage management, promoting the adoption of improved packaging technologies to ensure sustainable agricultural practices and seed security.

Table 1 : Effect of packing material on seed moisture of groundnut pods over 12 months of storage

Seed Treatments	SEED MOISTURE CONTENT (%)												
	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	7 MAS	8 MAS	9 MAS	10 MAS	11 MAS	12 MAS	MEAN (T)
PS-T1	7.80	7.69	7.71	7.42	7.21	7.05	6.81	7.53	6.06	6.18	5.78	5.07	**6.86**
PS-T2	7.87	7.59	7.51	7.09	7.05	6.87	7.17	7.18	6.43	6.52	6.03	5.35	**6.89**
PS-T3	7.85	7.75	7.78	7.66	7.69	7.60	7.47	7.39	6.94	6.99	6.73	6.89	**7.40**
PS-T4	7.80	7.77	7.79	7.56	7.49	7.61	7.20	7.03	6.66	7.17	6.66	6.57	**7.28**
PS-T5	7.91	7.63	7.76	7.14	7.47	7.10	7.29	7.10	6.69	6.48	5.66	5.36	**6.97**
PS-T6	7.90	7.78	7.78	7.61	7.64	7.43	7.11	7.47	6.69	6.77	6.19	6.02	**7.20**
MEAN (SP)	**7.86**	**7.70**	**7.72**	**7.41**	**7.43**	**7.28**	**7.18**	**7.28**	**6.58**	**6.69**	**6.18**	**5.88**	
CV (%)	3.64												
$CD_{(0.05)}$	Treatments (T)					Storage Period (SP)					Interactions		
	0.128					0.181					0.444		

Note: SP- Storage Period, T- Treatments, PS- Pods in packing material, MAS- Months after storage,
T_1- Polypropylene bag, T_2- Polylined gunny bag, T_3- Triple layer PICS bag,
T_4- Modified PICS bag, T_5- Malathion treated gunny bag, T_6- Gunny bag (Control)

Table 2 : Effect of packing material on germination of groundnut pods over 12 months of storage

Seed Treatments	SEED GERMINATION (%)													(%) Percent increase Over control
	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	7 MAS	8 MAS	9 MAS	10 MAS	11 MAS	12 MAS	MEAN (T)	
PS-T1	87 (69)	84 (66)	83 (66)	81 (64)	78 (62)	76 (61)	73 (59)	70 (57)	64 (53)	62 (52)	60 (51)	57 (49)	**75 (60)**	15
PS-T2	84 (66)	80 (63)	77 (61)	76 (61)	74 (59)	71 (57)	68 (56)	64 (53)	61 (51)	58 (50)	53 (47)	49 (44)	**68 (56)**	5
PS-T3	86 (68)	83 (66)	82 (65)	80 (63)	79 (63)	73 (59)	72 (58)	66 (54)	63 (53)	60 (51)	57 (49)	53 (47)	**71 (58)**	9

PS-T4	85 (67)	82 (65)	81 (64)	78 (62)	77 (61)	72 (58)	71 (57)	65 (54)	62 (52)	59 (50)	56 (48)	51 (46)	**70 (57)**	8
PS-T5	83 (66)	78 (62)	76 (61)	74 (59)	72 (58)	70 (57)	68 (56)	63 (53)	61 (51)	57 (49)	55 (48)	42 (40)	**67 (55)**	3
PS-T6	82 (65)	77 (61)	75 (60)	73 (59)	71 (57)	69 (56)	66 (54)	62 (52)	60 (51)	55 (48)	47 (43)	39 (39)	**65 (54)**	-
MEAN (SP)	**85 (67)**	**81 (64)**	**79 (63)**	**77 (61)**	**75 (60)**	**72 (58)**	**70 (57)**	**65 (54)**	**62 (52)**	**59 (50)**	**55 (48)**	**49 (44)**		
CV (%)	3.06													
$CD_{(0.05)}$	Treatments (T)				Storage Period (SP)				Interactions					
	0.805				1.138				1.015					

Note: Figures in parenthesis are Arc Sine transformed values,
SP- Storage Period, T- Treatments, PS- Pods in packing material, MAS- Months after storage,
T_1- Polypropylene bag, T_2- Polylined gunny bag, T_3- Triple layer PICS bag,
T_4- Modified PICS bag, T_5- Malathion treated gunny bag, T_6- Gunny bag (Control)

Table 3 : Effect of packing material on seedling dry weight of groundnut pods over 12 months of storage

Seed Treatments	**SEEDLING DRY WEIGHT (mg)**												
	1 MAS	**2 MAS**	**3 MAS**	**4 MAS**	**5 MAS**	**6 MAS**	**7 MAS**	**8 MAS**	**9 MAS**	**10 MAS**	**11 MAS**	**12 MAS**	**MEAN (T)**
PS-T1	432	417	403	388	372	357	343	327	312	297	282	267	**350**
PS-T2	390	375	361	346	333	318	299	284	271	255	246	224	**308**
PS-T3	421	405	393	375	362	348	335	317	301	285	271	257	**339**
PS-T4	399	384	369	354	338	324	309	293	278	264	248	233	**316**
PS-T5	348	333	318	303	284	278	254	243	241	213	198	184	**266**
PS-T6	310	295	281	266	250	235	220	206	190	176	160	146	**228**
MEAN (SP)	**383**	**368**	**354**	**339**	**323**	**310**	**293**	**278**	**266**	**248**	**234**	**219**	
CV (%)	0.84												
$CD_{(0.05)}$	Treatments (T)					Storage Period (SP)					Interactions		
	1.185					1.676					4.105		

Note: SP- Storage Period, T- Treatments, PS- Pods in packing material, MAS- Months after storage,
T_1- Polypropylene bag, T_2- Polylined gunny bag, T_3- Triple layer PICS bag,
T_4- Modified PICS bag, T_5- Malathion treated gunny bag, T_6- Gunny bag (Control)

Table 4 : Effect of packing material on seedling vigor index II of groundnut pods over 12 months of storage

Seed Treatments	**SEEDLING VIGOUR INDEX II**												
	1 MAS	**2 MAS**	**3 MAS**	**4 MAS**	**5 MAS**	**6 MAS**	**7 MAS**	**8 MAS**	**9 MAS**	**10 MAS**	**11 MAS**	**12 MAS**	**MEAN (T)**
PS-T1	37,738	35,190	33,288	31,285	29,020	27,150	24,904	23,017	19,896	18,347	16,842	15,157	**25,986**
PS-T2	32,785	29,892	27,904	26,280	24,521	22,464	20,404	18,070	16,601	14,717	13,141	10,970	**21,479**
PS-T3	36,054	33,507	32,066	30,024	28,473	25,426	24,030	20,793	18,840	17,029	15,446	13,547	**24,603**
PS-T4	33,762	31,452	29,768	27,468	26,057	23,294	21,806	18,976	17,255	15,577	13,825	11,832	**22,589**
PS-T5	28,802	25,874	24,069	22,441	20,432	19,343	17,243	15,240	14,612	12,147	10,895	7,655	**18,230**
PS-T6	25,219	22,629	21,053	19,299	17,680	16,152	14,524	12,766	11,364	9,606	7,492	5,635	**15,285**
MEAN (SP)	**32,393**	**29,758**	**28,025**	**26,133**	**24,364**	**22,305**	**20,485**	**18,144**	**16,428**	**14,570**	**12,940**	**10,799**	
CV (%)	4.54												
$CD_{(0.05)}$	Treatments (T)					Storage Period (SP)					Interactions		
	451.8					638.9					1565.1		

Note: SP- Storage Period, T- Treatments, PS- Pods in packing material, MAS- Months after storage,
T_1- Polypropylene bag, T_2- Polylined gunny bag, T_3- Triple layer PICS bag,
T_4- Modified PICS bag, T_5- Malathion treated gunny bag, T_6- Gunny bag (Control)

Table 5 : Effect of packing material on field emergence of groundnut pods over 12 months of storage

Seed Treatments	FIELD EMERGENCE (%)												
	1 MAS	**2 MAS**	**3 MAS**	**4 MAS**	**5 MAS**	**6 MAS**	**7 MAS**	**8 MAS**	**9 MAS**	**10 MAS**	**11 MAS**	**12 MAS**	**MEAN (T)**
PS-T1	85 (67)	84 (63)	81 (64)	78 (62)	76 (61)	73 (59)	71 (57)	67 (55)	65 (54)	60 (51)	58 (50)	57 (49)	**71 (58)**
PS-T2	81 (64)	80 (63)	78 (62)	74 (59)	72 (58)	70 (57)	67 (55)	65 (54)	62 (52)	56 (48)	53 (47)	52 (46)	**68 (55)**
PS-T3	84 (66)	83 (66)	79 (63)	77 (61)	75 (60)	72 (58)	70 (57)	66 (54)	64 (53)	62 (52)	57 (49)	56 (48)	**70 (57)**
PS-T4	83 (66)	82 (65)	80 (63)	75 (60)	73 (59)	71 (57)	68 (55)	64 (53)	63 (53)	58 (50)	55 (48)	53 (47)	**69 (56)**
PS-T5	82 (65)	76 (61)	73 (59)	71 (57)	69 (56)	67 (55)	65 (54)	62 (52)	61 (51)	57 (49)	54 (47)	45 (42)	**65 (54)**
PS-T6	80 (63)	75 (60)	72 (58)	70 (57)	68 (56)	66 (54)	63 (53)	60 (51)	58 (50)	55 (48)	47 (43)	41 (40)	**63 (53)**
MEAN (SP)	**83 (65)**	**80 (63)**	**77 (62)**	**74 (59)**	**72 (58)**	**70 (57)**	**67 (55)**	**64 (53)**	**62 (52)**	**58 (50)**	**54 (47)**	**51 (45)**	
CV (%)	2.87												
$CD_{(0.05)}$	Treatments (T)					Storage Period (SP)					Interactions		
	0.742					1.050					1.102		

Note: Figures in parenthesis are Arc Sine transformed values,
SP- Storage Period, T- Treatments, PS- Pods in packing material, MAS- Months after storage
T_1- Polypropylene bag, T_2- Polylined gunny bag, T_3- Triple layer PICS bag,
T_4- Modified PICS bag, T_5- Malathion treated gunny bag, T_6- Gunny bag (Control

Table 6 : Effect of packing material on electrical conductivity ($dSm^{-1}g^{-1}$) of groundnut pods over 12 months of storage

Seed Treatments	ELECTRICAL CONDUCTIVITY ($dSm^{-1}g^{-1}$)												
	1 MAS	**2 MAS**	**3 MAS**	**4 MAS**	**5 MAS**	**6 MAS**	**7 MAS**	**8 MAS**	**9 MAS**	**10 MAS**	**11 MAS**	**12 MAS**	**MEAN (T)**
PS-T1	0.63	0.74	0.79	0.82	0.85	0.88	0.91	0.94	0.96	1.09	1.12	1.37	**0.93**
PS-T2	0.7	1.01	1.06	1.09	1.12	1.15	1.18	1.21	1.23	1.36	1.39	1.86	**1.20**
PS-T3	0.66	0.82	0.87	0.9	0.93	0.96	0.99	1.02	1.04	1.17	1.2	1.39	**1.00**
PS-T4	0.69	0.97	1.02	1.05	1.08	1.11	1.14	1.17	1.19	1.32	1.35	1.54	**1.15**
PS-T5	0.78	1.11	1.16	1.19	1.22	1.25	1.28	1.31	1.53	1.46	1.59	1.68	**1.30**
PS-T6	0.68	1.26	1.31	1.34	1.37	1.4	1.43	1.46	1.58	1.61	1.74	1.98	**1.43**
MEAN (SP)	**0.69**	**0.99**	**1.04**	**1.07**	**1.10**	**1.13**	**1.16**	**1.19**	**1.26**	**1.34**	**1.40**	**1.64**	
CV (%)	4.79												
$CD_{(0.05)}$	Treatments (T)					Storage Period (SP)					Interactions		
	0.026					0.037					0.09		

Note: SP- Storage Period, T- Treatments, PS- Pods in packing material, MAS- Months after storage,
T_1- Polypropylene bag, T_2- Polylined gunny bag, T_3- Triple layer PICS bag,
T_4- Modified PICS bag, T_5- Malathion treated gunny bag, T_6- Gunny bag (Control)

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