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EFFECT OF MACHINE HARVEST ON STORABILITY OF GROUNDNUT SEEDS IN DIFFERENT STORAGE ENVIRONMENT

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ABSTRACT

Groundnut is an important oilseed crop worldwide; Seed quality is the direct determinant of crop yield. Mechanization becomes inevitable in the countries India. At the same time, handling the seeds with machine during harvest causes the damage in the initial seed quality. The initial seed quality decides the storability of the seeds. This experiment was conducted to study the effect of machine harvest on storability of the seeds. The seeds were harvested manually and with machine at physiological maturity and harvestable maturity stages and stored in ambient and cold storage conditions. Results revealed that the seeds harvested manually at physiological maturity stage and stored in cold storage recorded the maximum storability of the seeds for 8 months. At the same time, the seeds machine harvested at physiological maturity and stored in cold storage also recoded the 70 % germination (Indian Minimum germination standard for Groundnut) for 7 months. Hence where ever the machine harvest is necessary, the seeds could be stored in cold storage to maintain the seed quality.

KEYWORDS: Groundnut, machine harvest, seed quality, maturity stages.

INTRODUCTION

Peanut or groundnut (*Arachis hypogaea*) is a species in the legume or "bean" - (Fabaceae) family. India is the second-largest producer of groundnuts in the world. Ground Nuts are important protein crops in India grown mostly under rain-fed conditions. India produced 130.74 lakh tonnes of groundnut in year 2025-26. Groundnut seeds have a thin, fragile seed coat (testa) and an exposed radicle tip that are highly vulnerable to impact, abrasion, and crushing during mechanical digging, stripping, or shelling. Improper cylinder speeds or tight clearances in threshers lead to split kernels, skin abrasions, and internal micro-cracks. (Baskin 1970). Machine harvesting of groundnut (including tractor-driven diggers, lifters, and multi-crop threshers) significantly influences initial seed quality and long-term storability. Storing the groundnut seeds from harvest to the next sowing season with the required vigour and viability is a huge challenge in successful seed production.

MATERIALS AND METHODS

The groundnut seed crop was raised and one portion of the crop was harvested manually at physiological maturity stage and harvestable maturity stage, stripped and decorticated manually and used as basic material for storage study. The another portion of the crop was harvested by using machine (Groundnut digger and stripper) and threshed using decorticator. This material also used as basic material for this storage study. Mechanically shelled and manually shelled seeds were stored under controlled environments of 20° and 75 % relative humidity (Cold storage) and in an unconditioned warehouse (ambient) at State Coimbatore, India. All seed were treated with recommended fungicides prior to testing. The stored seeds were evaluated for its viability and vigour at monthly intervals by drawing the samples stored in different storage condition. The germination test of this seeds was conducted by placing 400 seeds in four replications with 100 seeds each in sterilized sand medium (ISTA, 2013) and evaluated on final count day *i.e.* on 10^{th} day. Seedling length was measured in randomly selected ten seedlings during the evaluation of the germination test. The vigour index I was calculated by multiplying the germination percentage and seedling length (Abdul-Baki and Anderson, 1973). The vigour index II was calculated by multiplying the germination percentage and seedling dry matter (Abdul-Baki and Anderson, 1973). Electrical conductivity of seed leachate was measured in the seeds placed for storage (Presley, 1958).

The data collected were subjected to statistical analysis and the critical difference values were calculated at 5 per cent probability level (Gomez and Gomez, 1984).

Table 1. Effect of manual and machine harvest, stage of harvest and storage conditions on seed moisture content (%) during storage

Treatments	Initial	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	240 DAS	Mean

Manual harvest at physiological maturity stage and store at ambient	7.8	7.9	8.2	8.7	8.9	9.2	9.2	9.3	9.3	8.7
Manual harvest at harvestable maturity stage and stored at ambient	7.8	8.1	8.5	8.9	9.1	9.4	9.5	9.5	9.5	8.9
Machine harvest at physiological maturity stage and stored in cold storage	7.8	8.0	8.1	8.9	9.1	9.5	9.7	9.8	9.9	9.0
Machine harvest at harvestable maturity stage at ambient	7.8	8.2	8.7	9.1	9.3	9.7	9.8	9.8	9.9	9.1
Manual harvest at physiological maturity stage and stored in cold storage	7.8	7.8	8.1	8.4	8.8	9.1	9.3	9.4	9.5	8.7
Manual harvest at harvestable maturity stage and stored in cold storage	7.8	7.9	8.3	8.6	8.9	9.3	9.4	9.5	9.5	8.8
Machine harvest at physiological maturity stage and stored in cold storage	7.8	8.0	8.3	8.9	9.1	9.4	9.5	9.6	9.6	8.9
Machine harvest at harvestable maturity stage and stored in cold storage	7.8	8.1	8.3	9.0	9.2	9.5	9.6	9.7	9.7	9.0
Mean	7.8	8.0	8.3	8.8	9.1	9.4	9.5	9.6	9.6	8.9
	T	M	T' M							
SE.d	0.12	1.11	2.21							
CD (P=0.05)	0.22	2.21	4.20							

Table 2. Effect of manual and machine harvest, stage of harvest and storage conditions on seed germination (%) during storage

Treatments	**Initial**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**180 DAS**	**210 DAS**	**240 DAS**	**Mean**
Manual harvest at physiological maturity stage and store at ambient	92	88	82	78	73	67	58	49	37	69
Manual harvest at harvestable maturity stage and stored at ambient	89	84	80	77	71	63	55	45	33	66
Machine harvest at physiological maturity stage and stored in cold storage	88	82	78	76	72	65	56	46	35	66
Machine harvest at harvestable maturity stage at ambient	85	80	72	73	70	63	53	43	30	63
Manual harvest at physiological maturity stage and stored in cold storage	92	90	87	84	81	80	77	73	70	82
Manual harvest at harvestable maturity stage and stored in cold storage	89	87	86	84	80	78	76	71	67	80
Machine harvest at physiological maturity stage and stored in cold storage	88	88	85	82	79	77	75	70	66	79
Machine harvest at harvestable maturity stage and stored in cold storage	85	83	81	78	76	73	72	68	63	75
Mean	89	85	81	79	75	71	65	58	50	73
	T	M	T' M							
SE.d	1.4	1.4	4.8							
CD (P=0.05)	2.8	2.8	9.7							

Table 3. Effect of manual and machine harvest, stage of harvest and storage conditions on seedling length (cm) during storage

Treatments	**Initial**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**180 DAS**	**210 DAS**	**240 DAS**	**Mean**
Manual harvest at physiological maturity stage and store at ambient	41.4	39.7	36.5	31.6	25.3	23.5	21.4	20.0	17.6	28.6

Manual harvest at harvestable maturity stage and stored at ambient	40.5	38.2	35.6	30.2	25.0	22.4	20.3	19.0	16.6	27.5
Machine harvest at physiological maturity stage and stored in cold storage	40.2	38.7	35.7	31.1	25.9	23.2	21.0	20.1	17.7	28.2
Machine harvest at harvestable maturity stage at ambient	40.1	37.4	34.4	30.0	23.6	21.2	19.1	18.2	15.5	26.6
Manual harvest at physiological maturity stage and stored in cold storage	41.4	40.7	38.5	34.0	32.5	29.3	27.2	26.8	24.4	32.8
Manual harvest at harvestable maturity stage and stored in cold storage	40.5	39.5	37.6	33.1	31.3	29.0	26.8	25.5	23.1	31.8
Machine harvest at physiological maturity stage and stored in cold storage	40.2	39.1	37.0	32.9	30.5	29.1	28.0	26.1	23.7	31.8
Machine harvest at harvestable maturity stage and stored in cold storage	40.1	38.9	36.7	32.2	30.0	28.5	26.4	25.3	22.7	31.2
Mean	40.6	39.0	36.5	31.9	28.0	25.8	23.8	22.6	20.2	29.8
	T	M	T'M							
SE.d	0.32	0.32	1.15							
CD (P=0.05)	0.65	0.65	2.31							

Table 4. Effect of manual and machine harvest, stage of harvest and storage conditions on seedling dry matter production (gm/seedling^{-10}) during storage

Treatments	**Initial**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**180 DAS**	**210 DAS**	**240 DAS**	**Mean**
Manual harvest at physiological maturity stage and store at ambient	3.82	3.82	3.76	3.66	3.49	3.07	2.51	2.02	1.89	3.12
Manual harvest at harvestable maturity stage and stored at ambient	3.86	3.56	3.75	3.58	3.25	2.81	2.27	2.03	1.78	2.99
Machine harvest at physiological maturity stage and stored in cold storage	3.81	3.81	3.75	3.56	2.88	2.52	2.01	1.85	1.62	2.87
Machine harvest at harvestable maturity stage at ambient	3.78	3.77	3.65	3.52	2.33	2.11	1.85	1.52	1.42	2.66
Manual harvest at physiological maturity stage and stored in cold storage	3.83	3.83	3.79	3.70	3.65	3.31	3.07	2.52	2.48	3.35
Manual harvest at harvestable maturity stage and stored in cold storage	3.82	3.80	3.74	3.64	3.45	3.20	2.85	2.31	2.18	3.22
Machine harvest at physiological maturity stage and stored in cold storage	3.81	3.80	3.76	3.60	3.39	3.18	2.77	2.33	2.05	3.19
Machine harvest at harvestable maturity stage and stored in cold storage	3.82	3.81	3.71	3.57	3.22	3.02	2.64	2.22	1.98	3.11
Mean	3.82	3.78	3.74	3.60	3.21	2.90	2.50	2.10	1.93	3.06
	T	M	T'M							
SE.d	0.23	0.23	1.19							
CD (P=0.05)	0.47	0.47	2.27							

Table 5. Effect of manual and machine harvest, stage of harvest and storage conditions on vigour index I during storage

Treatments	Initial	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	240 DAS	Mean
Manual harvest at physiological maturity stage and store at ambient	3811	3495	2995	2468	1845	1577	1243	982	650	2118
Manual harvest at harvestable maturity stage and stored at ambient	3607	3210	2844	2327	1772	1414	1118	855	547	1966
Machine harvest at physiological maturity stage and stored in cold storage	3533	3175	2782	2367	1867	1505	1177	926	621	1995
Machine harvest at harvestable maturity stage at ambient	3411	2995	2475	2186	1653	1337	1011	783	466	1813
Manual harvest at physiological maturity stage and stored in cold storage	3811	3666	3351	2858	2634	2346	2094	1955	1711	2714
Manual harvest at harvestable maturity stage and stored in cold storage	3607	3438	3233	2778	2503	2260	2040	1813	1548	2580
Machine harvest at physiological maturity stage and stored in cold storage	3533	3442	3147	2694	2410	2242	2098	1828	1566	2551
Machine harvest at harvestable maturity stage and stored in cold storage	3411	3227	2975	2513	2276	2082	1900	1718	1431	2393
Mean	3591	3331	2975	2524	2120	1845	1585	1358	1067	2266
	T	M	T'M							
SE.d	47.2	47.2	182							
CD (P=0.05)	94.6	94.6	363							

Table 6. Effect of manual and machine harvest, stage of harvest and storage conditions on vigour index II during storage

Treatments	Initial	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	240 DAS	Mean
Manual harvest at physiological maturity stage and store at ambient	186	198	231	284	372	485	582	627	658	403
Manual harvest at harvestable maturity stage and stored at ambient	213	224	256	307	388	469	573	612	637	409
Machine harvest at physiological maturity stage and stored in cold storage	226	238	271	326	414	495	601	648	681	433
Machine harvest at harvestable maturity stage at ambient	232	245	278	355	443	526	632	682	717	457
Manual harvest at physiological maturity stage and stored in cold storage	186	195	218	256	324	390	432	465	484	328
Manual harvest at harvestable maturity stage and stored in cold storage	213	217	242	279	347	406	449	477	498	348
Machine harvest at physiological maturity stage and stored in cold storage	226	231	255	291	364	426	467	503	526	365
Machine harvest at harvestable maturity stage and stored in cold storage	232	236	259	301	371	437	473	515	531	373
Mean	214	223	251	300	378	454	526	566	592	389
	T	M	T'M							
SE.d	6.4	6.4	24.1							

CD (P=0.05)	12.9	12.9	48.1							

RESULTS

Moisture content (%)

Moisture content significantly increased during storage irrespective of harvest method and storage condition. The initial moisture content of 7.8 % increased up to 8.9 % after 8 months of storage (Table 1). Between the harvesting method, machine harvested seeds recorded the much increase in moisture (9.9%) compared to manual harvested seeds (9.3 %) during this 8 month of storage. This indicates the minute damages caused by the machines during the harvest (digging, threshing) and post-harvest (decortication) operation. These damages either in seed coat or in seed internal tissues, makes the seed susceptible to absorb moisture during storage from the environment based on the degree of damage. Increase in seed moisture during the storage has the influence in the seed deterioration and it reflects in the seed quality parameters such as germination percentage, vigour index and electrical conductivity. The biological activity in the seeds had enhanced due to higher moisture content and also causes excessive heating; further promoting insect activities and mould growth. Reliable packaging materials, relative humidity (RH), temperature and seed moisture content (SMC) highly influence the seed longevity in storage (McDonald, 1999; Murdock et al., 2012; Bakhtavar et al., 2019b) but seed SMC is one of the most important factors that affect seed quality in storage (Bradford et al., 2018). Bewley et al., (2013) pointed out that high moisture content during storage as a greatest risk for seed quality.

Germination (%)

Manual harvest and machine harvest significantly differ in seed germination. The stage of harvest and storage environment also having major role in maintaining the seed viability. Germination is the most important function of a seed as an indicator of its viability and worth as a seed (Akter *et al.,* 2014). Germination testing is an essential tool used to assess seed viability and to predict the field performance of a seed lot. Low germination is the very first sign of seed deterioration after storage and ultimately describes loss of seed vigour and viability (Afzal *et al.,* 2017). Compared to cereals, oilseeds lose viability very fast; therefore, pest and disease-free and optimum storage condition is needed to retain their viability for a longer period. The seeds harvested manually and at physiological maturity stage and stored in cold storge maintained the 70 % germination at 8 months after storage (Table 2). Whereas seeds harvested with machine at harvestable maturity stage and stored in ambient condition recorded the least germination of 30 %. Irrespective of the method of harvest, the seeds stored under cold storage in cold storage, maintained the Indian minimum seed certification standard of 70 % for germination for a period of 6 months whereas the seeds stored in ambient maintained this standard only for 4 months. Mechanical injuries inflicted during harvest or mechanical shelling drastically shorten storage life. Wounded tissues respire faster, leak nutrients, and provide easy entry points for storage fungi and insects

Seedling length (cm) and dry matter production (mg/ seedlings $^{-10}$)

Seedling length and dry matter production are is the marker traits that indicates the seed deterioration status. During the initial evaluation, manual and machine harvest and harvest at physiological and harvestable maturity recorded the similar seedling length (Table 3) and dry matter production (Table 4). But the deterioration trend varies by the handling and storage environment. Up to 3 months of storage, the manual and machine harvested seeds, harvested at physiological and harvestable maturity and stored in ambient condition and cold storage recorded similar deterioration pattern (Table 3&4). After 3 months of storage, the machine harvested seeds at harvestable maturity and stored in ambient recorded faster deterioration and resulted in lowest seedling length of 15.5 cm at 8 months of storage when compare to manual harvest at physiological maturity stage and stored in cold storage (24.4 cm) (Table 3). The same trend observed in dry matter production also (Table 4). The machine harvested seeds at harvestable maturity and stored in ambient recorded faster deterioration and resulted in lowest dry matter production of 1.42 (mg / seedlings $^{-10}$) at 8 months of storage when compare to manual harvest at physiological maturity stage and stored in cold storage (2.48 mg/ seedlings $^{-10}$) (Table 4).

Seed vigour

Seed vigour differs significantly during storage. Manual harvested seeds at physiological maturity and stored in cold storage recorded the maximum vigour index I of 1711 (Table 5) and vigour index II of 174 (Table 6) after 8 months of storage. At the same time the seeds harvested with machine at harvestable maturity and stored in ambient recorded the lowest seed vigour index I of 466 and vigour index II of 43. This indicates the effect of harvest method, stage of harvest and storage environment. All these factors plays crucial role and contributes significantly in seed deterioration. Manual harvest at physiological maturity and stored at different storage environment have significant difference in vigour index. Manual harvest at physiological maturity and stored at ambient recorded the vigour index of 650 whereas the same seed stored in cold storage at 5^0c recorded the vigour index of 1711 (Table 5). Regardless of manual or machine harvest, and stage of harvest, the seeds stored in cold storage recorded the high vigour index between 1431 to 1711. This indicates the role of storage environment. Manual harvest at harvestable maturity and stored in cold storage recorded the vigour index of 1548 and machine harvest at harvestable maturity and stored in cold storage recorded the vigour index of 1431 (Table 5). This is the effect of machine harvest over manual harvest. This reduction in vigour index indicates the damage caused by machine harvest and its result in seed storability.

Undamaged machine-harvested lots (when equipment is properly adjusted for speed and soil moisture) can retain high initial germination and vigor comparable to manual harvesting. However, excessive impact force reduces initial germination percentage, increases electrical conductivity (due to electrolyte leakage from damaged cell membranes), and lowers seedling emergence (Baskin, C. C. and Delouche, James C., 2021). Machine-damaged seeds deteriorate exponentially faster when stored under high relative humidity (above 70–80%) and warm ambient temperatures. Keeping

seed moisture low (around 6–8%) and utilizing cool or hermetic storage conditions (such as PICS bags or controlled cold storage) is critical to preserving viability in machine-handled lots. While high-quality, unshelled, or gently handled groundnuts can maintain viability for 8-10 months under cool and dry conditions (10-15°C and 65-70% relative humidity), mechanically damaged or mechanically shelled lots lose viability within a fraction of that time-especially if relative humidity exceeds 80%

CONCLUSION

The machine harvest is causing initial seed damage and it affects the seed storability. But when the machine harvest is unavoidable, the seed quality can be maintained by storing it in cold storage condition.

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