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Study of some physiological and biochemical changes of Greengram seeds in three different storage containers

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Abstract
The Physiological and biochemical seed vigour changes such as brick gravel test; Tetrazolium staining test, changes in protein content and reducing sugar are occurred in seeds during storage. Literature reported that these changes mainly depend upon the type of storage containers, variety of the seeds used and storage conditions. In the present study three different bags Cotton bag (C1), Jute bag (C2) and Polythene bag (C3) of were used for the storage of greengram seed of three different varieties Gujarat 4 (V1), GAM 5 (V2) and Virat (V3) under ambient temperature and relative humidity for a period of 18 months. The seeds from each container were taken after 3 months (90 days) and examined for different physiological and biochemical observations.

Seed stored in polythene bag (C3) showed significantly higher brick gravel test germination (59.32%) as compared to those stored in jute bag (C2) (57.39 %) and cotton bag (C1) (54.28%) up to 540 days (T7) of the storage. Seed stored in polythene bag (C3) showed significantly higher value of Tetrazolium staining percentages (74.12%) as compared to those stored in cotton bag (C1) (68.87%) and jute bag (C2) (67.86%) up to 540 days (T7) of the storage. Maximum value for Tetrazolium staining percentages (74.12%) was observed in Gujarat-4 variety, followed by GAM-5 and Virat as 71.19% and 62.52% respectively at the end of 540 days of storage. The seed protein content was decreased in all three varieties Gujarat-4, GAM-5 and Virat i.e., 20.29%, 19.77% and 20.18% respectively after 540 days of storage. Seeds stored in polyethylene bag recorded maximum protein content as compared to cotton and jute bag. The reducing sugar content was decreased significantly in Gujarat-4, GAM-5 and Virat (0.97 %, 0.89% and 1.01%, respectively) after 540 days of storage. Seeds stored in polyethylene bag recorded maximum reducing sugar compared to cotton and jute bag at the end of storage. Thus, Gujarat 4 variety showed least effect on brick gravel germination and Tetrazolium staining and protein content during storage as compared to GAM 5 and Virat.

Keywords: Biochemical, brick gravel, greengram, physiological, protein content, reducing sugar, storage containers, tetrazolium staining

1. Introduction
Seed storage is a principal part of seed production programme. Seeds of many field crops are produced with greater care and cost. Hence, a good storage is essential to keep them alive and vigorous until required for subsequent sowing season. High temperature and high humidity conditions which are the common ambient feature of subtropical and tropical areas, induced deterioration of seed quality. Although several reviews are available on the loss of seed viability during storage and its assessment has been standardized. Greengram; the raw materials for vegetarian protein, occupy a significant place in India's national economy. According to FAO estimate, 70 per cent of human food comprises cereals and legumes and the remaining 30 per cent comes from animal [1]. Per capita net availability of pulses in India, however, has reduced from 51.1 g/day in 1971 to 47.2 g/day in 2014 as against World Health Organization recommendation of 80 g/day [2]. This raises questions about the nutritional aspect as pulses are considered to be 'poor man's protein'.

Pulses are commonly known as food legumes which are secondary to cereals in production and consumption in India. The total area covered under Greengram in India was 43.47 lakh hectares with a total production of 21.23 lakh tonnes. The coverage of area and its production was maximum in Rajasthan (43.77% & 44.03%) followed by Maharashtra (9.71 %) and Karnataka (9.05%) of the total area. Gujarat state covers 1.36 lakh hectares area which is 3.14% of total area of India with 9th position. Production of pulses in India has declined during the last three decades. The main reason for this can be traced to low productivity per hector. In South region of Gujarat state, Greengram crop are harvested in June. The seeds of greengram crops are stored for 7-8 months prior to sowing. The demand for seed is fluctuating and very often there are large surplus stocks of seed which need to be preserved till the time of next sowing.

Such left-over seed experience in the hot and humid monsoon month, would significantly decline physiological and biochemical properties.

One of the chief factors that affect the quality of seed is vigor. Seed vigour and viability illustrated by sigmoid curve. Although literatures were explained that seed sustainability reducing throughout storage and its assessment has been standardized. Seed ageing responsible to reduce seed germination [3]. Brick gravel test and Tetrazolium staining percentages are mainly performed to evaluating the quality of seeds. It is perform under the optimum growth conditions of specific seed varieties [4].

Pulses are more difficult to store than cereals and suffer much greater damage from insects and microorganisms [5]. The post-harvest losses of food grains are estimated to be 10 to 20% in India. India experiences severe losses in the storage of food grains, as per the official records economic loss to the tune of 11,700 tons of food grains was reported to have occurred in the government godowns during 2010 alone [6]. The decrease in the quality of greengram seeds is usually caused by lost in viability and change of relatively high protein and carbohydrate content in the seeds, increasing of moisture content of the seeds if the temperature and humidity of the storage environment are relatively high (Patel, 2018). Through sun drying after harvest, followed by storage, has been found to reduce the problem of loss of viability. Even keeping the seeds under ambient conditions in ordinary gunny bags, would result in significant loss of viability [7]. However, seed is not dried to relatively safe moisture content after harvest; its storability will be reduced [8].

To find out physiological and biochemical changes in greengram during different storage condition current study were conducted.

2. Review of Literature

Akter *et al.* (2014) reported that storing soybean seed in ambient conditions in polythene bag and tin container preserved soybean for longer period than storing in a cotton bag [9]. Bajpai *et al.*, (2015) studied seed vigour and their emulation to field emergence in groundnut and concluded that seedling vigour index declined gradually after 270 days of storage [10]. Jyothi (2021) performed experiment on *Persea macrantha* with storage containor and concluded that storage containers play an important role in seed physiological parameters [11].

Tatic *et al.* (2012) found that in sunflower and soybean, brick gravel test showed highest significant positive coefficient of correlation with field emergence followed by accelerated ageing test [12]. Geetha *et al.* (2014) supported that brick gravel test can be used to predict the vigour of mustard seeds. Sharma (2018) found that brick gravel test was very close to standard germination test but was not comparable with the field emergence [13].

The Tetrazolium staining test indirectly measures the respiration processes that occur in the mitochondria of the cells that make up the tissues of the seeds. The reducing reaction of the solution of the tetrazolium salt under the action of dehydrogenase enzymes results in triphenyl formazan, which presents a red carmin coloration [14]. Catao *et al.* (2018) explained that the tetrazolium test indicates that the seeds were viable; nevertheless, there was no germination at high temperatures. High vigour seeds develop a normal red stain. Aged or deteriorated tissues reveal a pale or mottled stain and dead tissues remain white. By the interpretation of the resulting staining patterns, seed viability, vigor and the main problems affecting seed quality are determined.

Gadewar *et al.*, (2020) performed experiment on soybean seeds and storage containors and concluded that polythene bag exhibited less protein degradation in compare of jute bag after 1.5 years. Ray and Bordolui (2022) revelead that Storage period showed significant variation for soluble protein content of seeds of tomato [15]. Dambhare (2018) observed that in reducing sugar decreases with increasing storage period in different varieties of soybean. Type of storage containers also effects on changes in reducing sugar. Zhang and Lu (2021) noted an increase in invertase activity, reducing sugar and sucrose content of potato tubers due to low temperature storage [16]. Ray and Baurdauli (2022) after two months of storage of tomato seed, a slight decrease in carbohydrate content were noted for all the storage containers except polythene packet and refrigerator.

3. Materials and Methods

Seeds of the following kinds and varieties i.e. Gujarat-4 (M1), GAM-5 (M2), and Virat (M3) were purchased from "Gujarat State Seeds Corporation Ltd.", Gujarat. The seed samples were sawn in field and mature harvested sundried seeds collected and stored in the respective containers Cotton bag (moisture pervious), Jute bag (moisture pervious) and Polyethylene bag 700 gauge (moisture vapour proof). Cotton bag, Jute bag and Polyethylene bag, are denotes by S1, S2 and S3 respectively. All the three bags will be of 25 cm x 30 cm in size. The respective storage containers were kept under ambient warmth and comparative dampness for a period of 1.5 years (i.e. 18 months).

The experiment was conducted at the Department of Botany, M.D. Science College, Porbandar, Gujarat, India. Portion of the seeds from each container were taken after every 90 days i.e., 0 days, 90 days (3 month), 180 days (6 month), 270 days (9 month), 360 days (12 month), 450 days (15 month) and 540 days (18 month) intervals are denoted by T1, T2, T3, T4, T5, T6 and T7 respectively and examined for changes found in physiological characteristics.

Brick Gravel Test

Crushed stone with a maximum particle size of 2 to 3 mm was used in the Brick Gravel test. With 250 ml water per 1100 grammes, it was moist. After that, it was combined and left to absorb water for roughly an hour. In the tray's base, a layer of moist brick gravel (3 cm deep) was deposited. To avoid cross infection, the seeds were kept on the gravel without contacting any other. A layer of 3 to 4 cm brick gravel was laid over it. For 10 to 14 days, the trays were covered with a lid and kept in the dark germination room. After the seedlings had emerged, the cover was removed. At the end of the test the trays were emptied and the seedlings were removed from the medium for examination. Evaluation of seedling was done as per prescription for normal and abnormal seedlings given in the rules for seed testing. The total of normal emerged seedlings is reported as per cent brick gravel value.

Tetrazolium Test

The Tetrazolium Test was used to analyse the staining pattern of seeds. To soften the seed coat, seeds were soaked in water at room temperature for 4 to 6 hours. For effective staining, the surrounding thin membrane around the cotyledons was also removed after the seed coat was removed. The seed was decoated and immersed in water for 15 to 20 minutes before being retrieved without damaging the seed tissue. The seeds

were immediately immersed in a 1 per cent Tetrazolium chloride solution. A large enough amount of Tetrazolium chloride solution was employed to completely cover the stain seeds. After that, the seed-filled beakers were left in the dark at 40°C for five hours. After the seeds had been coloured to satisfaction, the excess solution was drained and the seeds were rinsed in water before being inspected under magnification.

Estimation of Protein

Micro Kjeldahl's Method was used to determine the total protein content of the seed.

Estimation Reducing Sugar

Benedict's method was used to determine reducing sugar.

Statistical Analysis

The data obtained from the experiments were statistically analyzed by using factorial CRBD (Complete Randomized Block Design). ANOVA standard error (SE) and critical difference (CD) calculated using a 5% significance level.

Results

Brick Gravel Test (%)

The effect of container and storage period on brick gravel germination (%) in all three varieties V1, V2 and V3 is presented in **Table 1**.

Variety (V)

In variety Gujarat-4 (V1), the brick gravel germination (%) significantly decreased with increase in storage period. However, the rate of loss in brick gravel germination varied with the type of container used. Seed stored in polythene bag (C3) showed significantly higher brick gravel test germination (59.32%) as compared to those stored in jute bag (C2) (57.39 %) and cotton bag (C1) (54.28%) up to 540 days (T7) of the storage. Among the containers polythene bag (C3) showed significantly higher brick gravel test germination (72.81%) as compared to cotton bag (C1) (69.84%) and jute bag (C2) (70.04%) throughout the storage period.

In variety GAM-5 (V2), seed stored in polythene bag (C3) showed significantly higher brick gravel test germination (60.34%) as compared to those stored in jute bag (C2) (54.63%) and cotton bag (C1) (53.14%) up to 540 days (T7) of the storage. Among the containers polythene bag (C3) showed significantly higher brick gravel test germination (72.42%) as compared to jute bag (C2) (67.71%) and cotton bag (C1) (68.05%) throughout the storage period.

In variety Virat (V3), seed stored in polythene bag (C3) showed significantly higher brick gravel test germination (55.38%) as compared to those stored in cotton bag (C1) (51.29 %) and jute bag (C2) (52.36%) up to 540 days (T7) of the storage. Among the containers polythene bag (C3) showed significantly higher brick gravel test germination (69.83%) as compared to cotton bag (C1) (66.39%) and jute bag (C2) (66.14%) throughout the storage period.

Table 1: Effect of Varieties (V), Storage Containers(C) and Storage Period (T) three factor interaction on brick gravel germination (%) of Greengram seeds during storage.

V X C X T	V_1 (Gujarat - 4)			V_2 (GAM- 5)			V_3 (Virat)		
	C1	C2	C3	C1	C2	C3	C1	C2	C3
T_1	86.15	86.15	86.15	82.64	82.64	82.64	82.10	82.10	82.10
T_2	78.98	76.27	81.32	76.71	72.83	79.25	74.97	73.69	80.52
T_3	73.22	71.61	75.80	71.28	69.37	74.34	70.53	68.47	73.76
T_4	70.64	68.75	72.74	68.15	67.84	71.65	66.35	65.74	70.65
T_5	65.26	67.25	70.00	64.58	66.66	73.33	62.76	63.57	65.87
T_6	60.34	62.87	64.31	59.86	59.98	65.41	56.72	57.02	60.51
T_7	54.28	57.39	59.32	53.14	54.63	60.34	51.29	52.36	55.38
Average	69.84	70.04	72.81	68.05	67.71	72.42	66.39	66.14	69.83
SE	3.66								
CD(P=5%)	NS								

Tetrazolium Test (%)

The effect of container and storage period on value of tetrazolium staining percentages in all three varieties V1, V2 and V3 is presented in **Table 2.**

Variety (V):

In variety Gujarat -4 (V1), the value of tetrazolium staining percentages significantly decreased with increase in storage period. However, the rate of decrease in value of tetrazolium staining percentages varied with the type of container used. Seed stored in polythene bag (C3) showed significantly higher value of tetrazolium staining percentages (74.12%) as compared to those stored in cotton bag (C1) (68.87%) and jute bag (C2) (67.86%) up to 540 days (T7) of the storage. Among the containers polythene bag (C3) showed significantly higher value of tetrazolium staining percentages (86.61%) as compared to cotton bag (C1) (82.76%) and jute bag (C2) (82.38%) throughout the storage period.

Table 2: Effect of Varieties (V), Storage Containers(C) and Storage Period (T) three factor interaction on values of tetrazolium staining percentages of Greengram seeds during storage.

V X C X T	V_1 (Gujarat - 4)			V_2 (GAM- 5)			V_3 (Virat)		
	C1	C2	C3	C1	C2	C3	C1	C2	C3
T_1	98.42	98.42	98.42	99.00	99.00	99.00	96.42	96.42	96.42
T_2	92.00	92.14	96.00	88.00	84.00	96.00	84.00	80.00	92.00
T_3	86.45	85.42	91.63	85.63	82.41	90.49	80.82	74.61	87.21
T_4	82.02	80.24	86.24	81.34	80.49	84.58	75.84	72.21	82.46
T_5	78.05	79.21	81.27	78.25	77.56	80.17	68.76	70.54	79.52
T_6	73.54	73.36	78.59	73.68	71.03	76.42	63.57	61.23	68.41
T_7	68.87	67.86	74.12	65.75	66.94	71.19	59.26	52.06	62.52
Average	82.76	82.38	86.61	81.66	80.20	85.41	75.52	72.44	81.22

SE	4.256
CD(P=5%)	NS

In variety GAM-5 (V2), seed stored in polythene bag (C3) showed significantly higher value of tetrazolium staining percentages (71.19%) as compared to those stored in cotton bag (C1) (65.75%) and jute bag (C2) (66.94%) up to 540 days (T7) of the storage. Among the containers polythene bag (C3) showed significantly higher value of tetrazolium staining percentages (85.41%) as compared to cotton bag (C1) (81.66%) and jute bag (C2) (80.20%) throughout the storage period.

In variety Virat (V3), seed stored in polythene bag (C3) showed significantly higher value of tetrazolium staining percentages (62.52%) as compared to those stored in cotton bag (C1) (59.26%) and jute bag (C2) (52.06%) up to 540 days (T7) of the storage. Among the containers polythene bag (C3) showed significantly higher value of tetrazolium staining percentages (81.22%) as compared to cotton bag (C1) (75.52%) and jute bag (C2) (72.44%) throughout the storage period.

Protein Content (%)

The effect of container and storage period on protein content in all three varieties V1, V2 and V3 is presented in Table 3.

Variety (V)

Protein content in variety Gujarat-4 (V1) reduced dramatically as storage time increased. Protein content decreased at different rates depending on the type of container utilised. Up to 540 days (T7) of storage, seed stored in polythene bag (C3) had considerably greater protein content (20.29%) than seed placed in cotton bag (C1) (19.93%) and jute bag (C2) (19.47%). Throughout the storage period, the polythene bag (C3) had a considerably higher protein content (20.97%) than the cotton bag (C1) (20.79%) and jute bag (C2) (20.66%).

Seed placed in polythene bag (C3) had a considerably greater protein content (19.77%) than those stored in cotton bag (C1) (19.53%) and jute bag (C2) (19.04%) up to 540 days (T7) of storage in variety GAM-5 (V2). Throughout the storage period, the polythene bag (C3) had a considerably greater protein content (20.67%) than the cotton bag (C1) (20.43%) and jute bag (C2) (20.28%).

Table 3: Effect of Varieties (V), Storage Containers(C) and Storage Period (T) three factor interaction on protein content (%) of Greengram seeds during storage.

V X C X T	V1 (Gujarat - 4)			V2 (GAM- 5)			V3 (Virat)		
	C1	C2	C3	C1	C2	C3	C1	C2	C3
T_1	21.59	21.59	21.59	21.25	21.25	21.25	22.16	22.16	22.16
T_2	21.36	21.33	21.40	21.01	20.97	21.07	21.88	21.80	21.93
T_3	21.13	21.08	21.27	20.79	20.68	20.97	21.61	21.42	21.68
T_4	20.84	20.79	21.13	20.51	20.46	20.83	21.32	20.99	21.38
T_5	20.47	20.36	20.67	20.08	19.94	20.59	20.95	20.52	21.03
T_6	20.24	20.02	20.46	19.85	19.61	20.22	20.52	20.00	20.66
T_7	19.93	19.47	20.29	19.53	19.04	19.77	19.94	19.39	20.18
Average	20.79	20.66	20.97	20.43	20.28	20.67	21.20	20.90	21.29
SE	0.270								
CD(P=5%)	NS								

In variety Virat (V3), seed stored in polythene bag (C3) showed significantly higher protein content (20.18%) as compared to those stored in cotton bag (C1) (19.94%) and jute bag (C2) (19.39%) up to 540 days (T7) of the storage. Among the containers polythene bag (C3) showed significantly higher protein content (21.29%) as compared to cotton bag (C1) (21.20%) and jute bag (C2) (20.90%) throughout the storage period.

Reducing Sugar Content (%)

The effect of container and storage period on reducing sugar content in all three varieties V1, V2 and V3 is presented in **Table 4**.

Variety (V)

In variety Gujarat -4 (V1), the reducing sugar significantly decreased with increase in storage period. However, the rate of decrease in reducing sugar varied with the type of container used. Seed stored in polythene bag (C3) showed significantly higher reducing sugar (1.35%) as compared to those stored in cotton bag (C1) (1.30%) and jute bag (C2) (1.04%) up to 540 days (T7) of the storage. Among the containers polythene bag (C3) showed significantly higher reducing sugar (1.85%) as compared to cotton bag (C1) (1.74%) and jute bag (C2) (1.62%) throughout the storage period.

Seed stored in polythene bag (C3) exhibited considerably higher reducing sugar (1.36%) than those stored in cotton bag (C1) (1.25%) and jute bag (C2) (1.20%) up to 540 days (T7) of storage in variety GAM-5 (V2). During the storage time, polythene bag (C3) had considerably higher reducing sugar (1.85%) than cotton bag (C1) (1.78%) and jute bag (C2) (1.76%).

Seed placed in polythene bag (C3) exhibited significantly higher reducing sugar (1.30%) than those stored in cotton bag (C1) (1.28%) and jute bag (C2) (1.26%) up to 540 days (T7) of storage in variety Virat (V3). During the storage time, polythene bag (C3) had considerably higher reducing sugar (1.88%) than cotton bag (C1) (1.80%) and jute bag (C2) (1.76%).

Table 4: Effect of Varieties (V), Storage Containers(C) and Storage Period (T) three factor interaction on reducing sugar content (%) of Greengram seeds during storage.

V X C X T	V1 (Gujarat - 4)			V2 (GAM- 5)			V3 (Virat)		
	C1	C2	C3	C1	C2	C3	C1	C2	C3
T_1	2.32	2.32	2.32	2.25	2.25	2.25	2.31	2.31	2.31
T_2	2.13	2.10	2.17	2.11	2.08	2.14	2.18	2.14	2.23
T_3	1.95	1.89	2.02	1.97	1.94	1.99	2.07	2.03	2.12
T_4	1.63	1.53	1.90	1.88	1.82	1.91	1.73	1.67	1.94
T_5	1.47	1.32	1.67	1.64	1.63	1.75	1.54	1.50	1.66
T_6	1.40	1.13	1.54	1.39	1.40	1.54	1.46	1.44	1.57
T_7	1.30	1.04	1.35	1.25	1.20	1.36	1.28	1.26	1.30
Average	1.74	1.62	1.85	1.78	1.76	1.85	1.80	1.76	1.88
SE	0.147								
CD (P=5%)	NS								

5. Discussion

Brick Gravel Test (%)

Table 1 shows that the germination brick gravel test declined with increasing storage time, regardless of storage container, in all three Greengram seed kinds studied. At the brick gravel test, seeds held in cotton (C1) and jute (C2) bags showed a considerable reduction in germination. Low vigour of seeds linked with numerous funguses growing on it could explain the lower germination rate. The findings reveal that when seeds of Gujarat-4 (V1) are stored in polythene bag (C3), they lose less germinability than seeds stored in cotton (C1) and jute (C2) bags. Seed vitality decreased as storage time increased (Gadewar *et al.*, 2020).

In the brick gravel test, there were varietal differences in germination. During storage, Gujarat-4 (V1) seeds had significantly better germination than other types in the brick gravel test. This difference at the varietal level could be attributable to Gujarat-4's (V1) improved genetic make-up [17] compared to GAM-5 (V2) and Virat (V3). Same result were observed and supported by Dambhare, K. (2018) in soybean varieties. The findings of the brick gravel test are graphically represented in Figures 1.

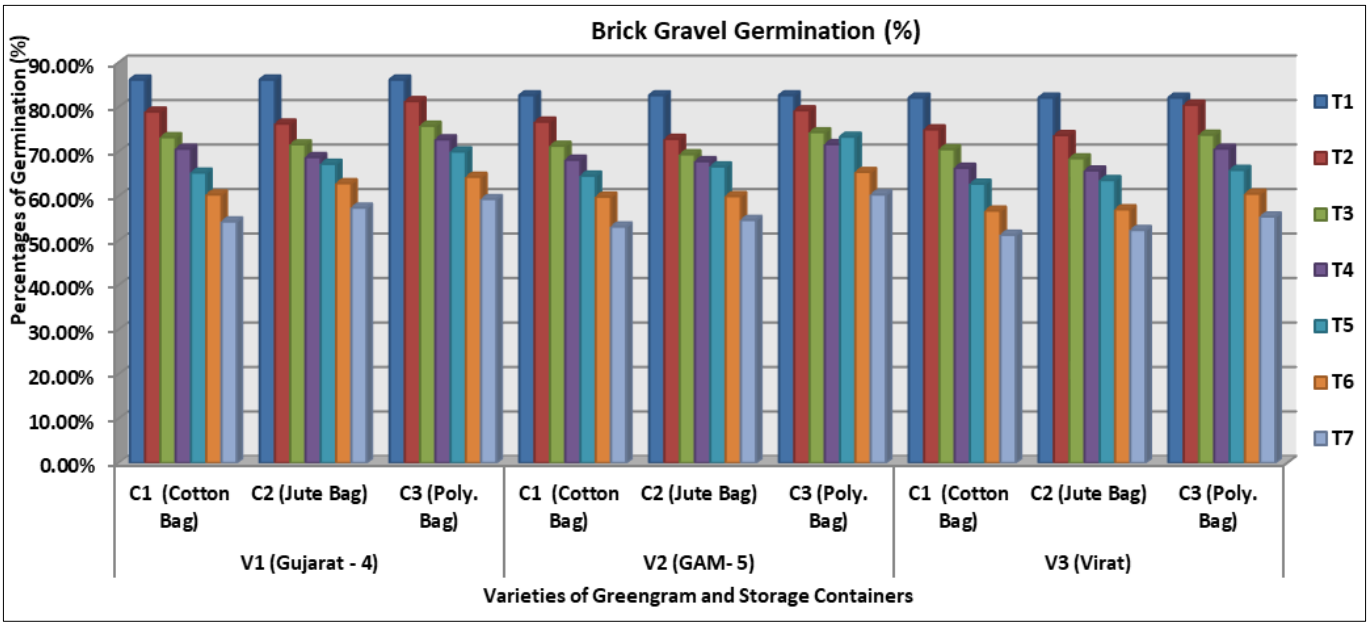

Fig 1: Effect of storage containers on Brick gravel germination (%) in Greengram seed varieties.

Tetrazolium Test (%)

Tetrazolium staining of seed percentages reduced with a proportionate increase in storage period in the current study (Table 2). Tetrazolium staining of seed percentages was significantly reduced in seeds stored in cotton (C1) and jute (C2) bags compared to those stored in polythene bag (C3). The loss of viability and vigour can be linked to a decrease in tetrazolium staining of seed percentages.

According to Singh *et al.* (2016), a tetrazolium test revealed that niger had more viable seeds than soybean [18]. Under ambient settings, niger seeds had superior storability than soybean seeds, according to the study. Tetrazolium staining of seed percentages revealed varietal differences. During storage, the seeds of variety Virat (V3) had much higher tetrazolium staining percentages than the other varieties studied. This difference at the varietal level could be related to Virat's (V3) greater genetic make-up to grow in stress regions compared to Gujarat-4 (V1) and GAM-5 (V2). Gadewar *et al.*, (2020) discovered a similar finding in soybean varieties stored in various containers. The results of tetrazolium staining of seed percentages have been visually represented in Figure 2.

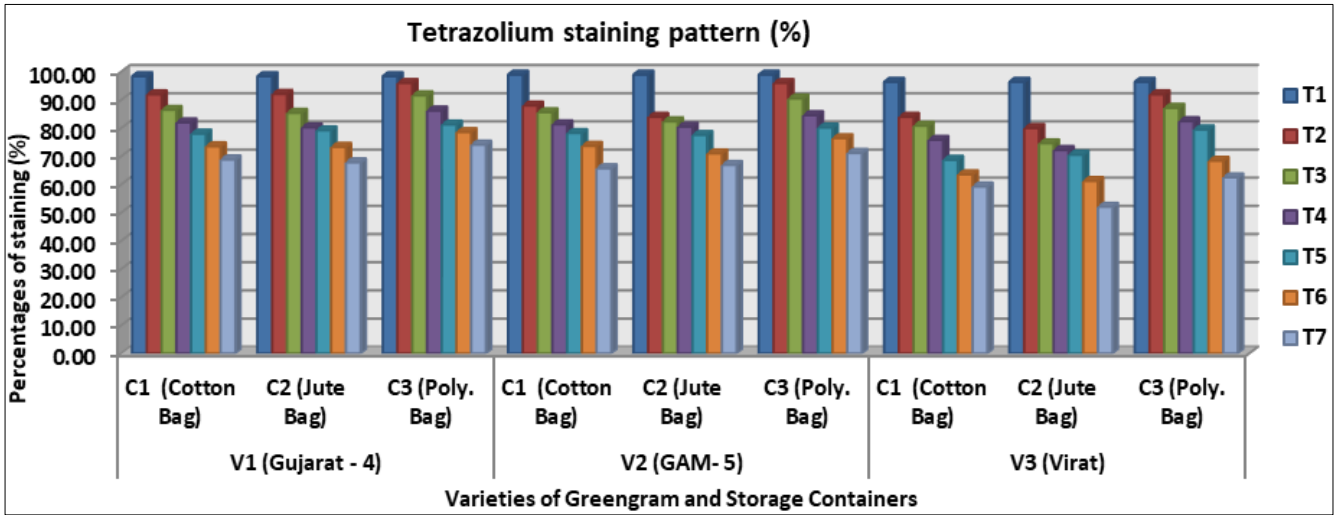

Fig 2: Effect of storage containers on Tetrazolium staining pattern (%) in Greengram seed varieties.

Protein Content (%)

The effect of varieties, storage containers, and storage time period on the protein content of Greengram seed during storage is shown in Table 3. Different kinds of Greengram seed placed in different containers during storage have a considerable impact on the protein content. Regardless of variety, protein content reduced as storage time increased. During all storage periods, the protein level was substantially higher in Virat (V3), Gujarat-4 (V1) and much lower in GAM-5 (V2). Regardless of variety, the protein content of Greengram seed stored in polythene bag (C3) was significantly higher than that of seed placed in cotton (C1) and jute (C2) bags over all storage periods.

Seed deterioration rate is highly determined by the type of container they are stored in, according to the research [19, 20, 21]. In the current investigation, it was discovered that seeds stored in cotton bag (C1) and jute bag (C2) lose protein content faster than seeds stored in polythene bag (C3). Protein concentration can be altered by numerous genotypes present during storage, according to Bellaloui *et al.*, (2011) [22] and Taski Ajdukovic *et al.*, (2010) [23]. The genotype had a significant impact on the seed's protein percentage. Protein content was found to be related when a variation of glutamine concentration occurred [24]. The results of the protein content estimation have been graphically depicted in Figures 3

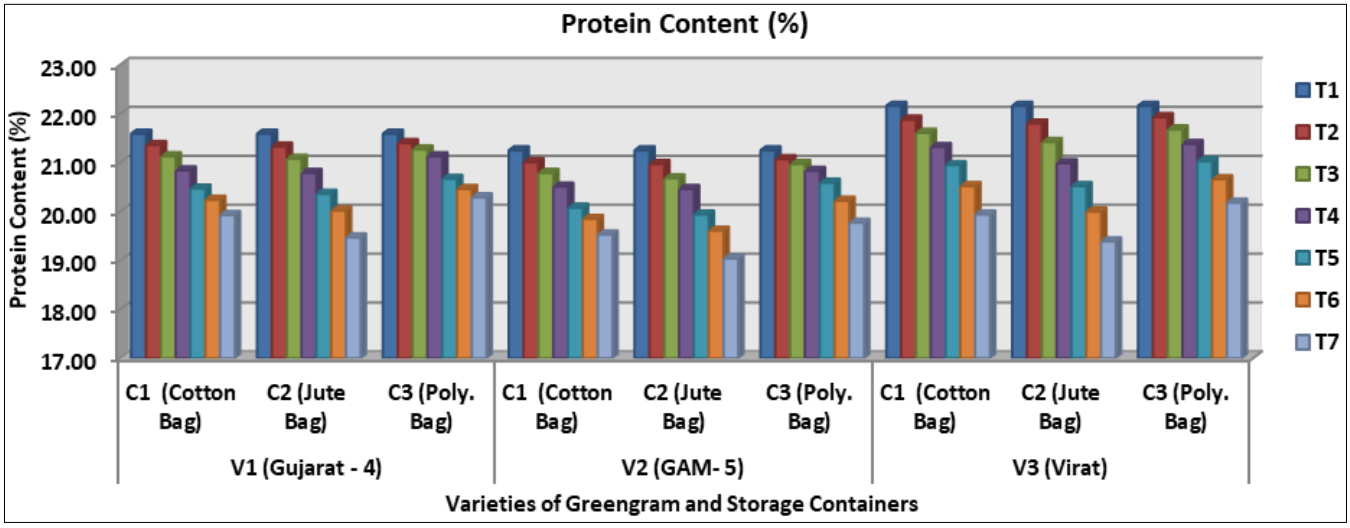

Fig 3: Effect of storage containers on Protein content (%) in Greengram seed varieties.

Reducing Sugar Content (%)

As per Table 4, the reducing sugar content of all three types Gujarat-4 (V1), GAM-5 (V2), and Virat (V3) decreased significantly after storage in the current study. However, the reducing sugar was identified in greater amounts in Virat (V3) followed by GAM-5 (V2) and Gujarat-4 (V1). With the increase in storage period, reducing sugar in seed declined irrespective of variety, which leads to poor germination and vigour at the end of storage period. This may be due to higher amylase activity that further relates to the moisture content of the seed [25]. Sharma *et al.*, (2007) and Filho *et al.*, (2016) found a decrease in reducing sugar over storage in soybean [26, 27].

After 540 days of storage, seeds stored in polythene bag (C3) had a greater value of reducing sugar than seeds stored in cotton bag (C1) and jute bag (C2). Saxena *et al.*, (2015) and Singh *et al.*, (2017) also found a drop in reducing sugar in cotton bags. This result could be ascribed to seed oxidation and respiration during storage, which induces biochemical changes in seeds, resulting in a decrease in reducing sugar [28, 29, 30, 31]. The results obtained from estimation of reducing sugar content have been illustrated graphically in Figure 4.

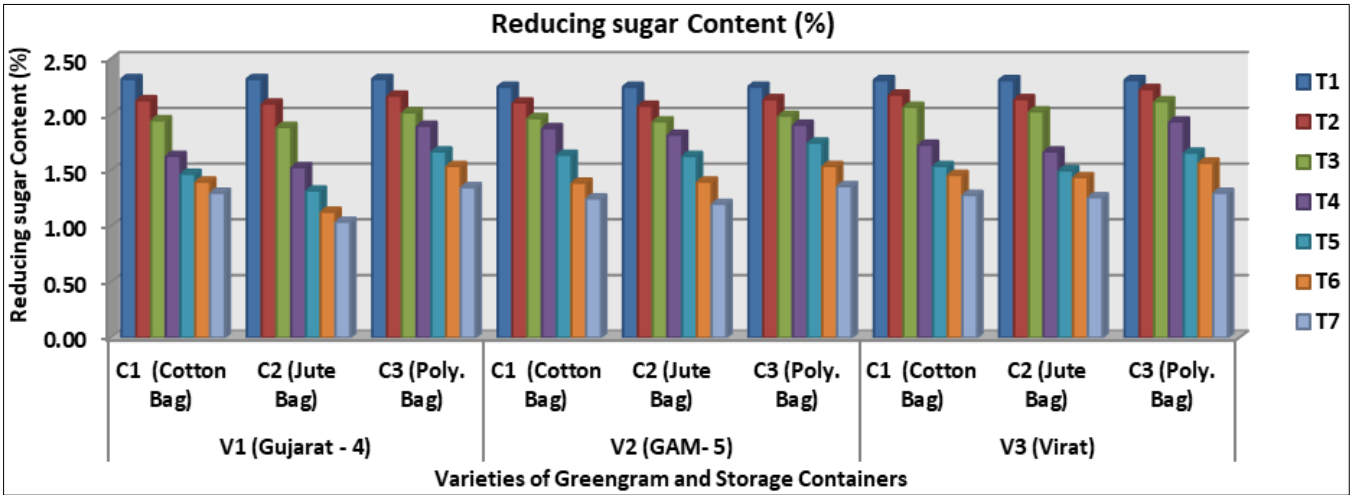

Fig 4: Effect of storage containers on reducing sugar (%) in Greengram seed varieties.

6. Conclusion

From the results obtained it can be concluded that Greengram, if well dried and stored properly, can retain viability and vigour upto the next planting season. For long term storage, Gujarat 4 Variety and storage container polyethylene bag of 700 guage is more suitable in comare of GAM 5 and Virat varieties and Cotton bag and Jute bag as storage containers. In case of Brick gravel germination, GAM 5 while reducing sugar was observed higher in Virat varieties.

7. References

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