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Impact of Storage Containers on Seed Quality and Longevity of Yellow Sarson

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ABSTRACT

Rapeseed and mustard are integral to India's oilseed economy. This study investigates the seed deterioration pattern of yellow sarson (*Brassica rapa* var. yellow sarson L.) in Gangetic West Bengal condition. Seeds of the Anushka variety were cleaned, dried, and stored in six containers viz. desiccator (S_1), polythene packet (S_2), paper packet (S_3), earthen pot (S_4), 700-gauge polyethene packet (S_5), and cloth bags (S_6) for eight months. Various seed quality parameters were assessed following ISTA guidelines, and the results indicate significant variations in germination, seedling dry weight, moisture content, and vigour. Storage in 700-gauge polyethylene packets and desiccators resulted in minimal deterioration, while cloth bags showed the highest decline, with germination falling below prescribed standards. The study provides valuable insights into the need for attention to storage conditions, especially considering the region's high humidity and temperature between harvesting and subsequent.

Keywords: Seed deterioration, Seed quality, Storage containers, Storage period, Yellow sarson

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INTRODUCTION

Rapeseed and mustard are recognized as crucial edible oilseed crops worldwide. The term 'Rape' is derived from the Latin word 'rapum,' signifying turnip and the term 'Mustard' originates from the Latin 'must' or 'mustum,' denoting unfermented grape juice, and 'ardens,' meaning hot and burning (Ahlawat, 2008). Rape, belonging to the Brassicaceae family, has a cultivation history dating back 3500 years. In India, rapeseed-mustard ranks as the second most important edible oilseed after groundnut, contributing to 27.8% of the Indian oilseed economy and 25% of total oilseed production (www.statista.com). Among the various rapeseed species, Yellow sarson (*Brassica rapa* var. yellow sarson L.) emerges as one of the key contributors in meeting the global demand for edible oil. However, the seed replacement rate of rapeseed remains below the threshold level due to the prevalent practice of local seed sourcing, often saved by farmers from previous season harvests. The quality of seeds significantly impacts crop yield and productivity. High-quality seeds are essential inputs that contribute to increased productivity and greater financial returns per unit area (Dutta, 2017; Hemming *et al*., 2018).

Seeds require safe storage due to the temporal gap of six months or longer, between harvesting and subsequent sowing. Preserving seed quality during storage is crucial for maintaining acceptable levels of germination and vigour until sowing. Numerous studies have highlighted the impact of storage containers on seed quality over time (Borteyet *al*., 2016; Moharana *et al*.,2017). However, the natural deterioration of stored seeds poses a significant scientific challenge of global concern. Various biotic and abiotic factors, including crop genotype, initial seed quality, storage containers, and storage conditions, contribute to seed deterioration under improper storage conditions. Among these factors, storage temperature and moisture content are pivotal, with moisture content usually exerting a more pronounced influence than temperature (Ray and Bordolui, 2022). Both packaging container and storage duration significantly affect seed viability and seedling vigour (Rao *et al*., 2006; Chakraborty *et al*., 2020). Theprimary objective of this study was to evaluate seed deterioration patterns under ambient storage conditions, employing various packing materials and the findings aim to provide valuable insights into seed quality dynamics over time, contributing to our understanding of optimal storage practices.

MATERIALS AND METHODS

The laboratory experiment was carried out at the Seed Testing Laboratory, Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal,employing a factorial Complete Randomized Design with three replications. This investigation used seeds of the yellow sarson variety, Anushka. After harvesting, the seeds were cleaned thoroughly, dried to a safe moisture level, and subsequently storedforeight months (Mar. 2022 to Nov. 2022). Seeds were carefully kept in various storage containers viz. desiccator (S_1), polythene packet (S_2), paper packet (S_3),

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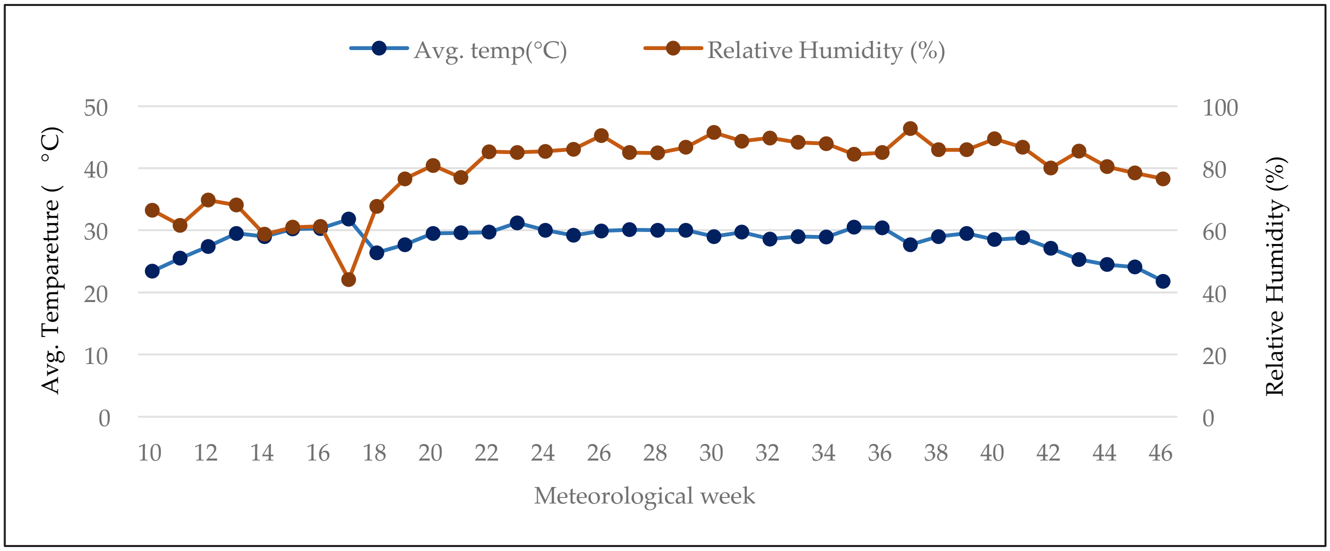

Fig. 1: Average temperature (°C) and relative humidity (%) during the storage period

earthen pot (S_4), 700-gauge polyethene packet (S_5), and cloth bags (S_6), ensuring minimal to no air spaces.

Various physiological parameters viz. germination percentage, root length (cm), shoot length (cm), speed of germination, dry weight (mg seedling^{-1}),vigour index etc. were evaluated for both freshly harvested seeds before storage and stored seeds attwo-month intervals, following ISTA (1999) guidelines. Statistical analysis of different traits was conducted using analysis of variance (Panse and Sukhatme, 1985) and the OPSTAT software program (Sheoran *et al.*, 1998).

RESULTS AND DISCUSSION

The study assessing seed deterioration patterns in the Anushka variety of yellow sarson under standard storage conditions with varying packaging materials revealed significant effects on diverse seed quality parameters.

Germination percentage

Germination is a complicated phenomenon involving several physiological and biochemical changes that contribute to embryo activation (Parihar *et al.*, 2014). Prior to storage and at two-month intervals, seeds underwent germination tests. The germination percentage was evaluated through the angular transformed (Tr) value, as mentioned in the parentheses. The overall mean revealed significant variations based on the storage container, duration of storage, and their interactions. Initially, a germination percentage of 100.00 (90.00) was observed (M_0), but a declining trend was noted over the storage period. The mean germination percentage at the termination of the storage period (M_4) was observed 95.77 (82.96). Among the different containers, seeds stored in cloth bags (S_6) exhibited the greatest decline in germination percentage, while the 700-gauge polyethylene packet (S_5) showed the least decline during storage. According to the Minimum Seed Certification Standard, the minimum required germination percentage for rapeseed is 85. In the present study, it was found that seeds stored in cloth bags and for more than six months exhibited a lower germination percentage than the established standard value, implying that cloth bags should not be used for safe storage when stored for more than six months (Table 1). Saisantosh and Patil (2018)also observed a continuous decrease in the germination percentage in onion seeds with a progressive extension in storage duration.

Root length (cm)

The root length of seedlings significantly varied with storage durations. The maximum seedling root length at seven days after setting was noticed maximum in M_0(11.72 cm) and with the progression in storage duration, it declined irrespective of storage containers. Significant variation was also observed for storage containers when the average was taken over the storage durations; it was noted the longest root in S_5(11.66 cm) which was statistically at par with S_1 (11.64 cm). The interaction effect of storage containers and periods of storage revealed non-significant variation for this trait.

Shoot length (cm)

Maximum shoot length was recorded in M_0 (2.91 cm) while it was minimum in M_4 (2.07 cm). The longest shoot was produced by the seeds stored in 700-gauge polyethylene packet(2.86 cm) which was on par with desiccator (2.83 cm). A non-significant interaction effect was observed between containers and storage duration. Among the containers, maximum deterioration was observed in cloth bags followed by paper packets, whereas minimum deterioration was noted for 700-gauge polythene packets followed by desiccator. Comparable findings were observed by Venge *et al.*, (2016) in soybean seeds during storage.

Speed of germination

Speed of germination is a measure of the initial establishment of crops, increasing stand population. Analysis of recorded data revealed significant variations in the speed of germination with storage containers, storage periods and their interaction. The speed of germination was initially measured 90.00 before storage (M_0), however, the value reduced over the storage period across all containers. The mean speed of germination was observed 74.13 after eight months of storage (M_4). Seeds stored in desiccator (S_1) showed a maximum speed of germination (87.58) followed by 700-gauge polyethylene packet (87.19). The rate of deterioration was faster after four months of storage, with the utmost deterioration noticed for S_6 (cloth bag). The recommendations of Copeland (1976), and Huda (2001) are in harmony with the findings of the current investigation.

Table 1: Deterioration in various physiological parameters during storage

Storage duration	Germination percentage*	Seedling root length (cm)	Seedling shoot length (cm)	Speed of germination
M_0	100.00 (90.00)	11.72	2.91	90.00
M_1	99.67 (88.59)	11.36	2.74	88.21
M_2	98.33 (86.27)	11.28	2.52	85.50
M_3	97.56 (85.18)	11.02	2.19	79.33
M_4	95.77 (82.96)	10.74	2.07	72.13
SEm (±)	0.23 (0.81)	0.028	0.022	0.111
CD (p=0.05)	0.65 (2.34)	0.080	0.063	0.320
Storage containers				
S_1	99.75 (88.69)	11.64	2.83	87.58
S_2	99.50 (87.97)	11.55	2.74	84.69
S_3	99.00 (85.94)	11.22	2.47	82.77
S_4	99.50 (87.97)	11.37	2.68	82.30
S_5	99.83 (89.32)	11.66	2.86	87.19
S_6	92.33 (76.56)	10.69	2.22	74.52
SEm (±)	0.32 (1.15)	0.039	0.031	0.157
CD (p=0.05)	0.92 (3.31)	0.113	0.089	0.453
Interactions				
SEm (±)	0.56 (1.98)	0.068	0.054	0.272
CD (p=0.05)	1.60 (3.21)	NS	NS	0.784

Legend:M0-Pre-storing period, M1- After two months, M2- After four months, M3- After six months, M4- After eight months; S1- Desiccator, S2- Polythene packet, S3- Paper packet, S4- Earthen pot, S5- 700-gauge polythene packet, S6- Cloth bag; NS- Non-significant (*Angular transformed value in parentheses)

Seedling dry weight (mg seedling^{-1})

Storage containers, storage duration and their interaction significantly influenced seedling dry weight (Table 2). The maximum dry weight of 4.28 mg seedling^{-1} was recorded at the initial storage period (M_0) which declined over the period of storage and at the end of the storage period it reached 3.97 mg seedling^{-1}. Among the storage containers, minimum deterioration of dry weight was recorded for desiccator (4.26 mg seedling^{-1}) followed by 700-gauge polyethylene packet (4.25 mg seedling^{-1}) which were found statistically at par. Conversely, cloth bags (S_6) showed maximal deterioration for this trait (4.09 mg seedling^{-1}). This finding corroborates those of Demir *et al.* (2016) in lettuce and Kavitha *et al.* (2017) in sesame.

Moisture content (%)

Seeds absorb moisture if stored in an environment with relative humidity exceeding their moisture content due to their hygroscopic nature. The water content of seeds is the most important aspect in determining their shelf life. Gorechi (1982) observed that seeds kept in high relative humidity experienced faster declines in viability and vigour compared to those stored in dry air.

The analysis of variance demonstrated an ascend in the moisture content of seeds over the storage duration. Initially, seeds were kept in different containers with a moisture percentage of 7.84 (M_0) but after eight months of storage (M_4) this value was raised to 9.96. Seeds stored in a cloth bag (S_6) had a moisture percentage of 10.23, while seeds stored in desiccator and 700-gauge polythene packet had moisture percentages of 7.92 and 7.94 respectively.

The minimum elevation in moisture content was noted for the desiccator, followed by the 700-gauge polythene packet, whereas the absorbance rate was higher in the cloth bag. This is because, the cloth bag is not a hermetically sealed container, but the desiccator and 700-gauge polythene packet are moisture-proof. Doijode (1997) reported similar kind of findings in Okra.

Table 2: Changes in various physio-chemical characters during storage

Storage duration	Seedling DW (mg seedling $^{-1}$)	Moisture content (%)	EC (µS cm^{-1} g^{-1})	Vigour index I
M_0	4.28	7.84	3.125	1461.12
M_1	4.21	7.98	4.456	1400.35
M_2	4.17	8.34	5.763	1352.42
M_3	4.10	9.32	7.542	1286.77
M_4	3.97	9.96	9.784	1222.81
SEm (±)	0.002	0.005	0.002	4.65
CD (p=0.05)	0.006	0.015	0.005	13.40
Storage containers				
S_1	4.26	7.89	4.712	1445.36
S_2	4.22	8.21	5.511	1416.38
S_3	4.18	8.77	5.614	1356.07
S_4	4.20	8.95	5.836	1399.14
S_5	4.25	7.92	4.834	1450.57
S_6	4.09	10.23	6.447	1192.22
SEm (±)	0.010	0.007	0.010	6.58
CD (p=0.05)	0.021	0.022	0.027	18.95
Interactions				
SEm (±)	0.007	0.012	0.004	11.40
CD (p=0.05)	0.030	0.037	0.012	32.83

Legend:M0-Pre-storing period, M1- After two months, M2- After four months, M3- After six months, M4- After eight months; S1- Desiccator, S2- Polythene packet, S3- Paper packet, S4- Earthen pot, S5- 700-gauge polythene packet, S6- Cloth bag; DW- Dry weight, EC-Electrical conductivity

Electrical conductivity (µS cm^{-1} g^{-1})

The electrical conductivity of seed leachates exhibits a positive correlation with seed degradation. The membrane permeability of seeds has been observed to increase during seed storage, manifested by an augmented release of electrolytes (Singh *et al*., 2022). Consequently, the electrical conductivity of seeds rises over the course of the storage period.

The highest conductivity was observed for M_4 (9.784 µS cm^{-1}g^{-1}), while the lowest was for M_0 (3.125 µS cm^{-1}g^{-1}). The rate of increase in electrical conductivity rises with the extension of storage duration. Autade and Ghuge (2018) reported a similar increase in the electrical conductivity of soybean seeds over storage periods. Among the storage containers, S_6 showed the maximum electrical conductivity (6.447 µS cm^{-1}g^{-1}),signifying the highest leachate release by the seeds. This was followed by S_4, S_3, S_2 and S_5, while minimum electrical conductivity was recorded for S_1 (4.712 µS cm^{-1}g^{-1}) when averaged over the storage durations. The lower electrical conductivity in containers like desiccators and 700-gauge polyethylene packets can be attributed to their moisture-proof design which prevents fluctuations in seed moisture content. This helps to maintain high membrane integrity, ultimately reducing lipid peroxidation, and preventing the release of free ions (Shelar *et al*., 2008).

Vigour index

Seed vigour is an important quality indicator that must be assessed alongside germination and viability to comprehensively evaluate the performance of a seed lot in the field. According to Heydecker (1979), improper storage conditions significantly impact seed vigour.

The storage duration exhibited substantial variability in the vigour index when averaged across different storage containers. The initial maximum vigour index was recorded at M_0 (1463.12), diminishing progressively over time. Among the containers, S_5recorded the highest vigour index(1450.57), followed by S_1 (1445.36). The interaction between storage containers and storage duration significantly impacts the seed vigour index. Basavegowda *et al*., (2013) reported that, commercial storage at 5-7 °C and 65% relative humidity exhibited the highest seed vigour, while working on chickpea.

CONCLUSION

Significant variations in the quality parameters of the yellow sarson variety "Anushka" were observed as a result of utilizing various packaging materials and varying storage durations. Notably, seeds stored in 700-gauge polythene packets and desiccators exhibited the least deterioration compared to other storage containers, whereas seeds stored in cloth bags showed the highest level of deterioration. Furthermore, distinct variations in seed quality parameters were evident across different storage periods. The freshly harvested seeds exhibited superior quality, which progressively declined with a prolonged storage period. Therefore, it can be concluded that the initial seed quality can be maintained for up to eight months with the use of proper storage containers. The desiccator or 700-gauge polythene packetcan be considered as potentially better options for utilization. In future, this study encompasses an opportunity to examine the impact of various seed-treating chemicals, priming agents, and diverse seed-coating methodologies, including seed dressing, film coating, and seed pelleting, when applied before storage.

CONFLICT OF INTEREST

All the author both individually and collectively, affirms that they do not possess any conflicts of interest either directly or indirectly related to the research being reported in the publication.

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