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EFFECT OF DIFFERENT SEED COATINGS AND STORAGE TEMPERATURE ON QUALITY OF MAIZE SEEDS

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ABSTRACT

Maize seed quality deteriorates during storage, resulting in reduced germination and poor crop establishment. Seed coating technology, which applies thin polymer layers to seeds, offers protection against biotic and abiotic stresses and may improve seed storability. This study evaluated the effects of different seed coatings and storage temperatures on maize seed quality and storability. Two film-coating polymers, ready-made polymer and carboxymethyl cellulose (CMC) were combined with fungicide (Homai: thiophanate-methyl 50% + thiram 30% WP) and insecticide (thiamethoxam 70% WS) to treat two maize varieties (MI Hybrid 4 and MI Hybrid 5). Six coating formulations and a non-coated control were tested in a completely randomized design with 28 treatments and four replicates. Seeds were stored in triple-laminated aluminium foil packets at ambient (25°C) and cold (15°C) temperatures for three months. Germination percentage, seed moisture content, shoot and root length, seedling length, and seedling vigour index (SVI) were assessed before storage and monthly thereafter. Germination declined with storage duration in all treatments; however, coated seeds showed a slower rate of decline than non-coated seeds. After three months, coated seeds maintained higher germination (up to 89.25% in MI Hybrid 4 and 78.0% in MI Hybrid 5) compared to controls. Seedling vigour index was highest in treatments C2 and C6, exceeding controls by over 500 units. Coated seeds-maintained moisture content below 12%, while non-coated seeds exceeded this level after two months. Furthermore, no significant differences in seed and seedling quality were observed between cold and ambient storage. The seed and seedling quality of coated seeds remained stable during storage, even under ambient air. Therefore, seed coating is an effective method to enhance the storability of maize seeds while preserving their quality.

Keywords: Germination, Seed-film coating, Seed quality, Seed storage, Seedling vigour index

INTRODUCTION

Achieving food security requires seed security, making robust seed systems essential for sustainable nutritional security (Dadlani & Yadava, 2023). Uniform and quick seed germination with uniform seedling emergence ensures improved crop establishment, creating ideal environments for growth and yield formation (Weerakkody & Mawalagedera, 2020). Consequently, distributing and producing high-quality seeds for vegetables, pulses, grains, and oil seeds is increasingly crucial.

Maize (*Zea mays*) is extensively grown worldwide on almost 200 million hectares (Lopez-Ridaura et al., 2021). Globally, maize is vital for human consumption, animal feed, and industrial products including starch and biofuel (Reddy et al., 2019). Maize has proven essential for food security in rural livelihoods (Tanumihardjo et al., 2019). Despite high adaptability, low-quality seeds are a major reason for poor maize productivity (Moharana et al., 2020).

Seed storage aims to ensure consistent supply of high-quality seeds for planting initiatives (Khadtar et al., 2018). Due to seasonal nature of agriculture, seed storage is essential, as seeds naturally lose viability and vigour during storage (Bhadauria et al., 2019). Maintaining seed viability is challenging due to biological factors including pest infestation and seed-borne pathogen infection, which significantly contribute to seed deterioration (Priyantha et al., 2021). Seed degradation causes considerable reductions in germination, seedling emergence, and growth (Moharana et al., 2017). In maize, pest and disease prevalence may reduce yield and quality (Reddy et al., 2019).

Locally, farmers frequently store seeds in ambient conditions, exposing them to temperature fluctuations. Storage temperature significantly impacts seed viability, germination rates, and overall performance. Seed viability and vigour are influenced by packaging containers, storage conditions, and duration (Moharana et al., 2017).

Among seed treatments, seed coating offers opportunities to maintain seed quality by protecting against soil, air, and seed-borne diseases (Javed et al., 2022). Coating materials serve as carriers for applying plant growth stimulants and seed protectants to seed surfaces where they are most effective. The coating's slow release prolongs active ingredient availability to developing seedlings (Dadlani & Yadava, 2023). Seed coatings have evolved to provide diverse benefits including pest and fungal protection, nutrient supply, growth regulation, and improved seed size for precision planting (Taylor, 2020). Seed film coating is highly effective for enhancing seed quality and protecting seeds from biotic and abiotic stresses (Javed et al., 2022). Considering these advantages, this experiment studied seed-film coating efficacy on maize seed quality and storability, and evaluated storage temperature effects.

MATERIALS AND METHOD

Experimental location and conditions

The experiment was conducted at the Central Seed Testing Laboratory (CSTL) and the Vegetable Seed Centre (VSC), Peradeniya, Sri Lanka, from August 2023 to February 2024. All laboratory experiments were carried out under controlled conditions following International Seed Testing Association (ISTA) guidelines. Germination tests were conducted in a germination chamber maintained at 25°C, while seed storage was carried out under ambient conditions (25°C) and cold room conditions (15°C) using triple-laminated aluminium foil packaging.

Seed material

Certified maize (*Zea mays* L.) seeds of two hybrid varieties, MI Hybrid 4 and MI Hybrid 5, were used in this study. Seed lots with an initial germination percentage above 75% and seed moisture content below 12% were selected from the Seed and Planting Materials Development Centre (SPMDC), Peradeniya, Sri Lanka.

Experimental design

The experiment was arranged in a factorial Completely Randomized Design (CRD) with three factors: seed film-coating formulation (six coated treatments and one non-coated control), maize variety (MI Hybrid 4 and MI Hybrid 5), and storage temperature (ambient and cold storage). Each treatment combination consisted of four replicates, resulting in a total of 28 treatments.

Seed film-coating formulations

Six seed film-coating formulations (C1–C6) were evaluated against a non-coated control (C0) for each maize variety (Table 1). Two polymers were used: a ready-made liquid polymer containing a colorant, and carboxymethyl cellulose (CMC). All coating formulations included the fungicide Homai (thiophanate-methyl 50% + thiram 30% WP) and the insecticide Thiamethoxam 70% WS at recommended rates.

Table 1. Seed film coating formulations used per kg of maize seeds

Per kg of seeds	
Coating 0 (C_0)	0g polymer+ 0g Homai + 0g Thiamethoxam+ 0ml distilled water
Coating 1 (C_1)	10g readymade polymer+ 2g Homai + 1g Thiamethoxam +25ml distilled water
Coating 2 (C_2)	15g readymade polymer+ 2g Homai + 1g Thiamethoxam+ 25ml distilled water
Coating 3 (C_3)	20g readymade polymer+ 2g Homai + 1g Thiamethoxam+ 25ml distilled water
Coating 4 (C_4)	20ml 1% CMC + 2g Homai + 1g Thiamethoxam + 20ml colorant
Coating 5 (C_5)	20ml 1.5% CMC + 2g Homai + 1g Thiamethoxam + 20ml colorant
Coating 6 (C_6)	20ml 2% CMC + 2g Homai + 1g Thiamethoxam + 20ml colorant

Seed coating procedure

Seed film coating was carried out using a mechanical seed coating machine at the Vegetable Seed Centre, Gannoruwa, Sri Lanka. For each formulation, the required quantities of polymer, fungicide, and insecticide were measured and mixed with distilled water in the machine's liquid mixing tank. Seeds were coated uniformly and collected in polyethylene bags after completion.

Since film coating temporarily increased seed moisture content, the coated seeds were dried in a forced-air oven at 35–40°C for 10–12 hours until moisture content decreased below 12%. For storage, 45 g of seeds per replicate were weighed, packed in triple-laminated aluminium foil packets, machine-sealed, and stored under ambient (25°C) and cold room (15 °C) conditions at the Seed Certification Service, Gannoruwa, Peradeniya. Seed quality assessments were conducted before storage and at 1, 2, and 3 months after coating.

Data collection

Germination percentage

For each treatment, four replicates of 100 seeds were placed in sand-filled germination boxes and incubated in a germination chamber at 25°C. Germination percentage was determined according to International Seed Testing Association (ISTA) guidelines by counting number of germinated seedlings with well-developed cotyledons, hypocotyl, epicotyl, primary roots, and true leaves. Abnormal seedlings and dead seeds were excluded, and final germination was recorded on the seventh day.

$$Germination\,\% = \frac{No.of\ Germinated\ Seedings}{Total\ seedlings} \times 100$$

Seed moisture percentage

For each treatment, four replicates of five grams of ground seeds were placed in pre-weighed moisture containers. The containers with samples and lids were weighed, then dried in a hot air oven at 103±2°C for four hours using the low constant temperature method (ISTA Rules, 2023). Samples were cooled in a desiccator and reweighed to calculate moisture percentage.

$$Moisture\,\% = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

where,

M_1 = weight of container with lid (g)

M_2 = weight of the container with lid and seeds before drying (g)

M_3 = weight of the container with lid and seeds after drying (g)

$M_2 – M_3$ = Moisture loss

$M_2 – M_1$ = fresh weight of the sample

Root length

Five normal seedlings were randomly selected from all replicates per treatment on the seventh day after germination. Root length was measured from the primary root tip to the hypocotyl base using a scale, and the mean root length was expressed in centimetres.

Shoot length

The same five seedlings used for root length measurement were assessed for shoot length on the seventh day after germination. Shoot length was measured from the first leaf tip to the hypocotyl base, and the mean shoot length was expressed in centimetres.

Seedling length

Seedling length was calculated as the sum of root and shoot length on the seventh day after germination, with the mean expressed in centimetres.

Seedling Vigour Index (SVI)

SVI was calculated by multiplying germination percentage by mean seedling length (Abdul-Baki and Anderson, 1973).

$$SVI = seed\ germiation\% \times mean\ seedling\ length\ (cm)$$

Statistical data analysis

The Replicated Generalized Linear Model (PROC GLM) was used to analyse the observation ratio scale. The repeated mixed model was used to analyse count and percentage data, mean separation was done using least square means (LS means). The discrete variables (i.e., count data) were subjected to non-parametric analysis (PROC CATMOD). Statistical Analysis System version 9.4 was used. All significances were declared at *p*=0.05.

RESULTS AND DISCUSSION

Germination percentage of maize seeds decreased with increasing storage period, but the reduction rate was lower in coated seeds compared to non-coated controls (Table 2). Overall, polymer-coated seeds maintained higher germination because the coating particles act as a moisture-attracting "wick," accelerating germination during imbibition (Manoharapaladagu et al., 2017).

In MI Hybrid-4, germination declined gradually over three months. The highest germination after three months was recorded in C2 and C6 formulations, with similar values under both ambient and cold storage. In contrast, uncoated control seeds (C0) showed a reduction of more than 10% over the same period. Most other coatings showed moderate reductions, while differences between storage temperatures were minimal. Overall, germination remained commercially acceptable (≥75%) for all coatings.

Table 2. Influence of seed coating formula and storage temperature on germination (%) of maize

Temperature	Treatment	Initial month		Month 1		Month 2		Month 3	
		MI Hybrid 4	MI Hybrid 5	MI Hybrid 4	MI Hybrid 5	MI Hybrid 4	MI Hybrid 5	MI Hybrid 4	MI Hybrid 5
Ambient T	C_0	90.5^{B}	78.5^{C}	86.5^{E}	75^{E}	84.5^{F}	73^{G}	81^{F}	68.5^{F}
	C_1	91^{A}	80^{B}	88^{DE}	76.75^{BCD}	86.25^{DE}	75.25^{DEF}	85.25^{CD}	74.5^{CD}
	C_2	92^{A}	81^{A}	90.5^{B}	80^{B}	90^{AB}	78.75^{AB}	89.25^{A}	78^{A}
	C_3	90.5^{B}	79^{C}	88.75^{CD}	76.75^{BCD}	86.25^{DE}	75.25^{DEF}	83.75^{DE}	73.25^{DE}
	C_4	90.5^{B}	78.5^{C}	87.75^{DE}	77.75^{BC}	87.25^{CDE}	75.25^{DEF}	83.75^{DE}	74.5^{CD}
	C_5	91^{B}	80^{B}	88.75^{CD}	78^{BC}	88.25^{BCD}	77^{CDE}	85.5^{CD}	74.75^{CD}
	C_6	92^{A}	81^{A}	90.5^{B}	80^{B}	90^{AB}	78.75^{AB}	89^{A}	77.75^{A}
Cold room T	C_0	90.5^{B}	78.5^{C}	86.5^{E}	75^{E}	84.5^{F}	73^{G}	81^{F}	68.5^{F}
	C_1	91^{B}	80^{B}	89^{CD}	77.75^{BC}	88.25^{BCD}	77.25^{BC}	87.5^{BC}	76.75^{BC}
	C_2	92^{A}	81^{A}	91.75^{A}	81.25^{A}	90.25^{A}	80.25^{A}	89.50^{A}	78^{A}
	C_3	90.5^{B}	79^{C}	89.25^{BCD}	77.25^{BCD}	87.25^{CDE}	75.25^{DEF}	86^{BCD}	73.75^{DE}
	C_4	90.5^{B}	78.5^{C}	88^{DE}	78^{BCD}	87.75^{BCD}	76.25^{DEF}	87.5^{BC}	75.25^{CD}
	C_5	91^{B}	80^{B}	89.25^{BCD}	77.25^{BCD}	89.25^{BC}	77.25^{BC}	88.25^{B}	76.25^{BC}
	C_6	92^{A}	81^{A}	91.75^{A}	81.25^{A}	90.25^{A}	80.25^{A}	89.25^{A}	77.75^{A}
SE		0.27	0.27	0.65	0.65	0.87	0.87	0.87	0.87

In MI Hybrid-5, C2 and C6 also maintained the highest germination (78%) after three months, irrespective of storage temperature, with only about a 3% reduction during storage. Uncoated seeds exhibited the lowest germination (68%) with a reduction of over 10%, while other coatings showed approximately 5% reduction. Differences between ambient and cold storage were negligible. Table 2 presents the detailed germination percentages of all treatments at different storage intervals.

Seed coating treatments significantly influenced shoot length, root length, seedling length, and seedling vigour index (SVI) of maize seeds stored for three months under both ambient and cold room conditions (Table 3). After three months of storage in MI Hybrid-4, shoot lengths of all coated treatments were significantly higher than the uncoated control, irrespective of storage temperature (Table 3). The difference exceeded 1 cm. Highest shoot lengths (over 19.0 cm) were observed in C2 and C6, significantly higher than other treatments. C1 and C5 recorded similar shoot lengths to C2 and C6 under ambient storage. Storage conditions did not significantly affect shoot length within coating treatments (Table 3).

Table 3. Effect of seed coating with polymer, fungicide and insecticide and storage temperature on shoot length (cm), root length(cm), seedling length(cm) and seedling vigour index (SVI) of maize seeds after three months of storage

Temperature	Treatment	Shoot length		Root length		Seedling length		SVI	
		MI Hybrid 4	MI Hybrid 5	MI Hybrid 4	MI Hybrid 5	MI Hybrid 4	MI Hybrid 5	MI Hybrid 4	MI Hybrid 5
Ambient T	C0	17.16^{G}	16.56^{I}	20.45^{D}	19.54^{E}	38.11^{F}	36.10^{F}	3231.15^{G}	2546.23^{G}
	C1	18.76^{BCD}	18.01^{FG}	22.02^{C}	20.98^{CD}	40.68^{E}	38.89^{CD}	3561.7^{DEF}	2976.69^{DEF}
	C2	19.07^{AB}	18.31^{BC}	22.34^{AB}	21.17^{ABC}	41.59^{AB}	39.41^{AB}	3713.03^{B}	3120.7^{B}
	C3	18.61^{CDEF}	18.10^{EF}	21.96^{C}	20.90^{CD}	40.58^{E}	38.95^{CD}	3545.46^{EF}	2930.53^{EF}
	C4	18.72^{CDE}	17.95^{GH}	21.96^{C}	21.03^{CD}	40.69^{E}	38.77^{DE}	3559.86^{DEF}	2960.3^{DEF}
	C5	18.83^{BC}	18.05^{FG}	22.23^{ABC}	20.96^{CD}	41.06^{BCD}	39.01^{CD}	3630.76^{CD}	3000.03^{CD}
	C6	19.10^{AB}	18.30^{BC}	22.23^{ABC}	21.19^{ABC}	41.49^{AB}	39.69^{AB}	3713.03^{B}	3120.7^{B}
Cold room T	C0	17.45^{G}	16.73^{I}	20.7^{D}	19.76^{E}	38.15^{F}	36.50^{F}	3233.25^{G}	2532.81^{G}
	C1	18.83^{BC}	18.16^{DE}	22.11^{ABC}	21.04^{BC}	40.95^{CDE}	39.20^{BC}	3620.96^{CDE}	3056.18^{CDE}
	C2	19.22^{A}	18.48^{A}	22.39^{A}	21.3^{A}	41.61^{A}	39.78^{A}	3772.06^{A}	3197.45^{A}
	C3	18.81^{BCD}	18.03^{FG}	22.04^{BC}	20.96^{CD}	40.86^{DE}	38.63^{DE}	3538.68^{F}	2961.21^{F}
	C4	18.86^{BC}	17.96^{GH}	22.12^{ABC}	20.98^{CD}	40.98^{CDE}	38.94^{CD}	3622.84^{CDE}	2999.39^{CDE}
	C5	18.87^{BC}	18.18^{DE}	22.18^{ABC}	21.06^{BC}	41.06^{BCD}	39.25^{BC}	3673.2^{BC}	3049.81^{BC}
	C6	19.27^{A}	18.47^{A}	22.38^{A}	21.3^{A}	41.6^{A}	39.71^{A}	3768.64^{A}	3197.45^{A}
SE		0.12	0.12	0.11	0.11	0.22	0.22	29.11	29.11

In MI Hybrid-5, shoot lengths were highest in C2 and C6 under cold conditions, followed by ambient storage of the same treatments (Table 3). The uncoated control recorded the lowest shoot length, with a difference exceeding 1.5 cm under both storage conditions. Storage temperature did not significantly affect shoot length within respective coating treatments.

In MI Hybrid-4, highest root lengths were observed in C2, C5, and C6 under both storage conditions. Additionally, C1 and C4 under cold storage showed root lengths greater than 22.0 cm, statistically similar to the highest values. Root length difference between coated and uncoated treatments exceeded 1.50 cm (Table 3). Root lengths were similar between storage conditions within each treatment.

In MI Hybrid-5, root lengths were highest in C2 and C6 under cold storage, though ambient storage was statistically similar (Table 3). All coating treatments showed root lengths similar to ambient storage of C2 and C6. The non-coated control recorded the lowest root length (19.5 cm) under both conditions, 1.5 cm lower than coated treatments. Root lengths were similar between storage conditions within each coating treatment.

After three months in MI Hybrid-4, highest seedling length was observed in C2 and C6, with similar values between storage conditions (Table 3). All six coatings showed higher seedling lengths than the control, with differences around 3.0 cm. C5 under both storage conditions showed similar values to ambient storage of C2 and C6. Seedling lengths were not different between storage temperatures in any treatment (Table 3).

In MI Hybrid-5, highest seedling length was observed in C2 and C6, with both storage conditions statistically similar (Table 3). C5 and C1 under cold storage showed similarity to ambient storage of C2 and C6. All coatings showed higher seedling lengths than the control, with differences exceeding 3.0 cm. Seedling lengths were similar within each coating treatment under both storage temperatures.

After three months in MI Hybrid-4, highest SVI was recorded in C2 and C6 under cold storage, followed by ambient storage of the same treatments (Table 3). Cold storage of C5 showed similar SVI. The lowest SVI was observed in the non-coated control. All coatings showed SVI more than 500 units higher than the control. Significant differences between ambient and cold storage were observed only in C2 and C6.

In MI Hybrid-5, highest SVI was recorded in C2 and C6 under cold storage. Ambient storage of C2 and C6 recorded similar SVI to cold storage of C1 and C5 (Table 3). The non-coated control showed the lowest SVI, with difference exceeding 500 units. Significant differences between storage conditions were observed only in C2 and C6.

Table 4: Effect of seed coating with polymer, fungicide and insecticide and storage temperature on moisture % of maize seeds after three months of storage

Temperature	Treatment	Initial month		Month 1		Month 2		Month 3	
		MI Hybrid 4	MI Hybrid 5	MI Hybrid 4	MI Hybrid 5	MI Hybrid 4	MI Hybrid 5	MI Hybrid 4	MI Hybrid 5
Ambient T	C0	11.34	11.37	11.92	12	12.22	12.72	12.42	13.02
	C1	11.2	11.27	11.3	11.4	11.32	11.62	11.3	11.87
	C2	11.27	11.17	11.37	11.32	11.52	11.5	11.72	11.72
	C3	11.2	11.2	11.42	11.32	11.47	11.27	11.6	11.42
	C4	11.17	11.37	11.47	11.37	11.42	11.42	11.55	11.52
	C5	11.07	11.3	11.2	11.47	11.2	11.47	11.3	11.57
	C6	11.02	11.27	11.1	11.37	11.07	11.57	11.2	11.8
Cold room T	C0	11.3	11.3	11.87	12.02	12.12	12.82	12.42	13.12
	C1	11.2	11.27	11.27	11.35	11.47	11.75	11.6	11.87
	C2	11.27	11.17	11.3	11.32	11.57	11.7	11.72	11.8
	C3	11.2	11.2	11.47	11.57	11.37	11.77	11.5	11.95
	C4	11.17	11.37	11.4	11.47	11.4	11.5	11.47	11.7
	C5	11.07	11.3	11.2	11.3	11.22	11.3	11.2	11.4
	C6	11.02	11.27	11	11.3	11.07	11.27	11.2	11.45

Seed moisture content of maize seeds increased gradually during storage under both ambient and cold room conditions in MI Hybrid-4 and MI Hybrid-5 (Table 4). After three months in both MI Hybrid-4 and MI Hybrid-5, all coating treatments-maintained seed moisture percentage well below 12% under both storage temperatures (Table 4). The moisture percentage of non-coated control exceeded 12% during three-month storage, irrespective of storage conditions (Table 4).

Seed-film coating promotes early emergence, growth, and yield of maize by establishing seedlings with greater vigour (John et al., 2005), as similarly observed in this study. Coated seeds delivered better seedling qualities; thus, field establishment may be similar to laboratory conditions, with coating compounds significantly influencing establishment and early growth. The C6 (20ml of 2% Carboxy Methyl Cellulose (CMC) + 2g Homai + 1g Thiamethoxam + 20ml colorant), and C2 (15g ready-made polymer + 2g Homai + 1g Thiamethoxam + 25ml distilled water) performed best at tested conditions.

Senescence in seeds is inevitable and irreversible. Polymer coating is a pre-storage treatment used alone or with fungicides and pesticides to slow seed deterioration and protect against pests and diseases (Gowda et al., 2018). This study proved all six coating formulations showed lower seed deterioration compared to uncoated control, with the two aforementioned combinations delivering less deteriorative impact.

Polymer seed coating significantly affects germination, seedling vigour, growth, and yield improvement in cowpea, maize, and mustard when used alone or with insecticides and fungicides (Reddy et al., 2019), as similarly observed in this study. In field conditions, external environment greatly influences seed emergence; thus, adding Homai and Thiamethoxam during coating benefits pest and disease mitigation.

Moisture content is a major factor affecting seed quality deterioration during storage. Moisture absorption can trigger volunteer germination or reduce viability. In studies using watermelon and okra seeds, moisture content in non-coated control was comparatively higher than coated treatments throughout storage (Priyantha et al., 2021). Coating facilitates moisture retention to maintain seed viability for longer periods even under ambient conditions. In this study, all coating methods retained moisture at accepted range for three months under both storage conditions.

Lower than 20°C and 50% humidity is ideal for storing uncovered seeds long-term, and seeds need waterproof containers (Rahmawati & Aqil, 2020). Critical barrier qualities of packing material affecting shelf life are water vapor and oxygen transmission rates (Dutta & Dutta, 2016). Triple laminated aluminium foil's water vapor transmission rate was 0.2910 g/m²/day and oxygen transmission rate were 0.21993cc/m²/day (Robertson, 2013). In tomato seed studies, triple laminated aluminium foil prevented moisture content fluctuation (Ariyarathna et al., 2020). Similarly, triple laminated aluminium packaging minimized seed quality deterioration despite storage temperature.

Since facilitating controlled conditions involves huge cost, polymer seed coating is an alternative approach to maintain seed quality during ambient storage (Gowda et al., 2018). In this study, coated seed quality deterioration was minimum under ambient storage. Although this study ended within three months, seed moisture, germinability, and seedling vigour suggested possibilities of longer storage periods.

CONCLUSIONS

Germination percentage of seed coating formulations remained unaffected compared to the uncoated control. Seedling vigour index of all seed coating formulations exhibited remarkable resilience, demonstrating no significant deviation when compared to control treatment. Each seed-coating formulation displayed an elevation in terms of shoot lengths, root lengths, and seedling lengths, surpassing those observed in the non-coated seeds.

After three months of storage, the seed moisture percentage was below 12% in the coated treatments, while the moisture content of the non-coated exceeded 12%. Seed and seedling quality were unaffected by storage temperature. The seed and seedling quality of coated seeds remain unchanged during the storage period even under ambient air conditions. The coating with 20ml of 2% Carboxy Methyl Cellulose + 2g Homai + 1g Thiamethoxam + 20ml colorant (C6) and 15g readymade polymer+ 2g Homai + 1g Thiamethoxam+ 25ml distilled water (C2) were found to be very effective; hence recommended as effective seed-film coatings for improving seed quality and enhancing storage life.

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