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Short Communication

Effect of Seed Coating on Storability of Barley (*Hordeum vulgare* L.) Seeds

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Barley (*Hordeum vulgare* L.) is a self-pollinated, diploid species (2n = 2x = 14) belonging to the tribe *Triticeae* of the family Poaceae. It is an important cereal crop cultivated globally and in India, covering approximately 453 thousand hectares with a production of 1.37 million tonnes and an average productivity of 30.0 q/ha (Anonymous, 2023). In Himachal Pradesh, barley is mainly grown during the *Rabi* season on about 20 thousand hectares, yielding around 36.2 thousand tonnes with an average productivity of 18.1 q/ha (Anonymous, 2021).

Seed quality is one of the key determinants of crop productivity, as the commercial success of a variety depends on its viability, vigour, and storability. Seed deterioration is a natural and irreversible process that begins once the seed reaches physiological maturity, leading to a gradual loss in germination and vigour over time (Doijode, 1990). Since seeds are generally stored for later sowing, proper storage conditions are critical. The rate of deterioration is influenced by both genetic and environmental factors but can be reduced by adopting suitable seed treatments or maintaining controlled storage environments (Parashurama *et al.,* 2021). Among various preservation techniques, seed coating has emerged as a cost-effective method to maintain seed quality without requiring expensive infrastructure (Javed *et al.,* 2022). It involves the application of thin polymer films (around 8 μm) embedded with fungicides, insecticides, or growth-promoting substances. These coatings are non-toxic, permeable to gases and water, and protect seeds from environmental stress and microbial infection, thereby improving germination, seedling emergence, and early growth (Dixit *et al.,* 2018). Polymers also act as carriers for nutrients, bioagents, and protectants, offering a versatile and efficient approach for seed enhancement.

Despite the importance of seed quality, systematic studies on barley seed storability under Indian conditions are limited. With the expansion of organized seed production, awareness of seed ageing and storage losses has increased. It has been reported that about 80% of certified seed in India is used within a single season, while 20% is retained for subsequent sowing (Bal, 1976). In Himachal Pradesh, rapid deterioration of barley seed is commonly observed due to untreated seeds, poor storage environments, and substandard packaging, emphasizing the need for improved preservation strategies. The present study was undertaken to evaluate the efficacy of polymer-based coatings, alone and in combination with fungicides and insecticides, for enhancing barley seed longevity under ambient storage conditions in the mid-hills of Himachal Pradesh. Seeds harvested during *Rabi* 2021–22 from the Hill Agricultural Research and Extension Centre, Bajaura (Kullu), were cleaned and manually coated with polymers, fungicides, insecticides, and *Trichoderma* spp. following standard protocols. The treated seeds were shade-dried for 72 hours to reduce their moisture content to approximately 13% before being packed in high-density

Table 1: Effect of different seed coating treatments on barley during storage

Treatment	Treatment Description	Germination (%)		Field Emergence (%)		Seedling Length (cm)		Seedling Dry Weight (mg)		Vigour Index – I		Vigour Index – II	
		Initial	12 Months	Initial	12 Months	Initial	12 Months	Initial	12 Months	Initial	12 Months	Initial	12 Months
T1	Control	88.33	82.67	75.67	70.67	39.87	37.82	20.00	18.38	3522.14	3126.23	1766.70	1519.42
T2	Polymer coating (Polykote) @ 3.0 ml/kg seed + 5.0 ml water	88.33	84.33	76.00	71.33	40.33	38.28	20.26	18.64	3562.77	3228.55	1789.63	1571.69
T3	Tebuconazole @ 1.0 g/kg seed	88.67	86.00	77.67	73.00	40.70	38.67	20.47	18.84	3608.73	3325.91	1814.72	1619.95
T4	Polymer + Tebuconazole @ 1.0 g/kg seed	89.00	86.67	78.33	73.67	40.80	38.82	20.56	18.94	3631.20	3364.10	1830.14	1641.18
T5	Vitavax Power (Thiram 37.5% + Carboxin 37.5%) @ 2.0 g/kg seed	88.67	86.33	78.00	73.33	40.75	38.77	20.55	18.92	3613.15	3346.86	1822.41	1633.71
T6	Polymer + Vitavax Power @ 2.0 g/kg seed	89.33	87.00	78.67	74.00	40.83	38.85	20.57	18.95	3647.77	3380.24	1837.58	1648.36
T7	Imidacloprid (Gaucho) @ 4.0 ml/kg seed	88.33	84.67	76.33	71.67	40.37	38.33	20.28	18.65	3565.70	3245.27	1791.11	1579.31
T8	Polymer + Imidacloprid (Gaucho) @ 4.0 ml/kg seed	88.33	85.67	77.33	72.67	40.67	38.63	20.46	18.83	3592.23	3309.58	1807.01	1612.82
T9	*Trichoderma harzianum* coating @ 5.0 g/kg seed	88.33	85.33	77.00	72.33	40.63	38.60	20.45	18.82	3589.30	3293.87	1806.71	1605.97
T10	Trichoderma virens coating @ 5.0 g/kg seed	88.33	85.00	76.67	72.00	40.40 /	38.37	20.29	18.66	3568.67	3261.17	1791.99	1586.38
	Mean	88.57	85.37	77.17	72.47	40.54	38.51	20.39	18.76	3590.17	3288.18	1805.80	1601.88
	SE (m±)	0.017	0.015	0.016	0.016	0.03	0.04	0.02	0.01	12.62	11.49	7.55	5.18
	CD (5%)	NS	0.045	0.047	0.048	0.09	0.11	0.06	0.03	37.48	34.13	22.44	15.38

NS: Non significant; CD= Critical differences polyethylene (HDPE) interwoven bags and stored under ambient conditions from March 2022 to March 2023. The experiment was laid out in a Completely Randomized Design (CRD) with three replications. Bimonthly observations were taken on germination, field emergence, seedling length, dry weight, rate of germination, and vigour indices following standard procedures (Abdul Baki and Anderson, 1973; Divya, 2022; Kotia, 2020). Moisture content was measured using a non-destructive moisture meter (PM 600). Data were statistically analyzed using OPSTAT software, and treatment differences were tested at the 5% level of significance (Sundararaj *et al.,* 1972). Germination and field emergence percentages were square-root transformed prior to analysis.

The resulted mentioned in Table 1 indicated that seed germination decreasing from 88.57% initially to 85.37% after twelve months of storage. Seeds treated with polymer + Vitavax Power (T6) recorded the highest germination (87.0%), followed by polymer + Tebuconazole (T4) at 86.67% and Vitavax Power alone (T5) at 86.33% (Table 1). The polymer coating appeared to act as a barrier against fluctuations in oxygen and moisture, thereby reducing ageing-related deterioration. Similar results have been reported in wheat and rice, where polymer-fungicide treatments maintained higher germination rates during storage (Thakur and Dhiman, 2020; Sharma and Dhiman, 2017).

Field emergence exhibited a similar pattern, declining from 77.17% to 72.47% over the storage period. The highest emergence (74.0%) was recorded in T6-treated seeds, demonstrating the protective effect of polymer-fungicide combinations against soil-borne pathogens and early pest damage. The rate of germination also decreased gradually, from an average of 80.51 to 79.22, with T6, T4, and T5 consistently showing superior performance (Table 1). Seedling length and dry matter content declined with time, but the highest values were recorded in T6 (38.85 cm length and 18.95 mg dry weight), indicating that the treated seeds retained better metabolic efficiency and resource utilization. These results corroborate findings in maize, soybean, okra, and radish, where similar seed treatments enhanced vigour under storage conditions (Sharma *et al.,* 2017; Goswami *et al.,* 2017; Parihar *et al.,* 2019; Divya, 2022; Kotia, 2020).

Seed vigour indices I and II declined from 3590.17 and 1805.80 initially to 3288.18 and 1601.88, respectively, after twelve months (Table 1). The highest vigour was consistently recorded in T6, followed by T4 and T5, indicating that polymer-fungicide combinations effectively mitigated physiological ageing. Improved vigour in these treatments can be attributed to enhanced seedling growth, maintenance of dry matter, and reduced cellular damage. Similar beneficial effects of polymer-based treatments have been reported in soybean, chickpea, wheat, and rice (Desai *et al.,* 2015; Roopashree *et al.,* 2018; Dixit *et al.,* 2018; Padhi *et al.,* 2017).

Seed moisture content showed slight variation during storage, increasing marginally from 13.26% to 13.85%. Significant differences among treatments emerged after two months, with the lowest moisture content recorded in polymer + imidacloprid (T8), followed by imidacloprid alone (T7) and polymer + Vitavax Power (T6). The polymer coating likely reduced exposure to ambient humidity, minimizing moisture absorption and preserving seed quality, which is consistent with earlier reports in soybean and wheat (Thakur and Dhiman, 2016).

Overall, the study clearly demonstrated that barley seed quality declines gradually during storage under ambient conditions, but polymer-based coatings, particularly when combined with fungicides, significantly retard deterioration. Treatments such as polymer + Vitavax Power (T6), polymer + Tebuconazole (T4), and Vitavax Power alone (T5) were most effective in maintaining germination, field emergence, vigour, and moisture stability over twelve months of storage. These results clearly indicate the practical utility of polymer-fungicide coatings as a cost-effective, environmentally safe, and efficient strategy for improving barley seed storability, especially in the mid-hill regions of Himachal Pradesh where storage conditions are suboptimal. Adoption of such treatments can help farmers and seed producers maintain seed viability and vigour, ensuring better field establishment, higher yields, and long-term seed security. Future research should explore integrating polymers with bioagents and micronutrients to develop multifunctional coatings that further enhance seed longevity and early seedling performance under variable environmental conditions.

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Author's Contribution

Conceptualization of research (PW, KCD, RKK, RK); Designing of the experiments (KCD, RKK, RK, PW); Contribution of experimental materials (KCD, PW); Execution of field/lab experiments and data collection (PW, KCD, RKK, RK); Analysis of data and interpretation (KCD, RKK, RK, PW); Preparation of the manuscript (PW, KCD, RKK, RK).

Conflict of Interest

Authors declare that they have no conflict of interests.

Ethical Compliance Statement

NA

Generative AI or AI/Assisted Technologies use in Manuscript Preparation

No

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