RESEARCH ARTICLE

Comparative analysis of morphological and yield-related parameters in wheat varieties subjected to accelerated aging stress

Sunita Bhandari

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In this investigation four varieties of wheat viz. VL-829, VL-802, UP-1109 and VL-892 and were subjected for estimated the effect of accelerated ageing at 45°C and 100% relative humidity for 15, 30 and 45 days along with control. The experiment was laid out in factorial RBD with three replications of each treatment. Aged seed from different treatments control, 45, 30, and15 days accelerated ageing of each variety were subjected to field experiment for evaluating plant growth, seed yield and its contributing characters. Results showed decline in all yield attributes and growth parameters with increase in ageing period. Rapid decline in seed yield contributing characters were observed in VL-802 whereas, less reduction observed in VL-892.

Key Words: *Wheat varieties; Accelerated ageing; Seed quality; Morphological characters; Yield parameters*

INTRODUCTION

Wheat, scientifically known as *Triticum aestivum* L., stands as the paramount crop globally, occupying a pivotal position among the three primary cereal crops, which include rice, maize, and wheat, collectively supplying 20% of the essential energy in the human diet [1,2]. Belonging to the gramineae family, specifically the *Triticum* genus, wheat, in its early stages, bears a striking resemblance to yard grass [3]. Its cultivation is widespread across India, with the exception of the Southern and North Eastern states. Uttar Pradesh, Haryana, Punjab, and Rajasthan stand as the major wheat-producing states, collectively contributing to nearly 80% of the total production. It's noteworthy that only 13% of the cultivated land is dedicated to rainfed wheat production. India is the world's second-largest producer of wheat, after China. With a productivity of 3507 kg, India produced 106.84 million tonnes from an area of 30.47 million hectares [4].

In the realm of seed storage, temperature and humidity play pivotal roles in determining the seed's longevity. The rate of seed germination loss varies significantly among different wheat cultivars when exposed to conditions of 42°C and 100% relative humidity. Hence, the storage potential of distinct wheat varieties hinges on their genetic makeup. To assess the storability of wheat seeds under these conditions, a specialized test is employed, known as accelerated ageing. This test serves as a physiological stress test, facilitating controlled seed deterioration through exposure to elevated temperature and high relative humidity, exceeding 90% [5]. Accelerated ageing is regarded as a predictive test for seed storability, as it induces cellular-level changes in seeds, simulating the effects of long-term storage within a relatively short period. This simulation is achieved by subjecting seeds to increased temperatures (40°C) and higher relative humidity levels (99%-100% RH) [6].

Accelerated ageing has been recognized as a good predictor of the storability of seed lots by investigating the seed quality status of the naturally aged seed vis-a-vis the freshly harvested seeds.

MATERIALS AND METHODS

The study titled "Comparative analysis of morphological and yield-related parameters in wheat varieties subjected to accelerated aging stress" was conducted at the Research Block of Seed Science and Technology, VCSG UUHF, College of Forestry, Ranichauri, Tehri Garhwal, Uttarakhand. Experimental material for present investigation comprised of four variety of wheat viz., VL-829, VL-802, UP-1109 and VL-892 were obtained from Research Station, Gaja, V.C.S.G., U.U.H.F., College of Forestry, Ranichauri, Tehri Garhwal. In accelerated ageing test, seed sample of four wheat varieties VL-829, VL-802, UP-1109 and VL-892 were taken in muslin cloth bags. This muslin cloth bags were placed on the desecraters which is already filled with water in such a way that seed places in muslin cloth bags were 2-3 cm above the water. The lid of desecraters is covered with tape and tied with rubber band. These desecraters were then placed in an incubator at 45°C for 15, 30 and 45 days of ageing and seed were further used for field experiments. Approximate 200 g seed of each variety was stored in cloth bags under storage condition for 15, 30 and 45 days. The field experiments were arranged using a Randomized Block Design (RBD) with three replications. Each replication included four treatments, which were planted in two rows. Each row had a length of three meters, with a row spacing of 25 centimeters and a plant-to-plant spacing of 5 centimeters.

Days to 50% field emergence

Field emergence was recorded after 15 days of sowing when the entire seedling emerged out from the soil, in each row.

Days of 50% head emergence

The number of days to 50% head emergence was recorded on each treatment in all three replications.

Days to maturity

Number of days taken for crop maturity was taken as the number of days from sowing to the maturity of crop.

Plant height (cm)

Plant height was recorded at the time of maturity stage. Heights of five randomly selected plants were measured by scale from the ground level to tip of the top most ear head. The average was expressed as plant height in cm.

Length of leaf (cm)

Leaf length of five randomly selected plants was recorded and averaged.

Number of tillers per plant

To record the number of tillers per plant, five plants were selected randomly from every plot from the marked row at harvest. Their tillers were counted and averaged to express the number of tillers per plant.

Number of seeds per ear

Number of seeds of five randomly selected heads were counted and averaged.

School of Agriculture, RNB Global University, Bikaner-334601, Rajasthan, India

Correspondence: *Sunita Bhandari, School of Agriculture, RNB Global University, Bikaner-334601, Rajasthan, India, E-mail: sunita.bhandari@rnbglobal.edu.in*

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Ear length (cm)

Ear length was measured from the basal to end of the tip of the head and was averaged for five randomly selected ears.

100 seed weight (g)

After threshing and recording the net plot yield, a random sample of fully grown 100 seeds was counted and weighed to record the test weight.

Seed yield per plant (g)

To record the number of seeds per plant, the pods of five randomly selected plants were harvested, threshed and seeds were weighed and averaged to express the seed yield per plant.

RESULTS

Field emergence

Field emergence was recorded after 15 days of sowing when the entire seedling emerged out from the soil, in each row.

In present investigation variety VL-892 showed the maximum mean value of the field emergence (59.16%) followed by VL-829 (56%), UP-1109 (54.83%) and VL-802 (49.41%). The interaction due to variety and accelerated ageing period had significant difference for field emergence as compared to control. It was observed that reduction in field emergence from control to 45 days accelerated ageing was 54.66 to 42.00 in VL-802, 67.33 to 48.33 in VL-829, 66.66 to 52.00 in VL-892 and 63.33 to 47.66 in UP-1109. In 15 days, accelerated aged seed significant reduction in field emergence was observed minimum recorded in VL-892 (2.49%) and maximum in VL-829 (15.84%) as compared to control. At 45 days aged seed, minimum reduction in field emergence was recorded in VL-892 (21.99%) followed by VL-802 (23.16%), UP-1109 (23.53%) and VL-829 (28.21%) over control (Table 1).

Days to 50% head emergence: The number of days to 50% head emergence was recorded on each treatment in all three replications. Varietal mean of wheat variety had significantly differed for different yield characters. Variety VL-892 took minimum number of days to 50% head emergence (146.16) which is statistically at par with VL-802 (146.25) followed by VL-829 (147.66) and UP-1109 (155.08). The interaction due to variety and accelerated ageing period had significant difference for 50% head emergence. Delay in 50% head emergence from control to 45 days. Accelerated ageing was 141.33 to 150.67 to in VL-802, 142.00 to 153.33 in VL-829, 143.00 to 147.33 in VL-892 and 149.33 to 160.33 in UP-1109. In 15 days Accelerated aged seed significant delay in 50% head emergence was observed maximum in UP-1109 (3.03%) and minimum in VL-802 (2.06%) over control. At 45 accelerated aged seed, maximum delay in 50% head emergence was observed in VL-829 (7.38%) followed by UP-1109 (6.86%), VL-802 (6.19%) and VL-892(2.93%) over control. Prolonged accelerated ageing caused delay in 50% head emergence in all varieties of wheat (Table 2).

Days to 50% maturity: Number of days taken for crop maturity was taken as the number of days from sowing to the maturity of crop. Variety VL-892 took the minimum days to 50% maturity (185.50) followed by VL-829 (188.16), VL-365 (188.41) and UP-1109 (193.41). The interaction due to variety and accelerated ageing period had significant difference for days to 50% maturity. Days to 50%, maturity is delay as increasing ageing period. Delay in days to 50% days to maturity from control to 45 days accelerated ageing was observed 186.00 to 190.66 in VL-365, 184.00 to 192.33 in VL-829, 182.66 to 191.35 in VL-892 and 192.33 to 195.66 in UP-1109. In 30 days, accelerated aged seed significant delay in days to 50% maturity was observed in maximum VL-892 (2.98%) and minimum in VL-829 (0.68%) over control. At 45 days accelerated aged seed, maximum delay days to 50% maturity was observed in VL-892 (4.43%) followed by VL-829 (4.33%), VL-365(2.44%) and in UP-1109 (1.70%) over control (Table 3).

Plant height (cm): Plant height was recorded at the time of maturity stage. Heights of five randomly selected plants were measured by scale from the ground level to tip of the top most ear head.

Variety VL- 892 showed the minimum mean value of plant height (69.83 cm) followed by VL-829 (76.25 cm) VL-802 (77.00 cm) and UP-1109 (80.58). The interaction due to variety and accelerated ageing period had non-significant difference for plant height. Plant height is reduced as increasing ageing periods. Reduction in plant height from control to 45 days accelerated ageing was 80.66 to 73. 66 cm in VL-802, 79.33 cm to 73.00 cm in VL-829, 73.66 cm to 66.33 cm in VL-892 and 84.66 cm to 76.33 cm in UP-1109. In 15 days Accelerated aged seed, significant reduction in plant height were observed minimum in UP-1109 (1.57%) and maximum in VL-802 (3.29%) over control. At 45 days accelerated aged seed, maximum reduction in plant height was observed in VL-892 (9.95%) followed by UP-1109 (9.83%), VL-802 (8.67%) and VL-829 (7.97%) over control and at this stage, VL-802 (73.66 cm) and VL-829 (73.00 cm) was statistically at par with each other (Table 4).

Number of tillers per plant: Variety UP-1109 showed the maximum mean value of numbers of tillers (4.65) which is statistically at par with VL-892 (4.49) followed by VL-829 (4.25) and VL-802 (3.47). The interaction due to variety and accelerated ageing period showed non- significant differences for this character. Plant tiller was reduced as increased ageing period. Reduction in plant tiller from control to 45 days accelerated ageing was 3.86 to 3.10 in VL-802, 4.66 to 3.93 in VL-829, 4.73 to 3.73 in VL-892 and, 4.73 to 4.86 in UP-1109. In 15 days accelerated aged seed, significant minimum reduction in plant tiller was observed in VL-365(8.54%) and maximum in UP (11.20%) over control. At 45 days accelerated aged seed, maximum reduction in plant tillers was observed in VL-802 (19.68%) followed by VL-829 (15.65%), VL-892 (21.14%) and UP-1109 (2.78%) over control. At this stage, UP-1109 (4.86) was statistically at par with VL-829 (3.93) and VL-892 (3.73) (Table 5).

Leaf length (cm): Variety UP-1109 had largest leaf length (23.83 cm) which is statistically at par with VL-892 (23.25 cm) followed by VL-829 (21.50 cm) and VL-802 (21.58 cm). The interaction due to variety and accelerated ageing period showed significant difference for leaf length. Leaf length was reduced as increased ageing period. Reduction in leaf length from control to 45 days accelerated ageing was 20.66 to 19.66 cm in VL-802, 24.33 to 19.66 cm in VL-829, 22.00 to 23.33 cm in VL-892 and 23.00 to 25.00 cm in UP-1109 (Table 6).

Ear length (cm): Variety VL-892 showed largest mean value of ear length (14.21 cm) followed by VL-829 (11.38 cm), VL-802 (10.31 cm) and UP-1109 (10.26 cm). The interaction due to variety and accelerated ageing period showed non-significant difference for ear length. Reduction in ear length from control to 45 days accelerated ageing was 12.00 to 9.43 cm in VL-802, 13.00 to 9.93 cm in VL-829, 15.56 to 12.86 cm in VL-892 and 11.40 to 9.53 cm in UP-1109. In 15 days accelerated aged seed, significant minimum reduction in ear length was observed in UP-1109 (5.45%) and maximum in VL-892 (6.49%) over control. At 45 days accelerated aged seed, maximum reduction in ear length was observed in VL-892 (17.35%) followed by VL-829 (12.46%), VL-802 (21.42%) and UP-1109 (16%) over control, at this stage (Table 7).

Seed per head: Variety VL-892 had highest seed per head (26.25) followed by VL-802 (23.83), UP-1109 (23.83) and VL-829 (22.83). The interaction due to variety and accelerated ageing period had significant. Reduction in seeds/head from control to 45 days accelerated ageing was 27.33 to 21.33 in VL-802, 30.66 to 18.66 in VL-829, 32.33 to 21.66 in VL-892 and 28.00 to 18.00 in UP-1109. In 15 days accelerated aged seed significant reduction in seeds/head was observed minimum in VL-829 (15.84%) and maximum in VL-892 (16.48%) over control. At 45 days accelerated aged seed maximum reduction in seeds was observed in VL-829 (39.13%) followed by UP-1109 (35.71%), VL-802 (21.95%) and VL-892 (32.66%) over control (Table 8).

Seed yield (g): Variety VL-892 showed the highest mean value of seed yield (22.47 g) followed by, VL-829 (21.89 g), VL-802 (21.72 g) and UP-1109 (21.18 g). The interaction due to variety and accelerated ageing period had significant difference for seed yield. Seed yield was reduced as increased ageing period. Reduction in seed yield from control to 45 days accelerated ageing was 28.35 to 16.66 in VL-802, 27.33 to 17.54 in VL-829, 28.33 to 18.00 in VL-892 and 25.58 to 17.66 in UP-1109. In 15 days accelerated aged seed, significant reduction in seed yield was observed minimum in VL-802 (15.34%) and maximum in VL-892 (19.13%) over control at 45 days accelerated aged, seed maximum reduction in seed yield was observed in VL-802 (41.23%) followed by VL-892 (36.46%), VL-829 (35.82%) and UP-1109 (30.96%) over control and this stage, VL-892 (17.66 g) and UP-1109 (17.66 g) statistically at par with each other (Table 9).

TABLE 1

Effect of accelerated ageing on 50% field emergence in wheat varieties

Accelerated ageing period	Varieties				
	VL-802	VL-829	VL-892	UP-1109	Mean
0	54.66	67.33	66.66	62.33	62.75
15	53	56.66	65	56.66	57.83
30	48	51.66	53	52.66	51.33
45	42	48.33	52	47.66	47.5
Mean	49.41	56	59.16	54.83	54.85
	Variety	Accelerated ageing		Variety × Accelerated ageing	
SE ±	0.39	0.39		0.79	
CD (5%)	1.1	1.1		2.21	

TABLE 2

Effect of accelerated ageing on days to 50% head emergence in wheat varieties

Accelerated ageing period	Varieties				
	VL-802	VL-829	VL-892	UP-1109	Mean
0	141.33	142	143	149.33	143.91
15	145.33	146.33	146.33	154	148
30	147.67	149	148	156.66	150.33
45	150.67	153.33	147.33	160.33	152.91
Mean	146.25	147.66	146.16	155.08	148.79
	Variety	Accelerated ageing		Variety × Accelerated ageing	
SE ±	0.36	0.36		0.73	
CD (5%)	1.06	1.06		2.12	

TABLE 3

Effect of accelerated ageing on days to 50% maturity in wheat varieties

Accelerated ageing period	Varieties				
	VL-802	VL-829	VL-892	UP-1109	Mean
0	186	184	182.66	192.33	186.25
15	187.33	186.66	182.66	192	187.16
30	189.66	189.66	185.33	196.66	189.58
45	190.66	192.33	191.33	195.66	192.5
Mean	188.41	188.16	185.5	193.41	188.87
	Variety	Accelerated ageing		Variety × Accelerated ageing	
SE ±	0.42	0.42		0 .84	
CD (5%)	1.21	1.21		2.43	

TABLE 4

Effect of accelerated ageing periods on plants height (cm) in wheat varieties

Accelerated ageing period	Varieties				
	VL-802	VL-829	VL-892	UP-1109	Mean
0	80.66	79.33	73.66	84.66	79.58
15	78	77	71.33	83.33	77.41
30	75.66	75.66	68	78	74.33
45	73.66	73	66.33	76.33	72.33
Mean	77	76.25	69.83	80.58	75.91
	Variety	Accelerated ageing		Variety × Accelerated ageing	
SE ±	0.29	0.29		0.59	
CD(5%)	0.87	0.87		1.75	

TABLE 5

Effect of accelerated ageing periods on no. of tillers in wheat varieties

Accelerated ageing period	Varieties				
	VL-802	VL-829	VL-892	UP-1109	Mean
0	3.86	4.66	4.73	4.73	4.5
15	3.53	4.2	4.5	4.2	4.1

30	3.4	4.2	5	4.8	4.35
45	3.1	3.93	3.73	4.86	3.9
Mean	3.47	4.25	4.49	4.65	4.21
	Variety	**Accelerated ageing**		**Variety × accelerated ageing**	
SE ±	0.18	0.18		0.37	
CD (5%)	0.53	0.53		1.07	

TABLE 6

Effect of accelerated ageing periods on leaf length (cm) in wheat varieties

Accelerated ageing period	**Varieties**				
	VL-802	**VL-829**	**VL-892**	**UP-1109**	**Mean**
0	20.66	24.33	22	23	22.5
15	22	20.66	22	24	22.16
30	24	21.33	25.66	23	23.5
45	19.66	19.66	23.33	25.33	21.99
Mean	21.58	21.5	23.25	23.83	22.54
	Variety	**Accelerated ageing**		**Variety × Accelerated ageing**	
SE ±	0.48	0.48		0.96	
CD (5%)	1.39	1.39		2.79	

TABLE 7

Effect of accelerated ageing on ear length (cm) in wheat varieties

Accelerated ageing period	**Varieties**				
	VL-802	**VL-829**	**VL-892**	**UP-1109**	**Mean**
0	12	13	15.56	11.4	12.99
15	10.16	11.7	14.44	10.36	11.66
30	9.66	10.9	14	9.76	11.08
45	9.43	9.93	12.86	9.53	10.44
Mean	10.31	11.38	14.21	10.26	11.54
	Variety	**Accelerated ageing**		**Variety × Accelerated ageing**	
SE ±	0.19	0.19		0.38	
CD (5%)	0.55	0.55		1.5	

TABLE 8

Effect of accelerated ageing on seed per head in wheat varieties

Accelerated ageing period	**Varieties**				
	VL-802	**VL-829**	**VL-892**	**UP-1109**	**Mean**
0	27.33	30.66	32.33	28	29.58
15	23	20.66	27	26.66	24.33
30	23.66	21.33	24	22.66	22.91
45	21.33	18.66	21.66	18	19.91
Mean	23.83	22.83	26.25	23.83	24.18
	Variety	**Accelerated ageing**		**Variety × Accelerated ageing**	
SE ±	0.42	0.42		0.84	
CD (5%)	1.21	1.21		2.43	

TABLE 9

Effect of accelerated ageing on seed yield in wheat varieties

Accelerated ageing period	**Varieties**				
	VL-802	**VL-829**	**VL-892**	**UP-1109**	**mean**
0	28.35	27.33	28.33	25.58	27.4
15	24	23.03	22.91	22	22.98
30	17.87	19.66	20.66	19.47	19.42
45	16.66	17.54	18	17.66	17.46
Mean	21.72	21.89	22.47	21.18	21.82
	Variety	**Accelerated ageing**		**Variety × Accelerated ageing**	
SE ±	0.32	0.32		0.64	
CD (5%)	1.2	1.2		2.5	

100 seed weight (g): Variety VL-892 showed maximum mean value of 100 seed weight (4.58 g) followed by UP -1109 (4.57 g), VL-802 (4.37 g) and VL-829 (4.20 g). The interaction due to variety and accelerated ageing period showed significant difference for 100 seed weight. At 15 days accelerated aged seed, reduction in 100 seed weight was observed maximum in VL-829 (4.64%) and minimum in VL-802 (1.98%) over control. At 45 days accelerated aged stage, maximum reduction in 100 seed weight was observed in VL-829 (13.5%) followed by Vl-365 (8.59%), UP-1109 (8.31%) and VL-892 (6.10%) over control and VL-892 (4.46) and UP-1109 (4.57) statistically at par with each other at this stage (Table 10).

TABLE 10

Effect of accelerated ageing on 100 seed weight in wheat varieties

Accelerated ageing period	Varieties				
	VL-802	VL-829	VL-892	UP-1109	mean
0	4.54	4.52	4.75	4.81	4.65
15	4.45	4.31	4.57	4.63	4.49
30	4.35	4.02	4.55	4.44	4.34
45	4.15	3.93	4.46	4.41	4.24
Mean	4.37	4.2	4.58	4.57	4.43
	Variety	Accelerated ageing	Variety × Accelerated ageing		
SE ±	0.4	0.4	0.81		
CD (5%)	0.11	0.11	0.23		

DISCUSSION

Wheat (*Triticum aestivum* L.) stands as one of the world's foremost staple crops, playing a pivotal role in providing a substantial portion of dietary calories for humanity. To address the ever-increasing global demand for wheat, it is imperative to ensure the production of high-quality seeds and promote robust plant growth. One widely employed technique for evaluating seed quality and its subsequent impact on plant growth is accelerated aging. This discussion delves into the effects of accelerated aging on seed yield and growth parameters across various wheat varieties.

In the current study, the assessment of seed yield and related characteristics was conducted on different varieties of wheat stored at a temperature of 45°C and under 100% relative humidity for 0, 15, 30, and 45 days. The results unveiled a noticeable delay in the time required for 50% head emergence in all wheat varieties subjected to the accelerated aging test. This delay in flowering during aging is likely attributed to the sluggish emergence of seedlings and suboptimal stand establishment. Furthermore, critical growth parameters such as ear length, the number of seeds per ear, plant height, and seed yield exhibited a decline as the aging period increased.

Numerous studies have compared the findings of accelerated aging tests with field emergence in various crop seeds, including wheat [7], sweet corn [8], soybean [9], cotton [10], watermelon [11] and rice [12]. In the present study, the results indicate a decrease in field emergence, head emergence, seed yield, and harvest index with prolonged aging periods. In oilseed brassicas, reeducation in seed yield and harvest index due to aging-related reductions in siliqua on plants. Poor and scattered stand establishment may also contribute to decreased crop yield in the field, as highlighted by previous research [13].

Sedghi et al., [14] germination can be reduced due to ageing or degeneration that affects seed vigor and quality. The percentage of aged seeds that germinate is declining; this could be attributed to a reduction in the amount of carbohydrates stored and in the activity of hydrolytic enzymes such as total amylase [15-19].

According to the study's findings, all three of the wheat kinds' days to blooming were delayed by seed ageing. Poor stand establishment and the delayed emergence of seedlings from aged seeds may be the cause of the flowering delay during ageing. According to the results above, the seed yield of several wheat varieties decreased as ageing periods increased. Genetic constitution has also been implicated in the variations in seed production amongst cultivars. These results mostly concur with in oilseed brassicas [13].

Verma et al., [20] in *Brassica campestris* are consistent with our results. The yield was related to all of its constituent parts and that the loss in seed yield could be attributed to low emergence and increased electrical conductivity of leaking as seeds grew older. Plant height, yield, and yield components were found to decrease with increasing seed age in maize [21]. Plants grown from aged seeds displayed decreased weights of the vegetative portions, pod counts and weights, and seeds counts and weights in soybeans [20]. The yield of seeds decreased with age, have shown comparable outcomes with pigeon pea [21].

Due to seed ageing, poorly established and dispersed stands may potentially reduce crop output [22,23]. Accelerated ageing generally results in a lower percentage of germination; the decrease in germination of aged seeds may be caused by a drop in alpha amylase activity, a decrease in sugar content, or denaturation of protein [24,25]. Reduced plant population and low vigour may be the cause of the yield decline and the contributing characteristics of aged seed [26,27]. Plant height reduction may result from membrane integrity, oxidation of lipid and a rise in fat acidity [28,29].

The function of viability loss in treated barley and pea seeds with varying combinations of accelerated ageing treatment due to field emergence [30]. This could be because test results determine the maximum plant-producing potential of seed lots and correlate fairly well with emergence under unfavorable field conditions (high temperature and high relative humidity), which are infrequently encountered in the field. The current study's findings showed that quality declined as the ageing duration went on in all of the accelerated aged seed lots (0, 15, 30, and 45 days) of each genotype. As each seed lot aged, its test weight dropped. Similar discovery finds in coriander (*Coriandrum sativum* L.) [31] and *Salvia* L. [32] reported that a decrease in 1000 seed weight was caused by seed ageing.

CONCLUSION

The experiment was conducted to assess the impact of three accelerated aging periods (15, 30, and 45 days) in comparison to a control under open field conditions. Various field parameters exhibited a decrease as the aging period extended. The results of accelerated aging indicated a negative impact on field emergence, subsequent plant growth, seed yield, and related characteristics when compared to the control. This study provides valuable insights into the influence of aging duration on the determinants of seed quality and the performance of selected wheat varieties. From the results, it can be concluded that, during accelerated aging, VL-892 exhibited the least reduction in yield-contributing characteristics and quality parameters when compared to the other three varieties. The effects of aging were most pronounced in VL-802, possibly due to increased moisture content. Significantly, there were variations among the wheat varieties in terms of germination percentage and seed vigor. This suggests the potential to identify wheat varieties with superior field performance. Among the varieties tested, VL-892, followed by VL-829, emerged as strong candidates for seed storage and multiplication purposes.

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