Influence of Accelerated Aged Seed on Seed Quality Parameters of Wheat (Triticum aestivum L.) Under Laboratory Conditions

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Availability of good quality seed at the time of planting is most important factor for successful production of any crop. This is because, good quality seed not only ensure proper emergence but rapid establishment of seedling in the field that enhance the seed yield. There are various factors such as temperature and moisture content which affect the quality of seed. Use of stored seed for sowing purposes results in poor yield due to physiological and biochemical changes during ageing. Deterioration of seed quality during ageing is a natural phenomenon. This is caused by alterations in various physiological viz. seed germination, seedling length, seed vigor and biochemical parameters such as seed leachate, seed viability and dehydrogenase activity. Changes in these parameters adversely affect seed yield and related characters. The present investigation on “Impact of accelerated ageing on the seed quality and yield contributing characters in wheat (Triticum aestivum L.) varieties” was conducted at Seed Testing laboratory and research block of seed science and technology, BFIT, Department of Agriculture.

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Uttara Khand during 2019-20. For this purpose four varieties of wheat viz. VL-802, VL-829, VL-892 and UP-1109 were subjected to accelerated ageing at 45°C and 100% relative humidity for 15, 30 and 45 days along with control. The experiment was laid out in CRD with three replications of each treatment. Under the laboratory conditions, every treatment showed significant difference for seed quality parameters after accelerated ageing. Variety VL-892 had more capability to maintain the seed quality attributes after 15, 30 and 45 days of accelerated ageing period as considered being good storer under ambient condition. Whereas VL-829 and UP-1109 showed potential for medium-term storage and VL-802 variety had poor storing potential based on the seed quality and yield parameters.

**Keywords:** Wheat; accelerated aging test; laboratory conditions; seed quality parameters.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important crop in the world and this is major crop among other three cereal crops i.e. rice, maize and barley that provided 20 percent of the energy in human food (Ahmadi et al., 2004) [1]. It belongs to the gramineae family (genus *Triticum*) and looks a lot like yard-grass, when it is small [2]. First time wheat was classified by Linnaeus [3]. Sakamura [4] classified wheat into three different groups with their chromosome number and ploidy level viz. Diploid (2n=14), tetraploids (2n=28) and hexaploid (2n=42).

China, India, United States, Russia, France, Canada, Germany, Ukraine, Australia, and Pakistan are the top ten wheat producing countries. The total world wheat production is estimated at 717 million metric tonnes in 2014-2015 [5]. China is the leading country of wheat producer followed by India and Russia in terms of individual country. However, as a group of countries European Union (EU) is the largest producer.

Wheat cultivation in India started 5000 years ago [6]. Presently, it is the second most important food crop in India after rice. Production and area of wheat has increased up to 2.89 per cent and 1.60 per cent respectively, at Compound Annual Growth Rate (CAGR) in last ten year (United States Department of Agriculture Database). During 2015-2016, in India, area and production of wheat were and 23 million hectare and 94 million metric tonnes, respectively (Ministry of Agriculture, GOI).

Wheat is grown in all the states of India except Southern and North Eastern states. Uttar Pradesh, Haryana, Punjab, Rajasthan are the major wheat producing states and accounts for almost 80% of total production. Only 13% area is used for cultivation of wheat in rainfed region.

The major rainfed areas of states Madhya Pradesh, Gujarat, Maharashtra, West Bengal and Karnataka are used for cultivation of wheat.

Availability of good quality seed at the time of planting is most important factor for successful production of any crop because good quality seed not only ensures proper emergence but rapid establishment of seedling in the field that enhance the seed yield. Quality seed is the prime factor for crop productivity [7,8]. It is as measured by its vigor and viability which plays an important role in establishment of seedling that ultimate correlated with crop yield. In modern agriculture, quality seed is an essential input that helps in exploring the full potential of variety. The seed that reaches to the farmers should have high genetic as well as physical purity. In India, farmer select and save the own seed for next sowing. Seeds being hygroscopic in nature tend to absorb or lose moisture until the vapor pressures of seed moisture and air reach equilibrium. During storage, seed absorb moisture from the humid atmosphere that increased moisture content of seed resulting rapid deterioration. During storage, most of seed quality attributes such as germination, seedling growth are reduced which reduce potential of seed germination under adverse condition [9-11].

For this purpose, a test is designed to evaluate the storability of seed by artificial ageing is known as accelerated ageing. It is a physiological stress test that permits controlled deterioration of seeds due to exposure to high temperature and high relative humidity (greater than 90%) [12]. It is considered as the prediction test for seed storability as this test bring changes in the seed at the cellular level as that at long terms storage comparatively within a short period of time by exposing seeds to increased temperature (40-45°C) and a higher (99-100% RH) relative humidity [13].
2. MATERIALS AND METHODS

2.1 Site of Experiment

2.1.1 Location

The experimental site, College of BFIT, Department of agricultural science is located between 30.3165˚N and 78.0322˚E longitude and latitude. It is situated at about 700 meters above the mean sea level under trans himalayan hill zones of Uttarakhand, India.

2.1.2 Climate

The mean monthly maximum and minimum temperature during the investigation period varies between 27.1°C to 2.6°C, respectively. The average annual rainfall of 15.1 to 406.0 mm was 2019. Detailed metrological data recorded for different parameters during the cropping period is presented in Appendix-I.

2.1.3 Soil

Soil of the experimental block of Seed Science and Technology was silty clay loam in texture having slightly acidic pH (5.5 to 6.8), low in available nitrogen (200 to 220 kg/ha) and available phosphorus (8.5 to 10.5 kg/ha) and also low in available potash (150 to 160 kg/ha). The depth of soil extends up to 1.0 meter.

2.2 Experimental Material

The experimental material for present investigation comprised of four variety of wheat viz., VL-802, VL-829, VL-892 and UP-1109 were obtained from Research Station, Gaja, and done at department of agriculture BFIT Dehradun. The details of experimental material are given in Table 1. Approximate 200g seed of each variety was stored in cloth bags under storage condition for 15, 30 and 45 days.

2.2.1 Experimental design and treatments

The present investigation comprised in laboratory conditions on four wheat varieties.

2.3 Laboratory Test

2.3.1 Accelerated ageing

Accelerated ageing is a physiological stress test that permits controlled deterioration of seeds due to the exposure to high temperature and high relative humidity (greater than 90%) [12], it is considered as the prediction test for seed storability as this test bring changes in the seed at the cellular level as that at long terms storage comparatively within a short period of time by exposing seeds to increased temperature (40-45°C) and a higher (99-100% RH) relative humidity [13]. In accelerated ageing test, seed sample of four wheat varieties VL-802, VL-829, VL-892, and UP-1109 were taken in muslin cloth bags. These muslin cloth bags were placed on the desecrater which was already filled with water in such a way that the seeds placed in muslin cloth bags were 2-3 cm above the water. The lid of desecrater was 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 germination test. These seeds were further utilized under laboratory and field experiment to predict the quality of the seeds.

Table 1. Brief description of experimental varieties of wheat

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Originating source</th>
<th>Released by</th>
</tr>
</thead>
<tbody>
<tr>
<td>VL-802</td>
<td>VPKAS, Almora</td>
<td>SVRC</td>
</tr>
<tr>
<td>VL-829</td>
<td>VPKAS, Almora</td>
<td>SVRC</td>
</tr>
<tr>
<td>VL-892</td>
<td>VPKAS, Almora</td>
<td>CVRC</td>
</tr>
<tr>
<td>UP-1109</td>
<td>G.B.P.U.A. &amp; T, Pantnagar</td>
<td>CVRC</td>
</tr>
</tbody>
</table>

Table 2. Treatments detail for accelerated ageing

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Treatments</th>
<th>Symbol used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>T1</td>
</tr>
<tr>
<td>2</td>
<td>15 days accelerated ageing</td>
<td>T2</td>
</tr>
<tr>
<td>3</td>
<td>30 days accelerated ageing</td>
<td>T3</td>
</tr>
<tr>
<td>4</td>
<td>45 days accelerated ageing</td>
<td>T4</td>
</tr>
</tbody>
</table>
2.4 Data Collection

2.4.1 Seed quality parameters

2.4.1.1 Moisture content

Seed moisture is determined by the air oven methods. In this method the seed moisture content is determined by removing the moisture from the seeds in an air oven.

2.4.1.2 First count test

Three replication of 25 seeds of every variety were taken randomly from each treatment. Seeds were kept in between paper (B.P.) media. Then the sample was placed at 25°C in germinator. First count was taken on the 4th day of test.

2.4.1.3 Standard germination

25 seeds were placed from samples of each treatments of every variety of three replication in between papers (B.P.) at 25°C. The seedlings were evaluated at and normal seedling was counted on 8th days. Germination per cent was calculated as formula given below.

Germination % = Normal seedling /Total no. of seed ×100

2.4.2 Yield attributes

2.4.2.1 Root length (cm)

Five normal seedlings were randomly selected on 8th days of germination test from each replication of each treatment. The length of root (cm) was measured with the help of scale and the mean root length was calculated in centimeters.

2.4.2.2 Shoot length (cm)

The shoot length (cm) was measured with the help of a scale on 5 randomly selected seedlings from each replication of each treatment. The value was obtained by calculating mean of 5 seedlings for each replication in centimeters.

2.4.2.3 Seedling Fresh weight (g)

Seedling fresh weight was recorded in the seed germination test on 8th days. The 5 normal seedlings were randomly taken from each replication of each treatment and were weighed, and the seed fresh weight was measured on an electronic balance in gram.

2.4.2.4 Dry weight (g)

Seedling dry weight was recorded in the seed germination test on 8th days. The 5 normal seedlings were randomly taken from each replication of each treatment. Seedlings were dried in oven at 80°C for 24 hrs. The dried seedlings were weighed on an electronic balance and expressed as gram.

Table 3. Treatments combinations

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>V1T1</td>
</tr>
<tr>
<td>2.</td>
<td>V1T2</td>
</tr>
<tr>
<td>3.</td>
<td>V1T3</td>
</tr>
<tr>
<td>4.</td>
<td>V1T4</td>
</tr>
<tr>
<td>5.</td>
<td>V2 T1</td>
</tr>
<tr>
<td>6.</td>
<td>V2 T2</td>
</tr>
<tr>
<td>7.</td>
<td>V2 T3</td>
</tr>
<tr>
<td>8.</td>
<td>V2 T4</td>
</tr>
<tr>
<td>9.</td>
<td>V3 T1</td>
</tr>
<tr>
<td>10.</td>
<td>V3 T2</td>
</tr>
<tr>
<td>11.</td>
<td>V3 T3</td>
</tr>
<tr>
<td>12.</td>
<td>V3 T4</td>
</tr>
<tr>
<td>13.</td>
<td>V4 T1</td>
</tr>
<tr>
<td>14.</td>
<td>V4 T2</td>
</tr>
<tr>
<td>15.</td>
<td>V4 T3</td>
</tr>
<tr>
<td>16.</td>
<td>V4 T4</td>
</tr>
</tbody>
</table>

3. RESULTS AND DISCUSSION

3.1 Influence of Accelerated Aged Seed on Seed Quality Parameters of Wheat under Laboratory Condition

3.1.1 Effect of accelerated ageing on moisture content (%) of wheat varieties

Variety UP-1109 showed the highest mean value of moisture content (12.58%) followed by VL-802 (11.57%), VL-829 (9.95%), and VL-892 (9.11%). The interaction due to variety and accelerated ageing period had significant difference for moisture content (%) (Table 4). Increased in moisture content (%) from AA1 to AA4 were 9.02 to 14.43 in VL-802, 8.13 to 12.66 in VL-829, 8.23 to 10.66 in VL-892 and 10.33 to 14.33 in UP-1109. In AA2 aged seed, significant increase in moisture content (%) minimum in VL-892 (3.44%) and maximum in UP-1109 (19.36%) over AA1. At AA4 aged seed, minimum increased in moisture content (%) in VL-892 (22.79%) followed by UP-1109 (27.91%), VL-829 (35.78%) and VL-802 (49%).
3.2 Effect of accelerated ageing on the first Count (%) in Wheat Varieties

Variety VL-892 showed the highest mean value of the first count (77.75%) followed by VL-829 (69.66%), VL-802 (65.00%) and UP-1109 (61.91%).

The interaction due to variety and accelerated ageing period had significant difference for first count (%) (Table 5). Reduction in first count (%) from AA1 to AA4 was 71.66 to 55.00 in VL-802, 82.66 to 53.66 in VL-829, 85.00 to 66.66 in VL-892 and 70.66 to 52.33 in UP-1109. In AA2 aged seed, significant reduction in first count (%) was observed minimum in VL-892 (1.17%) and maximum in UP-1109 (9.42%) over AA1. At AA4 aged seed, maximum reduction in first count (%) was observed in VL-829 (35.08%) followed by UP-1109 (25.94%), VL-802 (23.24%) and VL-892 (21.57%).

3.2.1 Effect of accelerated ageing on the standard germination (%) in wheat varieties

Variety VL-892 showed the highest mean value of the standard germination (83.74%) followed by UP-1109 (80.75%), VL-829 (80.33%) and VL-802 (70.41%).

The interaction due to variety and accelerated ageing period had significant difference for standard germination (%) (Table 6). Reduction in standard germination (%) from AA1 to AA4 was 82.66 to 58.00 in VL-802, 83.66 to 76.33 in VL-829, 87.33 to 79.00 in VL-892 and 84.66 to 71.00 in UP-1109. In AA2 aged seed, significant reduction in standard germination (%) was observed minimum in UP-1109 (0.36%) and maximum in VL-802 (12.49%) over AA1. At AA4 aged seed, maximum reduction in standard germination (%) in VL-802 (29.83%) followed by UP-1109 (16.3%), VL-829 (9.53%) and VL-892 (8.36%) over AA1.

3.2.2 Effect of accelerated ageing on the shoot length (cm) in wheat varieties

Variety VL-829 showed the largest mean value of shoot length (6.37cm) followed by VL-892 (6.29cm), UP-1109 (6.12cm) and VL-802 (5.90cm).

The interaction due to variety and accelerated ageing period had significant difference for shoot length (cm) (Table 7). Reduction in shoot length (cm) from AA1 to AA4 was 6.33 to 5.77 in VL-802, 7.40 to 5.16 in VL-829, 7.00 to 5.69 in VL-892 and 7.16 to 4.94 in UP-1109. In AA2 aged seed, significant reduction in shoot length (cm) was observed minimum in VL-802 (2.05%) and maximum in UP-1109 (12.01%) over AA1. At AA4 aged seed, maximum reduction in shoot length (cm) UP-1109 (31.00%) followed by VL-829 (30.27%), VL-892 (18.71%) and VL-802 (8.84%) over AA1.

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

Variety UP-1109 showed the largest mean value of root length (10.85cm) followed by VL-892 (10.66cm), VL-829 (10.15cm) and VL-802 (8.94cm).

The interaction due to variety and accelerated ageing period had non-significant difference for root length (cm) (Table 8). Reduction in root length (cm) from AA1 to AA4 was 10.36 to 7.63 in VL-802, 11.99 to 8.83 in VL-829, 11.98 to 9.93 in VL-892 and 11.53 to 10.13 in UP-1109. In AA2 aged seed, significant reduction in root length (cm) was observed in minimum in UP-1109 (1.82%) and maximum in VL-829 (13.84%) over AA1. At AA4 aged seed, minimum reduction in root length (cm) UP-1109 (12.14%) followed by VL-892 (17.11%), VL-802 (26.35%) and VL-829 (26.35%).
3.2.4 Effect of accelerated ageing on fresh weight (g) in wheat varieties

Variety UP-1109 showed the highest mean value of fresh weight (0.55g) followed by VL-892 (0.54g), VL-365 (0.52g) and VL-829 (0.24g). The interaction due to variety and accelerated ageing period had non-significant difference for fresh weight (g) (Table 9). Reduction in fresh weight (g) from AA1 to AA4 was 0.65 - 0.24 in VL-365,
Table 9. Effect of accelerated ageing on fresh weight (g) in wheat varieties

<table>
<thead>
<tr>
<th>Accelerated Ageing period</th>
<th>Varieties</th>
<th>0.65</th>
<th>0.51</th>
<th>0.58</th>
<th>0.61</th>
<th>0.14</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>VL-802</td>
<td>0.65</td>
<td>0.51</td>
<td>0.58</td>
<td>0.61</td>
<td>0.14</td>
</tr>
<tr>
<td>15</td>
<td>VL-829</td>
<td>0.51</td>
<td>0.51</td>
<td>0.53</td>
<td>0.52</td>
<td>0.51</td>
</tr>
<tr>
<td>30</td>
<td>0.24</td>
<td>0.43</td>
<td>0.51</td>
<td>0.51</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>Varieties</td>
<td>VL-802</td>
<td>0.52</td>
<td>0.48</td>
<td>0.54</td>
<td>0.55</td>
</tr>
<tr>
<td>SE±</td>
<td>Accelerated Ageing</td>
<td>0.21</td>
<td>0.21</td>
<td>0.42</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>CD (5%)</td>
<td>Variety ×Accelerated ageing</td>
<td>0.83</td>
<td>0.83</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10. Effect of accelerated ageing on dry weight (g) in wheat varieties

<table>
<thead>
<tr>
<th>Accelerated Ageing period</th>
<th>Varieties</th>
<th>0.27</th>
<th>0.45</th>
<th>0.66</th>
<th>0.52</th>
<th>0.47</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>VL-802</td>
<td>0.27</td>
<td>0.45</td>
<td>0.66</td>
<td>0.52</td>
<td>0.47</td>
</tr>
<tr>
<td>15</td>
<td>VL-829</td>
<td>0.64</td>
<td>0.52</td>
<td>0.36</td>
<td>0.41</td>
<td>0.48</td>
</tr>
<tr>
<td>30</td>
<td>0.36</td>
<td>0.51</td>
<td>0.35</td>
<td>0.55</td>
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<tr>
<td>45</td>
<td>0.42</td>
<td>0.72</td>
<td>0.56</td>
<td>0.42</td>
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</tr>
<tr>
<td>Mean</td>
<td>Varieties</td>
<td>VL-802</td>
<td>0.42</td>
<td>0.55</td>
<td>0.48</td>
<td>0.47</td>
</tr>
<tr>
<td>SE±</td>
<td>Accelerated Ageing</td>
<td>0.31</td>
<td>0.31</td>
<td>0.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD (5%)</td>
<td>Variety ×Accelerated ageing</td>
<td>0.12</td>
<td>0.12</td>
<td>0.24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

0.51 to 0.43 in VL-829, 0.58 to 0.51 to 0.61 to 0.51 in UP-1109. In AA2 aged seed, significant reduction in fresh weight (g) was observed in minimum in VL-892 (1.72%) and maximum in UP-1109 (16.39%) over AA1. At AA4 aged seed, minimum reduction in fresh weight (g) VL-829 (5.88%) followed by VL-892 (12.06%), UP-1109 (16.39%) and VL-365 (63.07%).

3.2.5 Effect of accelerated ageing on dry weight (g) in wheat varieties

Variety VL-829 showed the highest mean value of dry weight (0.55g) followed by VL-892 (0.48g), UP-1109 (0.47g) and VL-802 (0.42g). The interaction due to variety and accelerated ageing period had non-significant difference for dry weight (g) (Table 10).

4. SUMMARY AND CONCLUSION

4.1 Influence of Accelerated Aged Seed on Seed Quality Parameters of Wheat under Laboratory Conditions

In the present investigation, the experiment was conducted to carry out the influence of accelerated aged seed on seed germination and seedling vigor. Results of all three ageing treatments (15, 30 and 45 days) along with control used for this study. The analytical data suggested that:

Variety VL-892 showed the highest varietal mean of the first count (77.75%) followed by VL-829 (69.66%), VL-802 (65.00%) and UP-1109 (61.91%). Maximum reduction in first count (%) was observed in VL-892 (35.08%) followed by UP-1109 (29.83%), VL-829 (25.94%) and VL-802 (23.24%)

Variety VL-892 showed the highest Varietal mean of the standard germination (83.74%) followed by UP-1109 (80.75%), VL-829 (80.33%) and VL-802 (70.41%). Maximum reduction in standard germination (%) in VL-802 (29.83%) followed by UP-1109 (16.3%), VL-829 (9.53%) and VL-802 (8.16%) over AA1.

Variety VL-829 showed the largest varietal mean of shoot length (6.37cm) followed by VL-892 (6.29cm), UP-1109 (6.12cm) and VL-802 (5.90cm). Maximum reduction in shoot length (cm) UP-1109 (31.00%) followed by VL-829 (30.27%), VL-802 (18.71%) and VL-802 (8.84%) over AA1.

Minimum reduction in root length (cm) UP-1109 (12.14%) followed by VL-892 (17.11%), VL-802 (26.35%) and VL-802 (26.35%).
Variety UP-1109 showed the highest varietal mean of fresh weight (0.55g) followed by VL-892 (0.54g), VL-802 (0.52g) and VL-829 (0.24g). Minimum reduction in fresh weight (g) VL-829 (5.88%) followed by VL-892 (12.06%), UP-1109 (16.39%) and VL-802 (63.07%).

Variety VL-829 showed the highest mean value of dry weight (0.55g) followed by VL-892 (0.48g), UP-1109 (0.47g) and VL-802 (0.42g).

Variety UP-1109 showed the highest varietal mean of moisture content (12.58%) followed by VL-802 (11.57%), VL-829 (9.95%), and VL-892 (9.11%). Minimum increased in moisture content (%) in VL-892 (22.79%) followed by UP-1109 (27.91%), VL-829 (35.78%) and VL-802 (49%).

Under laboratory condition, results suggested that accelerated ageing for various days” depicted variable relative storability of seeds in different wheat varieties. Among 15 days 30 days and 45 days treatment, 45 days ageing period had maximum negative influence on most of the seed germination and seedling vigor parameters however, other accelerated ageing treatments had also showed significant negative effect over control with respect to different seed vigor parameters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


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