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## Study on wheat quality of stored wheat (*Triticum aestivum* L.) in laboratory

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**Abstract**

The study was conducted during 2018-19 at Seed Technology Research Unit, M. P. K. V. Rahuri for testing the effect of storage period on seed quality of wheat (*Triticum spp.* L.) for laboratory observations which were evaluated in Factorial Completely Randomized Design (FCRD) with three replications. The experiment consist of four varieties viz., Godavari (V<sub>1</sub>), Panchavati (V<sub>2</sub>), Tapovan (V<sub>3</sub>) and Trimbak (V<sub>4</sub>), and three seed ages viz., fresh seed (A<sub>0</sub>), Rvd I<sup>st</sup> seed (A<sub>1</sub>) and Rvd II<sup>nd</sup> seed (A<sub>2</sub>). The observations on seed quality character such as germination percentage, moisture content, root shoot length, seedling dry weight, vigour index (I), vigour index (II), mycoflora percentage was recorded monthly interval up to seven months at laboratory condition. The study revealed that, among the varieties significant differences were observed. The seed quality parameters viz., germination percentage (90.00%), root shoot length (32.23 cm), seedling dry weight (0.285 g) vigour index (I) (2905.06), vigour index (II) (25.66) were better in variety Godavari followed by Panchavati, Tapovan and Trimbak. Among the seed ages, fresh seed produced higher seed yield than others, Rvd II<sup>nd</sup> seed recorded less but stable performance. Seed quality parameters viz., germination percentage (94.64%), root-shoot length (32.61 cm), seedling dry weight (0.290 gm), vigour index (I) (3080.47) and vigour index (II) (27.43) were better in the fresh seed. However, mycoflora percentage was higher in Rvd II<sup>nd</sup> and lower in fresh seed. The wheat seeds can maintain the 85.75% germination percentage at the age of 31<sup>st</sup> months which is above IMSCS (85%).

**Keywords:** Wheat seed, stored wheat and mycoflora percentage

**Introduction**

Wheat is the most extensively grown world's important cereal grain crop and principle staple food for a large part of the world's population. It's widespread cultivation in all the continents and its versatility in adoption to diverse climatic and edaphic condition, it's value in human diet as a source of carbohydrates, proteins and it's baking qualities make it more important as a human food than other cereals. The many species of wheat together make up the genus *Triticum*; the most widely grown is common wheat (*T. aestivum*). In India, *Triticum aestivum* is generally cultivated in Northern hilly zones and Northern and Eastern plains. *Triticum aestivum* which is commonly referred as bread wheat. It is used for bread, rolls, *chapatis* and baby foods etc. *T. durum* used for paste products (macaroni, spaghetti, puffed breakfast cereals) is known as durum wheat. Wheat (*Triticum spp.* L.) is one of the most important world cereal crops and is a staple food for about one-third of the world's population (Hussain and Shah, 2002)<sup>[14]</sup>. It is major source of food grain and high adaptation of this crop as well as its diverse consumptions in the human nutrition lead to present, especially in developing countries (Farzi and Bigloo, 2010)<sup>[8]</sup>. It has the highest content of protein of all the staple cereals and contains essential minerals, vitamins and lipids. It is the primary source of protein in developing countries where 1.2 billion people are dependent on wheat for survival (CIMMYT, 2011). It grown on 220 million hectares (Singh and Trethowan, 2007)<sup>[24]</sup> constituting 15.4 per cent of the world's arable land (more land area than any other crop) and it is grown in almost all countries and climates (Curtis, 2002)<sup>[7]</sup> The validity of seed produced initially is for 9 months, after which it will be revalidated for further period of 6 months, provided the seed lot meets Indian Minimum Seed Certification Standards for germination. Seeds are usually produced in excess as a precaution against germination failure of crop in the subsequent crop growth period. The demand for seed fluctuates very often and there may be a large surplus of seeds which need to be stored for the subsequent 2-3 sowing seasons. Such left over seed when stored pass through the hot and humid monsoon periods which affect the viability and vigour of seeds. Quality seed is the cheapest and most critical input in agriculture which alone can result in 15-20% increase in productivity but its production and storage needs utmost care (Gupta and Kumar, 2016)<sup>[13]</sup>.

Temperature and moisture play a significant and fundamental role in determining the storage longevity of seeds (Krishnan *et al.*, 2004) [16]. Different periods and agreements of wheat seeds storage were studied, but there is no common opinion on the question of the best conditions to the long-term period of storage for different pristine quality of seeds (Villers *et al.*, 2010) [27]. In view of paucity of information, there is necessity to test the seed quality of aged seed lots to prolong the validity period. The research is envisaged to find out the seed quality of wheat was undertaken with object to study the seed quality parameters of old seed lots of wheat.

### Materials and Methods

An experiment was conducted during 2018-19 at Seed Technology Research Unit (STRU) Laboratory and research

field at M.P.K.V., Rahuri (Maharashtra state) to study the seed quality of old as well as new wheat (*Triticum spp. L.*) seeds. The seeds of four varieties viz., Godavari, Trimbak, Panchvati and Tapovan of age fresh, Rvd I<sup>st</sup> and Rvd II<sup>nd</sup> were procured from wheat specialist, Agriculture Research Station, Niphad, Dist. Nashik (Maharashtra state). The seeds were stored in cloths bag under ambient conditions at Seed Technology Research Unit, M.P.K.V., Rahuri using FCRD design with three replications.

### Details of Seed Samples

Initial observations were recorded for following seed quality parameters of seeds obtained from four above mentioned varieties during seven months of storage period in lab. The observations were recorded on following parameters.

| S. N. | Crop  | Variety             | Stage   | Date of Harvest         | Age of the seed (month) |
|-------|-------|---------------------|---------|-------------------------|-------------------------|
| 1     | Wheat | Panchvati (NIDW-15) | Nucleus | April -2017-18 (Fresh)  | 14                      |
| 2     |       |                     |         | April -2016-17 (RVD-I)  | 26                      |
| 3     |       |                     |         | April -2015-16 (RVD-II) | 38                      |
| 4     | Wheat | Godavari (NIDW-295) | Nucleus | April -2017-18 (Fresh)  | 14                      |
| 5     |       |                     |         | April -2016-17 (RVD-I)  | 26                      |
| 6     |       |                     |         | April -2015-16 (RVD-II) | 38                      |
| 7     | Wheat | Tapovan (NIAW-917)  | Nucleus | April -2017-18 (Fresh)  | 14                      |
| 8     |       |                     |         | April -2016-17 (RVD-I)  | 26                      |
| 9     |       |                     |         | April -2015-16 (RVD-II) | 38                      |
| 10    | Wheat | Trimbak (NIAW-301)  | Nucleus | April -2017-18 (Fresh)  | 14                      |
| 11    |       |                     |         | April -2016-17 (RVD-I)  | 26                      |
| 12    |       |                     |         | April -2015-16 (RVD-II) | 38                      |

### Germination percentage (%)

The germination percentage was tested according to ISTA Rule (Anon., 1999). 100 seeds from each treatment were kept for germination in four replication in germinator at 20<sup>o</sup> C temperature and at 70% relative humidity for 8 days using between paper method. Accordingly germination percentage was computed on normal seedling with the formula given below.

$$\text{Germination (\%)} = \frac{\text{Number of normal seedling}}{\text{Total numbers of seeds}} \times 100$$

### Moisture Content (%)

Moisture content were determined by Hot Air Oven Method by grinding the 10 gm seeds on grinding mill and dried at 103<sup>o</sup> C for 17 hours in hot air oven. The percentage of moisture content was calculated on the weight basis.

$$\text{Moisture content (\%)} = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

Where,

M<sub>1</sub> = Weight of container with lid.

M<sub>2</sub> = Weight of container with lid + seed before drying.

M<sub>3</sub> = Weight of container with lid + seed after drying

### Root-shoot Length (cm)

Ten normal seedlings were used for measuring root-shoot length in centimeters.

The average seedling length of ten seedlings from each replication was calculated and workout (Anonymous, 1999) [5].

### Seedling Dry Weight (g)

Ten normal seedlings used for measuring root-shoot length were kept in tin plate and dried in hot air oven maintained at 50<sup>o</sup>C temperature for 16 ± 2 hours. Then the seedlings were weighed after allowing them to cool in a desiccators for 30 minutes and weighed in grams.

### Vigour Index (I)

Ten normal seedlings from each replication were selected for calculation of vigour index (Abdul-Baki & Anderson, 1973) [1] and were calculated as under:

Vigour index (I) = Average seedling length (root + shoot) (cm) x Germination percentage

### Vigour Index (II)

Ten normal seedlings from each replication were selected for calculation of vigour index (Abdul-Baki and Anderson, 1973) and were calculated as under:

Vigour index-II was assessed as under:

Vigour index (II) = Dry Matter (mg) x Germination percentage (%)

### Seed Mycoflora (%)

The seed health was determined by blotter test to detect the presence of seed borne fungi of wheat seed. Three layers of blotters (size fitting to the size of petri dish) soaked in sterilized distilled water were placed in petri dish. Ten seeds were placed in each petri dish at equidistance and the petri dishes were kept in an incubator 20±2<sup>o</sup> C for 7 days beneath near ultra violet light (NUV) with a cycle of 12 hrs light and 12 hrs darkness. Three replications were maintained. The seeds were then examined on 8th day under stereo microscopic binocular microscope. The fungi were identified on the basis of sporulation and their fruiting structures (Agarwal, 1976) [2].

## Results and Discussion

### Germination (%)

The data regarding the germination percentage are presented in Table 1. From the Table 1 it was noticed that, the germination percentage differed significantly due to the varieties. The variety Godavari recorded significantly highest germination (90.00%) in July at the age of 14 months than other varieties. However, the variety Trimbak recorded lowest germination (81.67%) in January at the age of 20<sup>th</sup> month. The wheat cultivar have significant effects on the quality deterioration of wheat during the storage period (Anne *et al.*, 2010)<sup>[4]</sup>.

Tian *et al.* (2019)<sup>[26]</sup> reported that the germination rate was observed to occasionally increase slightly during storage, as it is greatly influenced by seed traits (variety, origin and quality).

The seed age had significant effect on germination percentage. The germination percentage was significantly highest in fresh seed (94.46%) in July (at the age of 14 month) followed by Rvd I<sup>st</sup> (89.13%) in July (26<sup>th</sup> month). The lowest germination percentage was observed in Rvd II<sup>nd</sup> (78.04%) in January (at the age of 44<sup>th</sup> month). Seed germination decreased with the increase of storage period. Similar findings had also reported by Malaker *et al.* (2008)<sup>[17]</sup>, Mersal *et al.* (2006)<sup>[20]</sup>, Singh *et al.* (2011)<sup>[24]</sup>, Matsue *et al.* (2002)<sup>[19]</sup> and Murthy *et al.* (2003)<sup>[21]</sup>.

The varieties had significant effect on moisture content. The variety Tapovan recorded significantly highest (8.97%) seed moisture content than other varieties in August month. However, the lowest seed moisture content (8.72%) was recorded in variety Godavari in July month.

**Table 1:** Effect of variety and seed age on germination (%) of wheat

| Treatments   | July          | August        | September     | October       | November      | December      | January       |    |
|--|---------------|---------------|---------------|---------------|---------------|---------------|---------------|----|
| <b>Variety</b>   |               |               |               |               |               |               |               |    |
| V <sub>1</sub> : Godavari                                  | 90.00 (72.19) | 89.39 (71.36) | 88.33 (70.34) | 87.28 (69.56) | 87.11 (69.28) | 86.39 (68.66) | 85.28 (67.63) |    |
| V <sub>2</sub> : Panchvati                                 | 88.89 (71.18) | 88.17 (70.50) | 87.00 (69.30) | 86.67 (68.99) | 85.78 (68.24) | 85.11 (67.66) | 84.06 (66.74) |    |
| V <sub>3</sub> : Trimbak                                   | 88.00 (70.11) | 87.06 (69.11) | 86.33 (68.53) | 85.50 (67.84) | 84.56 (67.05) | 83.83 (66.40) | 81.67 (64.78) |    |
| V <sub>4</sub> : Tapovan                                   | 88.11 (70.15) | 87.06 (69.19) | 86.61 (68.84) | 86.17 (68.38) | 85.17 (67.55) | 84.78 (67.22) | 84.28 (66.83) |    |
| Mean   | 70.91         | 70.04         | 69.25         | 68.69         | 68.03         | 67.48         | 66.50         |    |
| SE ±   | 0.27          | 0.26          | 0.26          | 0.22          | 0.26          | 0.23          | 0.22          |    |
| CD at 5%   | 0.76          | 0.72          | 0.74          | 0.60          | 0.73          | 0.63          | 0.61          |    |
| <b>Seed type</b>   |               |               |               |               |               |               |               |    |
| A <sub>0</sub> : Fresh                                     | 94.46 (76.53) | 93.17 (74.97) | 92.29 (73.93) | 91.75 (73.38) | 90.96 (72.57) | 89.96 (71.59) | 88.67 (70.38) |    |
| A <sub>1</sub> : RVD I <sup>st</sup>                       | 89.13 (70.77) | 88.21 (69.95) | 87.67 (69.47) | 87.25 (69.10) | 86.17 (68.19) | 85.79 (67.88) | 84.75 (67.04) |    |
| A <sub>2</sub> : RVD II <sup>nd</sup>                      | 82.67 (65.41) | 82.38 (65.20) | 81.25 (64.36) | 80.21 (63.59) | 79.83 (63.33) | 79.33 (62.97) | 78.04 (62.07) |    |
| Mean   | 70.91         | 70.04         | 69.25         | 68.69         | 68.03         | 67.48         | 66.50         |    |
| SE ±   | 0.24          | 0.22          | 0.23          | 0.19          | 0.23          | 0.20          | 0.19          |    |
| CD at 5%   | 0.66          | 0.63          | 0.64          | 0.52          | 0.63          | 0.55          | 0.53          |    |
| Age of seed on July 2018<br>from date of harvest<br>Month) | Fresh         | 14            | 15            | 16            | 17            | 18            | 19            | 20 |
|  | RVD I         | 26            | 27            | 28            | 29            | 30            | 31            | 32 |
|  | RVD II        | 38            | 39            | 40            | 41            | 42            | 43            | 44 |

The values in parenthesis are arc sin values

### Effect of seed age on moisture content (%)

The seed age had significant effect on moisture content (Table 2). The moisture content was significantly highest in fresh seed (9.03%) in August month followed by Rvd<sup>st</sup> (8.91) in August and January month. The lowest moisture content was observed in Rvd<sup>nd</sup> (8.72%) in July month. The initial seed moisture content recorded in July was 9.01%. The moisture content increases in August, December and January with the increase of storage period (9.03, 8.94 and 9.00%), respectively. Similar findings had also reported by Malaker *et al.* (2008)<sup>[17]</sup> and Kibar H. (2015)<sup>[15]</sup>. Moisture content was decreases with increase in storage period observed in September, October and November (9.00, 8.95 and 8.92%) respectively due to the changes in relative humidity during storage period. Similar findings had also reported by Sterlek *et al.* (2010)<sup>[25]</sup>.

The percentage germination decreased very slowly at a low moisture level, while it decreased rapidly at a high moisture level (Al-Yahya, 2001)<sup>[3]</sup>. Krishnan *et al.* (2004)<sup>[16]</sup> observed that the temperature and moisture play a significant and fundamental role in determining the storage longevity of seeds. The reduced respiration and enzymatic activity may be responsible for the accumulation of toxic substances under low moisture content that reduce seed viability (Ghive *et al.*, 2007)<sup>[10]</sup>. Gonzalez-Torralba *et al.* (2013)<sup>[11]</sup> reported that during storage grain can experience variations in composition and quality, especially if ambient conditions are unfavorable. Badawi *et al.* (2014)<sup>[6]</sup> observed that the increasing wheat seed moisture content before storage more than 14% significantly decreased standard germination and increased fungi infestation percentage.

**Table 2:** Effect of variety and seed age on moisture content (%) of wheat

| Treatments                 | July  | August | September | October | November | December | January |
|----------------------------|-------|--------|-----------|---------|----------|----------|---------|
| <b>Variety</b>             |       |        |           |         |          |          |         |
| V <sub>1</sub> : Godavari  | 8.80  | 8.88   | 8.85      | 8.83    | 8.81     | 8.85     | 8.89    |
| V <sub>2</sub> : Panchvati | 8.87  | 8.94   | 8.91      | 8.86    | 8.83     | 8.87     | 8.92    |
| V <sub>3</sub> : Trimbak   | 8.89  | 8.95   | 8.91      | 8.87    | 8.84     | 8.87     | 8.91    |
| V <sub>4</sub> : Tapovan   | 8.89  | 8.97   | 8.93      | 8.88    | 8.84     | 8.87     | 8.91    |
| Mean                       | 8.86  | 8.93   | 8.90      | 8.86    | 8.83     | 8.86     | 8.91    |
| SE ±                       | 0.012 | 0.009  | 0.006     | 0.006   | 0.005    | 0.005    | 0.006   |
| CD at 5%                   | 0.034 | 0.025  | 0.016     | 0.018   | 0.013    | 0.015    | 0.018   |

| Seed type   |        |       |       |       |       |       |       |    |
|---|--------|-------|-------|-------|-------|-------|-------|----|
| A0: Fresh   | 9.00   | 9.03  | 9.00  | 8.95  | 8.92  | 8.94  | 9.00  |    |
| A1: RVD Ist   | 8.86   | 8.91  | 8.88  | 8.84  | 8.81  | 8.87  | 8.91  |    |
| A2: RVD IInd  | 8.72   | 8.87  | 8.82  | 8.80  | 8.76  | 8.78  | 8.82  |    |
| Mean  | 8.86   | 8.93  | 8.90  | 8.86  | 8.83  | 8.86  | 8.91  |    |
| SE ±  | 0.011  | 0.008 | 0.005 | 0.006 | 0.004 | 0.005 | 0.005 |    |
| CD at 5%  | 0.030  | 0.022 | 0.014 | 0.016 | 0.011 | 0.013 | 0.015 |    |
| Age of seed on July 2018 from date of harvest (Month) | Fresh  | 14    | 15    | 16    | 17    | 18    | 19    | 20 |
|   | RVD I  | 26    | 27    | 28    | 29    | 30    | 31    | 32 |
|   | RVD II | 38    | 39    | 40    | 41    | 42    | 43    | 44 |

### Root-shoot Length (cm)

The data regarding the root shoot length are presented in Table 3. It was observed that the root shoot length of seedling was significantly differed due to the varieties irrespective of lots and seed age. Among the varieties, significantly maximum root shoot length of seedling (32.33 cm) was observed in variety Godavari (V<sub>1</sub>) in July followed by variety Panchavati (V<sub>2</sub>) (31.70 cm) in August. However, the minimum root shoot length of seedling (30.54 cm) was observed in variety Tapovan (V<sub>4</sub>) in January.

The effect of seed lots on root shoot length of seedling was non-significant in the July and November. Whereas, the maximum root shoot length (31.55 cm) was observed in lot<sup>2nd</sup> in August and the minimum root shoot length (30.89 cm) was observed lot I in December.

The data on root shoot length of seedling differed significantly due to seed age. The root shoot length was significantly highest in fresh seed (32.61 cm) in July. The lowest root shoot length was observed in Rvd II<sup>nd</sup> (30.02 cm) in November.

**Table 3:** Effect of variety and seed age on root shoot length (cm) of wheat

| Treatments  | July   | August | September | October | November | December | January |    |
|---|--------|--------|-----------|---------|----------|----------|---------|----|
| <b>Variety</b>  |        |        |           |         |          |          |         |    |
| V <sub>1</sub> : Godavari                             | 32.23  | 32.17  | 31.96     | 31.87   | 31.80    | 31.52    | 31.48   |    |
| V <sub>2</sub> : Panchavati                           | 31.66  | 31.70  | 31.56     | 31.43   | 31.46    | 31.16    | 31.21   |    |
| V <sub>3</sub> : Trimbak                              | 31.19  | 30.95  | 31.15     | 31.01   | 30.90    | 30.87    | 30.76   |    |
| V <sub>4</sub> : Tapovan                              | 30.88  | 30.75  | 30.59     | 30.82   | 30.61    | 30.73    | 30.54   |    |
| Mean  | 31.49  | 31.38  | 31.30     | 31.28   | 31.19    | 31.06    | 31.00   |    |
| SE ±  | 0.09   | 0.10   | 0.09      | 0.05    | 0.09     | 0.07     | 0.07    |    |
| CD at 5%  | 0.24   | 0.27   | 0.25      | 0.15    | 0.26     | 0.21     | 0.20    |    |
| <b>Seed age</b>                                       |        |        |           |         |          |          |         |    |
| A <sub>0</sub> : Fresh                                | 32.61  | 32.45  | 32.41     | 32.23   | 32.14    | 31.93    | 31.83   |    |
| A <sub>1</sub> : RVD I <sup>st</sup>                  | 31.65  | 31.35  | 31.33     | 31.37   | 31.42    | 31.32    | 31.07   |    |
| A <sub>2</sub> : RVD II <sup>nd</sup>                 | 30.21  | 30.38  | 30.21     | 30.25   | 30.02    | 29.96    | 30.10   |    |
| Mean  | 31.49  | 31.38  | 31.30     | 31.28   | 31.19    | 31.06    | 31.00   |    |
| SE ±  | 0.08   | 0.09   | 0.08      | 0.05    | 0.08     | 0.06     | 0.06    |    |
| CD at 5%  | 0.21   | 0.24   | 0.22      | 0.13    | 0.22     | 0.18     | 0.18    |    |
| Age of seed on July 2018 from date of harvest (Month) | Fresh  | 14     | 15        | 16      | 17       | 18       | 19      | 20 |
|   | RVD I  | 26     | 27        | 28      | 29       | 30       | 31      | 32 |
|   | RVD II | 38     | 39        | 40      | 41       | 42       | 43      | 44 |

### Seedling Dry Weight (g)

The data regarding the seedling dry weight are presented in Table 4. The varieties had significant effect on Seedling dry weight. The variety Godavari recorded significantly highest (0.28 g) seedling dry weight than other varieties in July. However, the variety Trimbak and Tapovan recorded the lowest (0.26 g) seedling dry weight in January. The effect of

seed lots on seedling dry weight was found to be non-significant. The seed age had significant effect on Seedling dry weight. The Seedling dry weight was significantly highest in fresh seed (0.29 g) followed by Rvd I<sup>st</sup> (0.28 g) in July. The lowest seedling dry weight was observed in Rvd II<sup>nd</sup> (0.26 g) in January.

**Table 4:** Effect of variety and seed age on seedling dry weight (g) of wheat

| Treatments                  | July   | August | September | October | November | December | January |
|-----------------------------|--------|--------|-----------|---------|----------|----------|---------|
| <b>Variety</b>              |        |        |           |         |          |          |         |
| V <sub>1</sub> : Godavari   | 0.28   | 0.28   | 0.28      | 0.28    | 0.27     | 0.27     | 0.28    |
| V <sub>2</sub> : Panchavati | 0.28   | 0.28   | 0.27      | 0.28    | 0.27     | 0.27     | 0.27    |
| V <sub>3</sub> : Trimbak    | 0.28   | 0.28   | 0.27      | 0.27    | 0.27     | 0.27     | 0.26    |
| V <sub>4</sub> : Tapovan    | 0.28   | 0.28   | 0.27      | 0.27    | 0.27     | 0.27     | 0.26    |
| Mean                        | 0.28   | 0.28   | 0.27      | 0.27    | 0.27     | 0.27     | 0.27    |
| SE ±                        | 0.0005 | 0.0006 | 0.0003    | 0.0005  | 0.0004   | 0.0004   | 0.0003  |
| CD at 5%                    | 0.0015 | 0.0017 | 0.0009    | 0.0013  | NS       | 0.0012   | 0.0008  |
| <b>Seed age</b>             |        |        |           |         |          |          |         |
| A <sub>0</sub> : Fresh      | 0.29   | 0.29   | 0.29      | 0.29    | 0.28     | 0.28     | 0.28    |
| A <sub>1</sub> : RVD Ist    | 0.28   | 0.28   | 0.27      | 0.27    | 0.27     | 0.27     | 0.27    |
| A <sub>2</sub> : RVD IInd   | 0.27   | 0.27   | 0.26      | 0.26    | 0.26     | 0.26     | 0.26    |
| Mean                        | 0.28   | 0.28   | 0.27      | 0.27    | 0.27     | 0.27     | 0.27    |
| SE ±                        | 0.0005 | 0.0005 | 0.0003    | 0.0004  | 0.0004   | 0.0004   | 0.0003  |

| CD at 5%  | 0.0013 | 0.0015 | 0.0008 | 0.0011 | 0.0010 | 0.0011 | 0.0007 |    |
|---|--------|--------|--------|--------|--------|--------|--------|----|
| Age of seed on July 2018 from date of harvest (Month) | Fresh  | 14     | 15     | 16     | 17     | 18     | 19     | 20 |
|   | RVD I  | 26     | 27     | 28     | 29     | 30     | 31     | 32 |
|   | RVD II | 38     | 39     | 40     | 41     | 42     | 43     | 44 |

### Vigour Index (I)

The data regarding the Vigour index (I) is presented in Table 5. The varieties had significant effect on vigour index (I). The variety Godavari recorded significantly highest (2905.06) vigour index (I) over rest of the other varieties in July. However, the variety Trimbak observed the lowest (2516.11) vigour index (I) in January. The effect of Seed lots on vigour index (I) was found to be non-significant.

The seed age had significant effect on vigour index (I). The vigour index (I) was significantly highest in fresh seed

(3080.47) followed by Rvd I<sup>st</sup> (2821.26) in July. The lowest vigour index (I) was observed in Rvd II<sup>nd</sup> (2349.70) in January.

Seed vigour decreased with the increase of storage period. Seeds deteriorate during storage, their performance potential and vigour decline before any loss in viability. Similar findings had also reported by Ghive *et al.* (2007)<sup>[10]</sup>, Grilli *et al.* (2008)<sup>[12]</sup>, Mathew (2010)<sup>[18]</sup>, Naguib *et al.* (2011)<sup>[22]</sup>, Tian *et al.* (2019)<sup>[26]</sup>.

**Table 5:** Effect of variety and seed age on vigour index (I) of wheat

| Treatments  | July    | August  | September | October | November | December | January |    |
|---|---------|---------|-----------|---------|----------|----------|---------|----|
| <b>Variety</b>  |         |         |           |         |          |          |         |    |
| V1: Godavari  | 2905.06 | 2878.78 | 2825.84   | 2785.42 | 2773.84  | 2724.43  | 2685.67 |    |
| V2: Panchvati   | 2819.27 | 2795.37 | 2746.86   | 2729.59 | 2704.63  | 2654.04  | 2628.92 |    |
| V3: Trimbak   | 2750.91 | 2698.21 | 2694.17   | 2655.85 | 2616.44  | 2591.85  | 2516.11 |    |
| V4: Tapovan   | 2723.89 | 2679.82 | 2651.97   | 2657.81 | 2609.94  | 2607.39  | 2576.28 |    |
| Mean  | 2799.78 | 2763.04 | 2729.71   | 2707.17 | 2676.21  | 2644.43  | 2601.75 |    |
| SE ±  | 10.94   | 11.54   | 12.01     | 9.71    | 10.55    | 10.23    | 8.54    |    |
| CD at 5%  | 30.57   | 32.26   | 33.57     | 27.15   | 29.50    | 28.60    | 23.86   |    |
| <b>Seed age</b>                                       |         |         |           |         |          |          |         |    |
| A0: Fresh   | 3080.47 | 3025.35 | 2987.29   | 2957.65 | 2923.86  | 2872.27  | 2822.26 |    |
| A1: RVD Ist   | 2821.26 | 2770.17 | 2747.26   | 2737.84 | 2708.06  | 2683.42  | 2633.27 |    |
| A2: RVD IInd  | 2497.61 | 2493.62 | 2454.58   | 2426.00 | 2396.71  | 2377.60  | 2349.70 |    |
| Mean  | 2799.78 | 2763.04 | 2729.71   | 2707.17 | 2676.21  | 2644.43  | 2601.75 |    |
| SE ±  | 9.47    | 9.99    | 10.40     | 8.41    | 9.14     | 8.86     | 7.39    |    |
| CD at 5%  | 26.47   | 27.94   | 29.07     | 23.51   | 25.55    | 24.77    | 20.67   |    |
| Age of seed on July 2018 from date of harvest (Month) | Fresh   | 14      | 15        | 16      | 17       | 18       | 19      | 20 |
|   | RVD I   | 26      | 27        | 28      | 29       | 30       | 31      | 32 |
|   | RVD II  | 38      | 39        | 40      | 41       | 42       | 43      | 44 |

### Vigour Index (II)

The data regarding vigour index (II) are presented in Table 6. The varieties had significant effect on vigour index (II). The variety Godavari recorded significantly highest (25.66) vigour index (II) over other varieties in July month. However, the variety Trimbak showed lowest (21.36) vigour index (II) in January month. The seed age had significant effect on vigour index (II). The vigour index (II) was significantly highest in

fresh seed (27.43) followed by Rvd 1<sup>st</sup> (25.24) in July month. The lowest Vigour index (II) was observed in Rvd 2<sup>nd</sup> (20.07) in January. Seed vigour decreased with the increase of storage period. Seeds deteriorate during storage, their performance potential and vigour decline before any loss in viability. Similar findings had also reported by Ghive *et al.* (2007)<sup>[10]</sup>, Grilli *et al.* (2008), Naguib *et al.* (2011)<sup>[22]</sup> and Tian *et al.* (2019)<sup>[26]</sup>.

**Table 6:** Effect of variety and seed age on vigour Index (II) of wheat

| Treatments  | July   | August | September | October | November | December | January |    |
|---|--------|--------|-----------|---------|----------|----------|---------|----|
| <b>Variety</b>  |        |        |           |         |          |          |         |    |
| V1: Godavari  | 25.66  | 25.05  | 24.82     | 24.44   | 23.82    | 23.62    | 23.80   |    |
| V2: Panchvati   | 25.07  | 24.54  | 23.85     | 24.06   | 23.37    | 23.22    | 22.70   |    |
| V3: Trimbak   | 24.77  | 24.26  | 23.71     | 23.44   | 23.03    | 22.47    | 21.36   |    |
| V4: Tapovan   | 24.77  | 24.21  | 23.54     | 23.13   | 23.14    | 22.67    | 22.01   |    |
| Mean  | 25.07  | 24.51  | 23.98     | 23.77   | 23.24    | 23.00    | 22.47   |    |
| SE ±  | 0.10   | 0.08   | 0.08      | 0.07    | 0.08     | 0.07     | 0.06    |    |
| CD at 5%  | 0.27   | 0.23   | 0.21      | 0.20    | 0.23     | 0.20     | 0.18    |    |
| <b>Seed age</b>                                       |        |        |           |         |          |          |         |    |
| A0: Fresh   | 27.43  | 26.90  | 26.40     | 26.22   | 25.69    | 25.21    | 24.66   |    |
| A1: RVD Ist   | 25.24  | 24.70  | 24.10     | 24.00   | 23.45    | 23.14    | 22.68   |    |
| A2: RVD IInd  | 22.54  | 21.95  | 21.44     | 21.08   | 20.89    | 20.63    | 20.07   |    |
| Mean  | 25.07  | 24.51  | 23.98     | 23.77   | 23.24    | 23.00    | 22.47   |    |
| SE ±  | 0.08   | 0.07   | 0.07      | 0.06    | 0.07     | 0.06     | 0.05    |    |
| CD at 5%  | 0.23   | 0.20   | 0.18      | 0.17    | 0.20     | 0.17     | 0.15    |    |
| Age of seed on July 2018 from date of harvest (Month) | Fresh  | 14     | 15        | 16      | 17       | 18       | 19      | 20 |
|   | RVD I  | 26     | 27        | 28      | 29       | 30       | 31      | 32 |
|   | RVD II | 38     | 39        | 40      | 41       | 42       | 43      | 44 |

**Mycoflora (%)**

The data regarding the mycoflora (%) are presented in Table 7. The varieties had significant effect on mycoflora percentage. The variety Trimbak recorded significantly the highest mycoflora (18.44%) over other varieties in January month. However, the variety Panchavati recorded the lowest mycoflora (9.72%) in early month of storage i.e. in July. The seed age had significant effect on mycoflora (%). The

mycoflora percentage was significantly highest in Rvd 2<sup>nd</sup> seed (21.88%) followed by Rvd 1<sup>st</sup> seed (15.25%) in January month. The lowest mycoflora (%) was observed in fresh seed (5.79%) in July. The infection of mycoflora increased and seed germination decreased with the increase of storage period. Similar findings had also reported by Ghive *et al.* (2007)<sup>[10]</sup>, Malaker *et al.* (2008)<sup>[17]</sup>, Fourar *et al.* (2011)<sup>[9]</sup>.

**Table 7:** Effect of variety and seed age on mycoflora (%) of wheat

| Treatments  | July   | August | September | October | November | December | January |    |
|---|--------|--------|-----------|---------|----------|----------|---------|----|
| <b>Variety</b>  |        |        |           |         |          |          |         |    |
| V1: Godavari  | 10.50  | 10.00  | 10.78     | 12.61   | 12.56    | 13.83    | 14.39   |    |
| V2: Panchavati  | 9.72   | 11.06  | 12.11     | 12.72   | 13.94    | 15.17    | 16.00   |    |
| V3: Trimbak   | 11.65  | 11.89  | 13.61     | 14.67   | 15.17    | 17.33    | 18.44   |    |
| V4: Tapovan   | 10.83  | 11.78  | 12.50     | 13.11   | 14.11    | 15.50    | 15.72   |    |
| Mean  | 10.67  | 11.18  | 12.17     | 13.28   | 13.94    | 15.46    | 16.14   |    |
| SE ±  | 0.25   | 0.25   | 0.22      | 0.24    | 0.24     | 0.30     | 0.26    |    |
| CD at 5%  | 0.71   | 0.71   | 0.61      | 0.68    | 0.67     | 0.84     | 0.72    |    |
| <b>Seed age</b>                                       |        |        |           |         |          |          |         |    |
| A0: Fresh   | 5.79   | 5.92   | 7.13      | 7.96    | 8.54     | 10.04    | 11.29   |    |
| A1: RVD Ist   | 9.17   | 10.38  | 12.08     | 12.63   | 13.54    | 14.96    | 15.25   |    |
| A2: RVD IInd  | 17.04  | 17.25  | 17.54     | 19.25   | 19.75    | 21.38    | 21.88   |    |
| Mean  | 10.67  | 11.18  | 12.17     | 13.28   | 13.94    | 15.46    | 16.14   |    |
| SE ±  | 0.22   | 0.22   | 0.19      | 0.21    | 0.21     | 0.26     | 0.22    |    |
| CD at 5%  | 0.61   | 0.62   | 0.53      | 0.59    | 0.58     | 0.73     | 0.63    |    |
| Age of seed on July 2018 from date of harvest (Month) | Fresh  | 14     | 15        | 16      | 17       | 18       | 19      | 20 |
|   | RVD I  | 26     | 27        | 28      | 29       | 30       | 31      | 32 |
|   | RVD II | 38     | 39        | 40      | 41       | 42       | 43      | 44 |

**Conclusion**

The seed age had significant effect on seed quality of wheat. The seed recorded significantly higher germination (94.46%) at the age of 14<sup>th</sup> months after harvest, while it was (88.67%) at the age of 20<sup>th</sup> months. The seed maintained germination (85.7%) even at the age of 31<sup>st</sup> months which is above IMSCS (85%).

The wheat seeds maintained the 85.75% germination at the age of 31<sup>st</sup> months which is above Indian Minimum Seed Certification Standards (85%).

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