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The Impact of Storage Duration on the Yield of Wheat (*Triticum* spp. L.)

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ABSTRACT: Unpredictable weather patterns, extreme temperatures and irregular rainfall can disrupt crop cycles and affect overall agricultural production and productivity. Environmental changes are responsible for scarcity of resources like land, water, and agricultural inputs. Among various agricultural inputs seed is the basic unit in farming process. Implementing adaptive measures to face the challenges of climate change, we can use the aged seed for sowing upto which the seed can maintain its viability and vigour. By checking the viability of seed we can revalidate seed after ending of validation period two more times than the common validity period. The research was conducted during *rabi* 2018-19. Experiment was set out in Factorial Randomized Block Design (FRBD) with two replications at Post Graduate Institute, research field, MPKV, Rahuri. The experiment include four varieties *viz*., Godavari (V_1), Panchavati (V_2), Tapovan (V_3) and Trimbak (V_4), three seed ages fresh seed (A_0), revalidated (Rvd) Ist seed (A_1) and revalidated (Rvd) IInd seed (A_2). The study revealed that, significant difference were observed among the varieties. Yield characters i.e. field emergence (77.75 %), yield per plot (1.74 kg) and yield per hectare (44.41 q) were superior in respect of variety Godavari followed by Panchavati, Tapovan and Trimbak. Due to various seed ages the field emergence percentage differed significantly and was more in fresh seed (87.56 %) followed by RvdIst and RvdIInd seed. The yield attributes *viz*., yield per plot (2.07 kg) and yield per hectare (52.84 q) differed significantly due to various seed age and were highest in the fresh seed followed by RvdIst and RvdIInd seed. There were no definite relationship observed in the days to 50 % flowering, plant height, number of tillers per plant and days to maturity among the plants from fresh seed, RvdIst and RvdIInd seed. Out of the various seed ages, fresh seed produced higher seed yield than others and RvdIInd seed reported less but consistent performance.

Keywords: Storage period, wheat, yield, seed age, revalidate seed.

INTRODUCTION

Climate change has a significant impact on world agriculture, raising concerns about the security of the world's food supply. Although the green revolution increased global food grain production, the speed of crop management and improvement at the moment is insufficient to feed billions of people. Wheat was major crop in green revolution era. Wheat is a staple food for large portion of the world's population. India holds the second position after China in production and contributes about 13% share to the global wheat market (Sharma and Kumar 2022). It is a primary source of dietary carbohydrates and provides essential nutrients, including proteins, vitamins and minerals. Carbohydrate and protein are two main constituents of wheat (De Santis *et al.*, 2021). On an average wheat contains, 11-12 % protein in its seeds which is rich in non-essential amino acids like glutamine and proline. In addition, it contains a significant amount of minerals (Ca, Se, Na, K, Mg, Zn and Fe) and vitamins (thiamine, niacin, folate and riboflavin) (Kumar *et al*., 2011; Poutanen *et al.*, 2020). As we know seed is a basic input in agriculture. Production of quality seed is key challenge in almost all the agriculture crops. High quality seeds possesses many advantages such as, it ensures better germination, uniform plant stand in field and provide resistance to different diseases. When we use high-quality seeds, productivity increases by 15-20% (Prisyazhnaya *et al.*, 2020; Siroshtan *et al.*, 2021). Quality seed can be produced by many ways by maintaining isolation distance, avoiding mechanical mixture, use of certified seed varieties and many more. Because of this, production and storage of quality seeds

needs utmost care and management (Bishaw *et al*., 2007; Gupta and Kumar 2016). Many factors hampers seed quality but, temperature and moisture play a significant and fundamental role in determining the storage longevity of seeds (Krishnan *et al*., 2004; Malaker *et al*., 2008; Khazaei *et al*., 2016; Saeed *et al*., 2020). Till date, different periods and agreements of wheat seeds storage were studied, but there is no solid opinion on the question of best conditions to the long-term period of storage for different pristine quality of seeds (Villers *et al*., 2010). The viability and vigour of seed lots declined considerably after two years as indicated by different physiological and biochemical parameters (Verma *et al.,* 2003).

In view of inadequacy of information, there is need to assess the quality of aged seed lots, to extend the validity period. The research was framed, entitled "The impact of storage duration on wheat yield" and were carried out with object, toanalyze the yield quality parameters of aged seed lots of wheat.

MATERIAL AND METHODS

The present investigation entitled, "The impact of storage duration on the yield of wheat (*Triticum* spp. L.)", was conducted during 2018-19 at Seed Technology Research Unit (STRU) Laboratory and research field of MPKV, Rahuri (Maharashtra).

Experimental Material

1. Seed. The seeds of four varieties of age fresh, RvdIst and IInd were obtained from wheat breeder, Agriculture Research Station, Niphad, (Maharashtra).

2. Storage. The seeds were stored in cloths bags under ambient conditions, at Seed Technology Research Unit, MPKV, Rahuri.

Details of experimental plot. The experiment were laid out during *Rabi*, 2018-19 at Post Graduate Institute, Research Field, MPKV, Rahuri in Factorial Randomized Block Design (FRBD) with two replications. Each plot comprised of 3 × 2 m^2 (Gross) and 2.80 × 1.40 m^2 (Net) areas. Row to row spacing were kept at 22.5 cm. All the recommended packages of practices of university were adopted to carry out experiment.

Table 1: Details of seed samples.

Sr. No.	Variety	Stage	Date of Harvest	Age of the seed on July 2018 from date of harvest (month)
1.	Panchvati (NIDW-15)	Nucleus	April -2017-18 (Fresh)	14
2.			April -2016-17 (RVD-I)	26
3.			April -2015-16 (RVD-II)	38
4.	Godavari (NIDW-295)	Nucleus	April -2017-18 (Fresh)	14
5.			April -2016-17 (RVD-I)	26
6.			April -2015-16 (RVD-II)	38
7.	Tapovan (NIAW-917)	Nucleus	April -2017-18 (Fresh)	14
8.			April -2016-17 (RVD-I)	26
9.			April -2015-16 (RVD-II)	38
10.	Trimbak (NIAW-301)	Nucleus	April -2017-18 (Fresh)	14
11.			April -2016-17 (RVD-I)	26
12.			April -2015-16 (RVD-II)	38

List of observations recorded

Field emergence (%). The field emergence count was taken on 7thday after sowing. The seedling emerged with more than three centimeters above the soil surface was counted and expressed in percentage.

Days to 50 (%) flowering (No.). The number of days from sowing to 50 % flowering were noted, when 50 % of plants in each plot flowered.

Plant height (cm). The plant height was recorded at physiological maturity in the randomly selected tagged plants by measuring the height from ground level to the tip of the ear head. The average height of plant was calculated and expressed in centimeters.

Number of tillers (No.). The number of tillers per plant were counted from each tagged plant in each plot and average of it were expressed.

Days to maturity (No.). Number of days from germination to physiological maturity were recorded when more than 50 % panicles were ripe and turned yellow.

Grain yield (kg/plot). All the plant in net plot (2.80 × 1.40 m) were harvested, dried and threshed. The seeds of all the variety thoroughly sundried before weighing and average grain yield (kg) per net plot was calculated.

Grain yield (qt/ha). From the net plot yield in kilograms, the seed yield (qt) per hectare were worked out. Yield (qt/ha) = Net plot yield (kg) × Hectare factor (H.F.)

$$\text{H. F.} = \frac{10,000\,(\text{m}^2)}{\text{Net plot area}\,(\text{m}^2)}$$

RESULT AND DISCUSSION

Quality seed production is key activity in agriculture because yield and final crop stand in the field is depends on initial seed. Quality of seed depends on many factors such as, source of seed used for sowing, isolation distances, mechanical mixture and package of practices followed. Apart from this, proper drying and storage period also affects on quality of seeds. In this study, we studied effect of variety and seed age on seed yield and yield contributing traits of wheat at field condition. Hereby, data on effect of variety, and seed age on seed yield and yield contributing traits are given in Table 2.

Table 2: Effect of variety and seed age on yield contributing parameters of wheat.

Treatments	FE(%)	DFF	PH (cm)	NTPP	DM	NYPP(kg)	Y(q/ha)
Varieties							
Godavari (V_1)	77.75 (62.28)	64.08	86.17	10.33	113.50	1.74	44.41
Panchavati(V_2)	75.17 (60.56)	62.08	102.58	10.17	107.08	1.36	34.74
Trimbak(V_3)	76.75 (61.63)	63.83	94.42	12.25	112.17	1.71	43.56
Tapovan(V_4)	74.58 (60.20)	66.17	89.08	11.17	114.25	1.66	42.43
Mean	**76.06**	**64.04**	**93.06**	**10.98**	**111.75**	**1.62**	**41.28**
SE ±	**0.31**	**0.23**	**0.40**	**0.43**	**0.44**	**0.04**	**1.01**
CD at 5 %	**0.87**	**0.65**	**1.12**	**1.20**	**`1.24**	**0.11**	**2.83**
Seed age							
A_0	87.56 (69.36)	64.13	92.94	11.13	111.81	2.07	52.84
A_1	75.13 (60.11)	64.06	93.13	11.00	111.63	1.66	42.44
A_2	65.50 (54.04)	63.94	93.12	10.81	111.81	1.12	28.57
Mean	**76.06**	**64.04**	**93.06**	**10.98**	**111.75**	**1.62**	**41.28**
SE ±	**0.27**	**0.20**	**0.35**	**0.37**	**0.38**	**0.03**	**0.88**
CD at 5 %	**0.76**	**NS**	**NS**	**NS**	**NS**	**0.10**	**2.45**

Note- The values in parenthesis are arc sin transformed values, FE: Field emergence, DFF: Days to 50 % flowering, PH: Plant height, NTPP: Number of tillers/plant, DM: Days to maturity, NYPP: Net yield per plot and Y: Yield.

1. Field Emergence (%)

A. Effect of variety. The varieties had significant effect on field emergence (%). The variety Godavari recorded significantly higher field emergence (77.75 %) over other varieties. However, the variety Tapovan recorded the lowest field emergence (74.58 %).Vigour and viability are two important measures to predict the planting value of seed as the seeds germinate, it further develops into a plant. Seed lots of varieties of a particular region may vary in seed viability and vigour stated by Verma *et al.* (2003).

B. Effect of seed age. The seed age had significant effect on field emergence. The field emergence percentage was significantly highest in fresh seed (87.56 %) followed by RvdIst(75.13 %). The lowest field emergence percentage was observed in RvdIInd(65.50%). High temperature during storage may result in increased respiration and rapid consumption of the storage materials, leading to seed deterioration and negatively affecting germination, emergence and establishment of wheat seedlings. Similar findings had also reported by Almansouri *et al*. (2001); Tekrony (2006); Marshall and Lewis (2009). Poor quality of seed has both direct and indirect impacts on crop establishment, crop health, and ultimately on yield conveyed by Lamichhane *et al.* (2018). The seedling establishment and emergence rate index decreased significantly as the age of the seed increased observed by Verma *et al.* (2003).

2. Days to 50 (%) Flowering

A. Effect of variety. The varieties under study significantly differed in their days required to 50 (%) flowering. The variety Tapovan recorded significantly higher (66.17) days to 50 (%) flowering than other varieties. However, the variety Panchavati exhibited less number (62.08) of days required to 50% flowering. Similar, results were obtained by, Tekrony (2006). The effect of the long seed storage on the plant growth varies with the cultivar observed by Matsue *et al*. (2002).

B. Effect of seed age. Days to 50 (%) flowering was the same as that of plants from fresh seeds in all cultivars, but that of RvdIInd seeds varied with the cultivar. The seed age had non-significant effect on days to 50 (%) flowering. The flowering date was not influenced by seed storage but was delayed in some cultivars. Similar findings had also reported by Matsue *et al*. (2002).

3. Plant height (cm)

A. Effect of variety. From the data it was noticed that, the plant height was significantly differed due to the varieties. Significantly the highest plant height (102.58 cm) was recorded in variety Panchavati followed by variety Trimbak (94.42 cm). However, the lowest plant height (86.17 cm) were recorded in variety Godavari irrespective of seed lot and seed age. Plant height is a varietal character and it is the genetic constituent of the cultivar, therefore, plant height was different among the cultivar reported by Chamely *et al.* (2015).

B. Effect of seed age

The seed age had non-significant effect on plant height. There was no definite relationship in the plant height among the plants from thefresh seed, RVD Ist and RVD IInd seed. Similar findings had also reported by Matsue *et al.* (2002).

4. Number of tillers per plant

A. Effect of variety. The number of tillers per plant differed significantly due to different varieties. The variety Trimbak recorded significantly higher number of tillers (12.25) per plant than other varieties. However, the minimum number of tillers (10.17) per plant observed in Panchavati variety. The results indicate that tillering pattern of different varieties differed due to genetic potentiality of the varieties same results are also observed by Chamely *et al.* (2015) in rice crop.

B. Effect of seed age. The seed age had non-significant effect on number of tillers per plant. At low plant density, tillers contributed at least 40 % to plant yield and a better yield stability in later sowings was associated with a higher contribution of tillers to yield (Arduini *et al*., 2018). The vigorously growth of number of tillers recorded during 26 to 40 DAS than

number of tillers remains same on or after 40 to 105 DAS (Agrawal and Nath 2018).

5. Days to maturity

A. Effect of variety. The varieties had significant effect on days to maturity. The variety Tapovan recorded significantly higher (114.25) days to maturity over other varieties, which is considered as late mature genotype. However, the variety Panchavati recorded the lowest (107.08) of days to maturity.

B. Effect of seed age. The seed age had non-significant effect on days to maturity. The number of days to maturity was significantly highest in fresh and RvdIInd seed (111.81) and the lowest number of days to maturity was observed in RvdIst (111.63). The maturing date of the plants from old seeds was the same as that of the plants from the fresh seeds in all cultivars, but that of the plants from RvdIInd seed varied with the cultivar. Same observations had also reported by Matsue *et al*. (2002).

6. Grain Yield Per Plot (kg)

A. Effect of variety. The varieties had significant effect on grain yield per plot. The variety Godavari recorded significantly higher (1.74 kg) grain yield per plot than other varieties. However, the variety Panchavati recorded the lowest (1.36 kg) grain yield per plot. The yield potential of winter wheat depends significantly on the species and variety used (Ratajczak *et al*., 2020; Solomon and Daniel 2021).

B. Effect of seed age. The seed age had significant effect on grain yield per plot. The grain yield per plot was significantly highest in fresh seed (2.07 kg) followed by RvdIst (1.66 kg). The lowest grain yield per plot was observed in RvdIInd (1.12 kg). Seed yield decreased with passage of time as observed in *Brassica* crop by Verma *et al.* (2003).

7. Grain Yield (q/ha)

A. Effect of variety. The varieties had significant effect on grain yield per hectare. The variety Godavari recorded significantly higher (44.41 q) grain yield per hectare over other varieties. However, the variety Panchavati recorded the lowest (34.74 q) grain yield per hectare. Yield is affected by variety due to their resistance to a particular disease or insect pest as mentioned by Cornell *et al.* (2020). Some cultivars had inferior grain yield after the seed storage for over 3 years and above. Similar findings had also reported by Matsue *et al*. (2002).

B. Effect of seed age. The seed age had significant effect on grain yield per hectare. The grain yield per hectare was significantly highest in fresh seed (52.84 q) followed by RvdIst (42.44 q). The lowest grain yield per hectare was observed in RvdIInd (28.57 q). In the plant from the old seeds, no significant differences from fresh seeds were observed in the yield components and grain yield. On the other hand, in the plants from the very old seeds, the mean yield components and grain yield were significantly different from those in the fresh seeds in some cultivar. Similar findings had also reported by Matsue *et al*. (2002); Marshal *et al*. (2009).

CONCLUSIONS

The quality seeds are essential for productive agriculture. Strong early development, optimum germination, and substantial crop yields are all guaranteed by high-quality seeds. They exhibit homogeneity, disease resistance, and desired genetic features. A large increase in crop yield and overall agricultural sustainability can be achieved by planting high-quality seeds. The field emergence percentage of different varieties differed significantly from each other; variety Godavari recorded higher field emergence than rest of varieties, similarly the yield contributing parameters recorded higher values *viz.*, yield per plot and yield per hectare in variety Godavari followed by Trimbak, Tapovan and Panchavati. The field emergence percentage due to different seed ages differed significantly and was more in fresh seed followed by RvdIst and RvdIInd seed. The yield attributes *viz.*, yield per plot and yield per hectare differed significantly due to different seed age and were maximum in the fresh seed followed by RvdIst and RvdIInd seed. There was no definite relationship observed in the days to 50 % flowering, plant height, number of tillers per plant and days to maturity among the plants from fresh seed, RvdIst and RvdIInd seed.

FUTURE SCOPE

Seed purity and seed quality need to be maintained for better crop stand and higher yield. Crop wise improved storage practices need to be prepared to maintain longer seed viability. Collaborative research need to be planned in such a way that fruitful results should be obtained. Proper care should be taken while drying because moisture is the key factor which ultimately determines the life span of seed. Advanced storage techniques like cryopreservation need to be used to maintain the viability of seeds.

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Conflict of Interest. None.

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