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RESEARCH PAPER

Influence of desiccants on seed quality attributes of wheat crop under hermetic storage

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Abstract : An investigation was undertaken with main objectives to know the effect of desiccants on seed quality parameters of crop seeds during storage and to assess the benefit cost ratio of storage method (economics) in wheat with initial seed moisture content of 12.3 %, was carried out at Department of Seed Science and Technology, College of Agriculture, UAS, Dharwad. Quantity of desiccants stored per kilogram of seed in wheat seeds is 0.37 kg for zeolite beads, one kg for silica gel, calcium carbonate and control without desiccant in airtight container. The experiment was laid out in Completely Randomized Design with four treatments and five replications. Seed stored with zeolite beads recorded the highest germination (88.8 %) which was on par with silica gel (87.2 %) at the end of storage period. Lower seed moisture and hundred seed weight was observed in the seeds stored with silica gel at the end of storage period. Higher shoot length, root length, seedling vigour-I and seedling dry weight was observed in seeds stored with zeolite beads which was on par with Silica gel at the end of storage period. compared to control. Therefore, it can be concluded that the zeolite beads can safely be used for seed drying without impairment in seed quality.

Key Words : Wheat seeds, Drying, Desiccants, Moisture, Hermetic container

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INTRODUCTION

Wheat belongs to genus *Triticum;* It is the world's largest cereal crop species and described as 'King of cereals' due to its larger acreage, high productivity and its prominent position in the international food grain trade. Majority of wheat varieties belongs to three main species of genus *Triticum durum, Triticum aestivum* and *Triticum dicoccum.* Wheat is the major staple food crop for over ten billion people in as many as 43 countries of the world. In India, it is the second most important cereal crop next to rice and is considered as a key crop of the green revolution.

Seed is the critical determinant of agricultural production on which depends the performance and efficacy of other inputs. Quality seeds appropriate to different agro-climatic conditions and sufficient quantity at affordable prices are required to raise productivity. Seed quality depends on factors like source, time of harvest, techniques of harvesting and processing including seed drying and storage practices. Special techniques

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are required for seed collection, handling, processing and storage of the seeds. Generally seeds are dried under the sun, if the crop is harvested during rainy season or under cloudy weather it is very difficult to dry the seed. In such condition, high temperature and humidity combine to cause rapid deterioration of seeds under ambient conditions of storage resulting in low seed quality, poor stand establishment, lower productivity and disincentive to invest in improved seeds.

Delay in drying or slow drying together with high temperature (above 25°C) will tend to reduce viability considerably in orthodox seeds. The recommended methods for safe seed drying to a very low moisture content using seed drying chambers or seed dryers, where the relative humidity of the drying environment is controlled. (Ellis *et al.*, 1995.)

It may not be easily implemented in the seed industry due to the high cost of establishing, running and maintaining. Therefore, there is a need for low cost drying methods to be used as alternatives to such expensive seed drying equipments in order to lower the moisture content and to maintain safe moisture level suitable for seed storage to suit all the situations *i.e.* from individual small farmers to big seed growers. As an alternative desiccant drying technology, seed drying using desiccant. Keeping allaboveconsiderations the present investigation was plannedto know the effect of desiccants on seed quality during storage with the following objectives: To know the effect of desiccants on seed quality parameters of wheat seeds during storage.

MATERIAL AND METHODS

The storage experiment was conducted in the Seed Quality Research Laboratory of National Seed Project, Seed unit, College of Agriculture, Dharwad, on "effect of desiccants on seed quality of wheat crop under hermetic storage". Freshly harvested seeds of wheat (UAS 304), were obtained from the Seed unit, University of Agricultural Sciences, Dharwad, Karnataka. The seeds are stored with 12.3 per cent initial moisture content. Quantity of desiccants stored per kilograms of seed in wheat seed is 0.37 kilograms for zeolite beads (Rhino Research table), one kg for both silica gel and dehydrated calcium carbonate, respectively. The seeds were then mixed with the desiccants (Zeolite beads, Silica gel) and $CaCO_3$ dehydrated along with control and kept in hermetic container and stored for nine months under control conditions from August, 2016 to May, 2017. Samples were drawn from hermetic containers at monthly intervals and data on seed quality parameters were recorded. Relative humidity and temperature present in the hermetic container was noted by using EXTECH Hygro-thermometer with direct readings. These hygro-thermometers placed in each hermetic container and readings were noted 24 hrs intervals throughout the storage period. The experiments were laid out in Completely Randomized Design (CRD) replicated thriceand the data recorded was subjected to Analysis of Variance (ANOVA) technique (Gomez and Gomez, 1984). Standard error of difference was calculated for each treatment effect and critical difference (CD) was calculated at 5 per cent probability level to compare the mean difference among the treatments. The data of parameters expressed in percentages were transformed into square root transformation should be done for per cent data (on count basis) lying within the range of 70-100 per cent before subjecting to statistical analysis (Snedecor and Cochran, 1967). The seed quality parameters such as moisture content germination, root length , shoot length, dry weight of seedling and seedling vigour index were recorded.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Germination:

The loss in germinability and vigour of seed during storage is inevitable. These losses occur in storage due to various factors such as moisture content, temperature, relative humidity, length of storage period and storage containers.

In the present study it revealed that initial germination was 98.0 per cent in wheat seeds variety UAS-304. A significant positive effect on seed germination percentage was observed with desiccants. The seed germination percentage was above minimum seed certification standards (85%) in Zeolite beads and silica gel treatments, but lower in seed stored with calcium carbonate and control without desiccants (77.2 and 76.2 %), respectively after 9 months of storage. The germinability in all treatments decreased as storage period progressed. However, seeds packed in airtight container with drying beads and silica gel maintained high germination percentage of 88.8 and 87.2 per cent, respectively throughout the storage period. After five months of storage the germination per cent of wheat seeds was significantly influenced. The retention of high seed viability with desiccant might be due to slow lowering of seed moisture at ultra dry conditions *i.e.,* by zeolite beads and silica gel during storage which resulted on low seed respiration and maintenance of cell membrane integrity. Further the drying process is much slower with zeolite than silica gel. The faster drying is always not good in retention of seed quality. Similar results were reported by Ellis *et al*. (1991) in onion seeds were high germination up to three years observed when moisture content was maintained from 6.0 to 6.8 per cent (dry treatment) or 3.6 to 3.7 per cent (ultra dry treatment) and stored under a temperature of 2^0 to 20^oC. The onion seeds stored in glass container and aluminium foil with silica gel at 5^0C and -20^0C retained germination of 90 per cent and 76 per cent, respectively after seven years of seed storage (Doijode, 1995).

Table 1: Effect of desiccants on germination per cent of wheat crop seeds during storage

Treatments	Initial	1 month	2 month	3 month	4 month	5 month	6 month	7 month	8 month	9 month
T_1	98.0 (81.84)	96.6 (79.34)	95.8(78.14)	95.4(77.58)	95.2 (77.31)	93.0 (74.63)	90.4(71.92)	90.0(71.54)	89.4(71.04)	88.8(70.47)
T_2	98.0(81.84)	97.6(81.06)	96.2(78.73)	95.6(77.86)	94.8(76.79)	91.8(73.33)	89.4(70.97)	88.2(69.88)	87.8(69.56)	87.2(69.04)
T_3	98.0(81.84)	97.2(80.33)	95.0(77.05)	94.6(76.53)	94.4(76.28)	86.8(68.67)	78.8(62.56)	78.0(62)	77.6(61.84)	77.2(61.49)
T_4	98.0(81.84)	95.2(77.31)	93.6(75.32)	93.2(74.85)	92.6(74.19)	86.0(68)	85.0(67.19)	80.8(63.99)	76.6(61.06)	76.2(60.78)
Mean	98.0	96.65	95.15	94.7	94.25	89.4	85.9	84.25	82.85	82.35
S.E.±	-	1.38	1.30	1.32	1.11	0.85	1.6	1.5	1.15	0.79
C.D. (P=0.01)	-	NS	NS	NS	NS	3.7	6.94	6.47	4.96	3.42

Values in parenthesis are arcsine transformed values NS= Non-significant
T_1- Seed stored with zeolite bead T_2-seedstored with silica gel
T_3- Seed stored with$CaCo_3$ T_4- Seed stored in hermetic container without desiccant (control).

Table 2: Effect of desiccants on shoot length of wheat crop seeds during storage

Treatments	Initial	1 month	2 month	3 month	4 month	5 month	6 month	7 month	8 month	9 month
T_1	16.3	16.2	15.6	14.9	14.6	14.3	14.2	13.8	13.6	13.3
T_2	16.3	16.1	15.3	14.4	14.1	13.8	13.4	13.1	12.9	12.7
T_3	16.3	15.9	14.8	14.3	13.9	13.6	13.1	12.9	12.5	12.1
T_4	16.3	15.1	14.0	13.8	13.3	12.3	11.8	11.2	11	10.8
Mean	16.3	15.8	14.9	14.4	14.0	13.5	13.1	12.8	12.5	12.3
S. E. ±	-	0.27	0.19	0.18	0.19	0.18	0.18	0.19	0.17	0.16
C.D. (P=0.01)	-	NS	0.80	0.76	0.82	0.76	0.78	0.81	0.73	0.69

NS= Non-significant
T_1- Seed stored with zeolite bead T_2-seedstored with silica gel
T_3- Seed stored with$CaCo_3$ T_4- Seed stored in hermetic container without desiccant (control).

Table 3: Effect of desiccants on root length of wheat crop seeds during storage

Treatments	Initial	1 month	2 month	3 month	4 month	5 month	6 month	7 month	8 month	9 month
T_1	19.8	19.5	18.7	18.4	17.8	17.6	17.5	17.2	17.0	16.9
T_2	19.8	19.2	18.3	18.1	17.6	17.1	17.0	16.7	16.4	16.1
T_3	19.8	18.6	18.3	17.4	17.4	17.0	16.6	16.3	15.9	15.5
T_4	19.8	18.3	17.8	17	17.2	16.7	16.3	15.8	15.0	14.7
Mean	19.8	18.9	18.3	17.7	17.5	17.1	16.8	16.5	16.1	15.8
S.E. ±	-	0.29	0.22	0.27	0.30	0.22	0.21	0.24	0.24	0.23
C. D. (P=0.01)	-	NS	NS	NS	NS	NS	NS	1.05	1.04	1.01

NS=Non-significant
T_1- Seed stored with zeolite bead T_2-seedstored with silica gel
T_3- Seed stored with$CaCo_3$ T_4- Seed stored in hermetic container without desiccant (control).

Shoot and root length :

Seedling length and dry matter production of the seedlings are the manifestation of physiological efficiency of germinating seeds, which depend upon the seed vigour (Heydecker, 1973). Seedling growth in terms of root and shoot has been regarded as a good measure of seed vigour of the seeds (Abdul Baki and Anderson, 1973).

Desiccant seed drying and storage was significantly influenced in all treatments from 2nd and 7th month onward in shoot length and root length, respectively. Wheat seeds dried and stored with zeolite beads showed the highest shoot length (13.3 cm) which was on par with silica gel (12.7 cm) followed by calcium carbonate (12.1 cm). The lowest shoot length was in control (10.8 cm) after 9 months of storage period. Seeds stored with zeolite beads showed the highest root length (16.9 cm) and was on par with silica gel (16.1 cm) followed by calcium carbonate (15.5 cm). The lowest root length was in control (14.7 cm) after 9 months of storage period. The results are in accordance with findings of Doijode (1995) who have observed higher shoot length of 0.21cm day^{-1} in onion seeds stored in glass container with silica gel and 0.22 cm day^{-1} in aluminium foil container with silica gel at 5^0C. Higher seedling length might be due to lower respiration rate and metabolic activities which were governed by lower moisture content that was maintained by zeolite beads and other desiccants till the end of storage period. Higher root and shoot length is an indication of maintenance of vigour in the seeds preserved with these desiccants.

Seedling vigour index -I :

The higher vigour index I at the end of storage period in wheat crop seeds was noticed with zeolite beads (2691) which was on par with silica gel (2515), followed by vigour index of seed stored with calcium carbonate and control (2133 and 1945), respectively, after 9 months of storage period.

The seeds stored with silica gel and zeolite beads maintained low moisture which might have resulted in lower respiration rate, lower metabolic activity and maintenance of higher seed vigour during storage. This lower moisture maintained in a airtight container might be responsible for higher germination, seedling length,

Table 4: Effect of desiccants on seedling vigour index I of wheat crop seeds during storage

Treatments	Initial	1 month	2 month	3 month	4 month	5 month	6 month	7 month	8 month	9 month
T_1	3533	3449	3287	3177	3089	2964	2860	2790	2744	2691
T_2	3533	3441	3232	3109	3006	2837	2715	2628	2573	2515
T_3	3533	3352	3138	2995	2957	2653	2341	2278	2204	2133
T_4	3533	3179	2982	2869	2825	2498	2385	2182	1997	1945
Mean	3533	3355	3159	3037	2969	2738	2575	2470	2380	2321
S.E. ±	-	58	34	43	46	41	76	64	53	48
C. D. (P=0.01)	-	NS	147	189	201	175	327	274	226	208

NS= Non-significant
T_1- Seed stored with zeolite bead T_2-seedstored with silica gel
T_3- Seed stored with$CaCo_3$ T_4- Seed stored in hermetic container without desiccant (control).

Table 5: Effect of desiccants on seedling dry weight of wheat crop seeds during storage

Treatments	Initial	1 month	2 month	3 month	4 month	5 month	6 month	7 month	8 month	9 month
T_1	168	165	164	160	156	155	154	151	150	149
T_2	168	165	162	158	155	153	152	149	149	148
T_3	168	163	162	156	150	144	136	132	130	129
T_4	168	164	160	153	151	142	133	129	123	121
Mean	168	164	162	156	153	148	143	140	138	136
S.E. ±	-	2.41	2.38	2.3	2.25	2.19	2.12	2.07	2.04	2.02
C. D. (P=0.01)	-	NS	NS	NS	NS	9.45	9.16	8.94	8.8	8.72

NS= Non-significant
T_1- Seed stored with zeolite bead T_2-seedstored with silica gel
T_3- Seed stored with$CaCo_3$ T_4- Seed stored in hermetic container without desiccant (control).

seedling dry weight and seedling vigour indices as a result of greatly extending storage life as reported by (Hong *et al*., 2005). In addition Padma and Reddy (2000) reported that onion seeds were dried with silica gel to 5.3 per cent seed moisture content and stored in polythene bag maintained higher vigour index I with 474 after 20 months of seed storage compared to cloth bag 413. Doijode (1995) observed high vigour indices I and II of 591 and 162, respectively for the seeds stored in glass container with silica gel compared to 415 vigour index I and 113 vigour index II without silica gel. Modern crop production systems require a high degree of precision in crop establishment. The need for high plant population densities and uniform plant stand requires seeds of high quality that constantly produce rapid and uniform seedlings from each sown seed.

Seedling dry weight :

The initial seedling dry weight of wheat crop (168 mg/10) was recorded before storage. Effect of desiccants on seedling dry weight is an indicator of seedling vigour and Statistically significant variation was observed for dry matter production from 5th month, onwards. Seed stored with Zeolite beads showed the highest seedling dry weight of (149 mg/10) followed by silica gel (148 mg/10), whereas seedling dry weight of 129 mg/10 and 121 mg/10 was observed for seed stored in calcium carbonate and control, respectively after 9 months of storage period. Higher seedling dry weight in the seeds stored with zeolite beads and other desiccants might be due to prevalence and operating of low metabolic rate and high vigour retention which in turn may be the result of lower moisture content. Higher seedling dry weight is an indication of maintenance of high vigour in the seeds preserved with desiccants. These results are in line with the findings of Doijode (1995) who observed that onion seeds stored in a glass container with silica gel maintained higher seedling dry weight of 0.3 mg day^{-1} compared to the seed stored without silica gel at 5^{o}C after seven years of storage.

Moisture content :

The seed stored in airtight container with silica gel and zeolite beads showed the lowest seed moisture content throughout the storage period and were on par with each other treatments. Silica gel reduced the initial

Table 6: Effect of desiccants on moisture content of wheat crop seeds during storage

Treatments	Initial	1 month	2 month	3 month	4 month	5 month	6 month	7 month	8 month	9 month
T_1	12.3	9.60	8.81	6.98	5.91	5.80	5.73	5.65	5.63	5.60
T_2	12.3	8.45	7.94	6.84	5.83	5.60	5.40	5.32	5.23	5.14
T_3	12.3	11.3	11.14	10.85	10.75	10.74	10.74	10.74	10.73	10.73
T_4	12.3	12.35	12.38	12.44	12.56	12.56	12.68	12.79	12.88	13.1
Mean	12.3	10.42	10.06	9.27	8.76	8.67	8.63	8.62	8.61	8.64
S.E. ±	-	0.16	0.15	0.14	0.14	0.13	0.14	0.14	0.14	0.14
C.D. (P=0.01)	-	0.67	0.65	0.61	0.59	0.57	0.58	0.59	0.59	0.59

T_1- Seed stored with zeolite bead T_2-seedstored with silica gel
T_3- Seed stored with$CaCo_3$ T_4- Seed stored in hermetic container without desiccant (control).

Table 7: Effect of desiccants on 100 seed weight of wheat crop seeds during storage

Treatments	0 months	1 months	2 months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
T_1	2.93	2.7	2.63	2.54	2.48	2.43	2.42	2.39	2.38	2.37
T_2	2.93	2.65	2.55	2.48	2.36	2.25	2.23	2.21	2.19	2.17
T_3	2.93	2.91	2.91	2.87	2.8	2.76	2.76	2.76	2.75	2.75
T_4	2.93	2.95	2.98	2.99	3.07	3.01	3.1	3.14	3.17	3.19
Mean	2.93	2.80	2.77	2.72	2.68	2.61	2.63	2.62	2.62	2.62
S.E. ±	-	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
C.D. (P=0.01)	-	0.18	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17

T_1- Seed stored with zeolite bead T_2-seedstored with silica gel
T_3- Seed stored with$CaCo_3$ T_4- Seed stored in hermetic container without desiccant (control).

seed moisture content from 12.3 to 6.84 per cent within first three months of storage and further it reduced to 5.14 per cent at the end of nine months of storage period, whereas Zeolite beads reduced seed moisture content from 12.3 to 5.60 per cent. The other treatment with calcium carbonate and control without desiccants in airtight container reduced the seed moisture to 10.73 and 13.1 per cent, respectively. This may be due to highly polar surface within the pores which is main driving force for moisture adsorption from the seeds. Similar results on silica gel was reported by Vodouhe *et al.* (2008) who dried three species of egusi seeds with silica gel and gave the lowest moisture content of (3.6 to 4.6 %) in *Citrullus lunatus*, (3.3 to 4.3 %) in *Cucumeropsis edulis* and (4.6 to 7%) in *Lagenaria siceraria*.

Hundred seed weight :

The significant lowest 100 seed weight was recorded with silica gel (2.17 g) followed by Zeolite (2.37 g). Highest hundred seed weight was observed in seed stored with control without desiccants and calcium carbonate 3.19 and 2.75 gram, respectively. This may be due to fluctuation of seed moisture content with (T_4) during storage, leading to deterioration of seed quality. These results are similar to the findings of Hussaini *et al.* (1988) in maize seeds.

Conclusion:

The above research findings had resulted to conclude that the zeolite bead has professed advantages over other desiccants used in the present study, which include that they have higher regeneration capacity, greater affinity for water, particularly at low humidity. Moreover, the present results also indicated that drying by zeolite bead has reduced its moisture content to a desired level also maintained better seed quality parameters throughout the storage period.

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