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Storage Container, Seed Moisture Level and Storage Condition Effects on Germination and Prevalence of Seed-Borne Fungi of Onion Seed

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Keywords: storage container, seed moisture content, storage condition, germination, seed-borne fungi, onion seed.

I. Introduction

Onion (*Allium cepa* L.) belonging to the family Alliaceae is an important spice and popularly used as condiments for flavoring a number of foods (Vohra *et al*., 1974). As demand of onion is increasing, production of onion needs to increase in order to meet the requirement in the years to come. There exist enormous scope to increase the productivity of onion of which the most important one is the availability and use of good quality seed having high germination capacity and health status (Kant *et al*., 1999). Seed is the basic and essential input for any crop production. High quality seed is a critical input on which all other inputs will depend for their full effectiveness (Thompson, 1979). In majority of the Asian countries, particularly in Bangladesh most of the onion seeds used comes from farmers' saved sources which are badly infected by fungi with very poor germination. A good quality seed may also be seriously deteriorated if it is stored under suboptimal condition. Poor storage condition gives rise to deterioration of seed quality and the resultant loss of viability. But the farmers are ignorant about modern technologies of seed storage. They store seeds traditionally in various types of containers such as earthen pots, bamboo container, gunny bag or plastic bags during the wet monsoon period after harvest. Seeds stored in such types of containers are prone to invasion by storage fungi. Preservation of onion seeds is a major problem in Bangladesh. Storage period is more than six months (April to October) before sowing in the next season. Unfortunately high rainfall, high humidity and high temperature prevail in this period causing detrimental effect to the seed viability. As a result seeds absorb moisture from atmosphere and these containers are not suitable to protect seeds from microbial infestation. The seeds store in ordinary containers absorbs moisture from the environment and subsequently loses their viability quickly and deteriorates germination percentage and reduces seedling vigor (Hossain, 1978).

The factors affecting onion seeds longevity in store had been quantified by Ellis and Roberts (1981). The percentage of viability of onion seed after a period of storage depends on the initial viability, the seed moisture content and the storage temperature. According to Usberti and Gomes (1998) seed viability deterioration rate depends on the storage condition which includes temperature, relative humidity, seed

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moisture levels and storage containers. Onion seeds lose viability at a faster rate than seeds of most other vegetables. Obviously under less favorable storage condition, the seeds will show still poorer storability. It is difficult to maintain good seed viability for more than a year under ambient condition in unsealed containers. Seeds stored in air tight containers after proper drying the problem of vigor and viability could be considerably reduced (Islam *et al*., 2013).

Storage temperature and relative humidity as well as seed moisture levels are most important for prevalence of fungi in seeds. Growth of storage fungi enhance in high temperature and relative humidity in storage and initial high moisture content of seeds (Neergaard, 1979). *Aspergillus* spp. *Penecillium* spp. and *Fusarium* spp. can cause losses of onion seeds in storage (Gupta *et al*., 1984; Fakir, 2001). Storage fungi also play an important role in reducing quality of seeds in storage. They bring down germinability, discoloration of the seed, biochemical changes, accumulation of toxins and loss in weight (Neergaard, 1979). Storage life of seeds could be maintained over a longer period by using proper packaging materials and better environment (Roknuzzaman *et al*., 2008; Khalequzzaman *et al*. 2012; Lambat *et al*., 2015; Mollah *et al*., 2016). Therefore, the experiment was conducted to evaluate the effects of different storage containers, seed moisture levels and storage conditions on seed germination and prevalence of seed-borne fungi of onion seed.

II. Materials and Methods

Three independent laboratory experiments were conducted to investigate the effect of seed containers and seed moisture level, seed containers and storage conditions, and seed moisture level and storage conditions on seed germination and prevalence of seed-borne fungi of onion. Freshly harvested onion seeds attained three moisture levels of 5, 7, and 9% were kept in five storage containers. Five storage containers were aluminum foil bag, polythene bag, metal container, plastic container and earthen pot. The seeds were stored in three storage conditions such as ambient temperature, refrigerator and dehumidified conditions. The ambient temperature during storage period was recorded (30 ± 2° C). The refrigerator temperature was maintained 8 ± 1° C. The temperature was maintained at 20° C in dehumidified storage with 40% relative humidity. The experiments were laid out at completely randomized design. The seeds were stored for 170 days (one season, after harvest to next sowing season). Data on seed germination and prevalence of seed-borne fungi were recorded just prior to storage (0 days), 70 days after storage (DAS) and 140 DAS following standard methods.

Germination: Four hundred seeds were randomly taken from each sample for germination test. Three layered moistened blotter paper was placed on germination petri-dishes. Hundred seeds were used on each petri-dish and kept at 25°C temperature for 12 days for germination. Seedlings were counted every day up to the completion of germination at 12 day. Only the normal seedling was counted for calculating the germination percentage (ISTA, 1996).

Prevalence of seed-borne fungi: Seed-borne pathogens associated with the onion seed sample was determined by blotter method (ISTA, 1996). In this method, three layers of blotter papers (Whatman No. 1) were soaked in sterilized water and placed in the bottom of the 9 cm diameter Pyrex glass Petridish. Four hundred seeds from each sample were taken randomly and then placed on the moist blotter paper at the rate of 25 seeds per plate. The petri dishes with seeds were then incubated at 25±2° C temperature, 12/12 hours alternating cycles of NUV light and darkness for seven days. After incubation, the seeds were examined under steriobinocular microscope for the presence of seed-borne fungal pathogens and identified by observing their growth characters. In case of confusion, temporary slide was prepared and examined under a compound microscope and identified using appropriate keys (Mathur and Kongsdal, 2003). Results were expressed in percentage of seeds infected by the seed-borne pathogens.

III. Results

a) *Independent effect of storage container, seed moisture level and storage condition on seed germination*

Significant variations were observed in germination percentage due to the effects of different storage containers, seed moisture levels and storage conditions at 70 and 140 days after storage (DAS). The germination percentage decreased with the increase in storage period from 0 to 140 days. At 140 DAS the highest germination (74%) was obtained from the seeds stored in aluminum foil bag which was statistically similar with the seeds stored in plastic container (72%) and polythene bag (71%). The significantly lowest germination (60%) was obtained from seeds stored in earthen pot. The seeds which were stored with 7% moisture level had the highest germination (75%), whereas the seed stored with 5% and 9% moisture content had 73% and 57% germination, respectively at 140 DAS. Germination percentage with 5% and 7% moisture level was significantly similar. At 140 DAS, the highest germination percentage (70%) was recorded from seeds stored in a refrigerator and dehumidifier, whereas the significantly lowest germination percentage (65%) was obtained from seeds stored at ambient condition (Fig. 1).

b) *Independent effect of storage container, seed moisture level and storage condition on prevalence of seed-borne fungi*

The seed-borne fungal population increased with increase in storage period. Significant effects of storage containers, seed moisture levels and storage conditions were observed on prevalence of seed-borne fungi at 70 and 140 days after storage (DAS) (Fig. 2). At 140 DAS the lowest infection of fungi was recorded when the seeds were stored in aluminum foil (6.40%) which was statistically similar with the seeds stored in polythene bag (6.44%) and plastic container (6.75%). The significantly highest fungal population (9.69%) was recorded in seeds which were stored in earthen pot followed by metal container (7.25%). Seed-borne infection was increased with the increase of initial moisture level of seeds. The seeds containing 7% moisture yielded the significantly lowest prevalence of fungi (6.95%) followed by 5% moisture level (6.97%) but seeds containing 9% moisture had significantly highest (8.00%) prevalence of seed-borne fungi at 140 DAS. Considering storage conditions, the lowest prevalence of fungi at 140 DAS was observed in seeds stored in refrigerator (5.98%) which was statistically similar with dehumidified condition (6.12%) whereas significantly the highest prevalence of seed-borne fungi (9.80%) was recorded in seeds in ambient condition.

c) *Interaction effect of storage container and seed moisture level on germination and prevalence of seed-borne fungi*

The seeds which were tested at 70 and 140 DAS, the germination percentage varied significantly in different types of storage containers with various seed moisture levels. The germination percentage of seed gradually decreased with increase in storage period. At 140 DAS, the highest germination was obtained from seeds which were stored in aluminum foil bag with 7% initial moisture content (82%) followed by polythene bag with 5 and 7% moisture content (81%). The lowest germination was recorded from seeds having 9% initial moisture content and stored in earthen pot (50%) followed by polythene bag (56%) with same moisture level (Table 1). Table 1 also showed that the highest fungal prevalence was recorded at 140 DAS in earthen pot (10.42%) with 9% moisture content followed by earthen pot 9.33% and 9.25% with 7% and 5% moisture content, polythene bag (7.83%), aluminum foil bag and plastic container (7.67%) and metal container (7.42%) with 9% moisture content. The lowest fungal incidence was recorded in seeds stored in aluminum foil bag with 7% moisture content (5.50%), followed by polythene bag with 7% moisture content (5.58%).

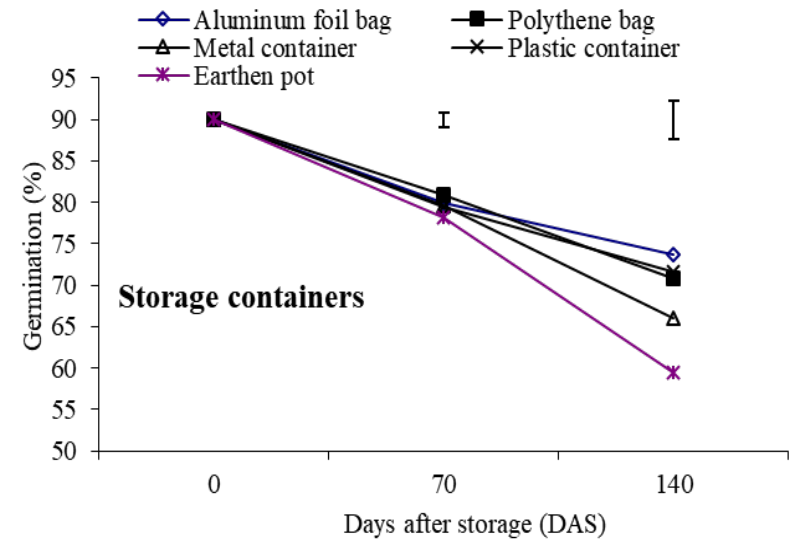
d) *Interaction effect of storage container and storage condition on germination and prevalence of seed-borne fungi*

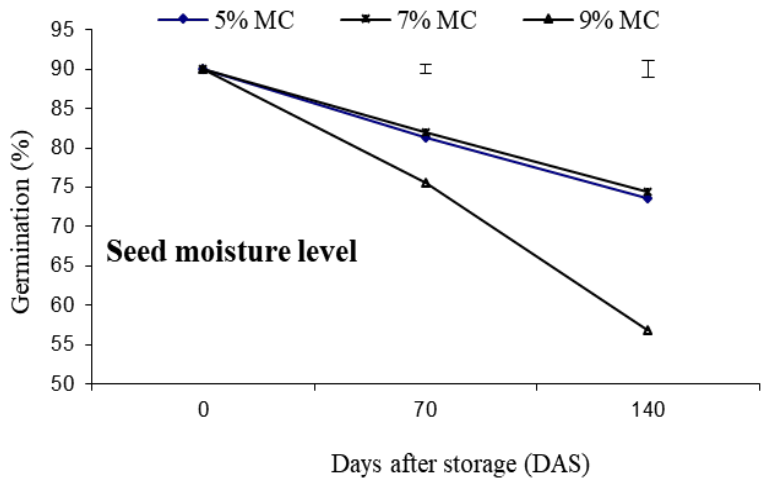
At 140 DAS, the seed stored in aluminum foil bag in refrigerator gave the highest germination (77%) followed by in aluminum foil bag in dehumidified condition (75%) and plastic container in dehumidified condition (74%) and plastic container in refrigerator (73%). Polythene bag under dehumidified and refrigerator (72%) also showed better performance. The lowest germination of seeds was recorded from earthen pot under ambient condition (57%) (Table 2). Significantly the highest prevalence of seed-borne fungi was recorded at 140 DAS in earthen pot in ambient condition (12.58%) followed by metal container with ambient storage condition (10.67%). The lowest prevalence of fungi was recorded in seeds stored in aluminum foil bag in refrigerator (5.08%) followed by aluminum foil bag and plastic container in dehumidified storage conditions (5.25%) (Table 2).

e) *Interaction effect of moisture content and storage condition on germination and prevalence of seed-borne fungi*

Significant variation was observed in germination in seeds with various moisture level and storage condition at 70 and 140 DAS. At 140 DAS, the highest germination (76%) was recorded in seeds stored in refrigerator with 7% moisture content followed by refrigerator with 5% moisture content (75%), dehumidified conditions (74%) with both 7% and 5% moisture content. The lowest germination was recorded in seeds in ambient condition with 9% moisture content (50%) which was followed by dehumidified storage condition with same moisture content (60%) (Table 3).

The highest prevalence of fungi was recorded in seeds stored in ambient condition with 9% moisture content (10.80%) followed by 9.50 and 9.10% at 5 and 7% seed moisture content also in ambient condition, respectively. The lowest prevalence was found in seeds with 7% moisture content stored in refrigerator (5.55%) followed by dehumidified (5.65%) and refrigerator (5.75%) at 5% moisture content (Table 3).





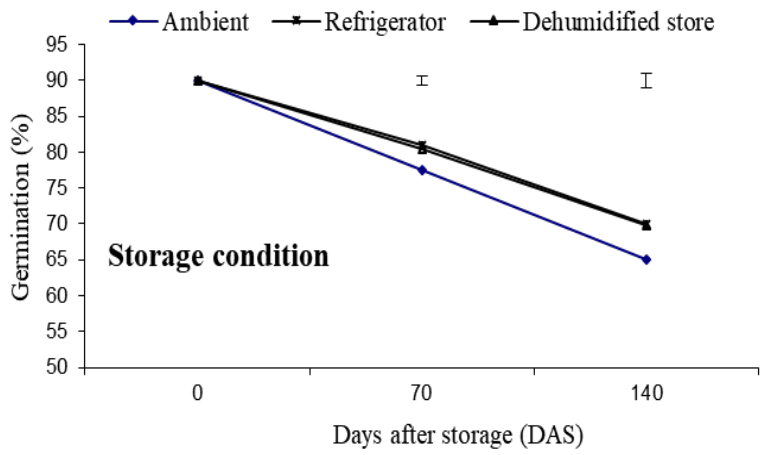


Fig. 1: Effect of storage container, seed moisture level and storage condition on germination of onion seed. Vertical bar indicates LSD $_{(0.05)}$ value

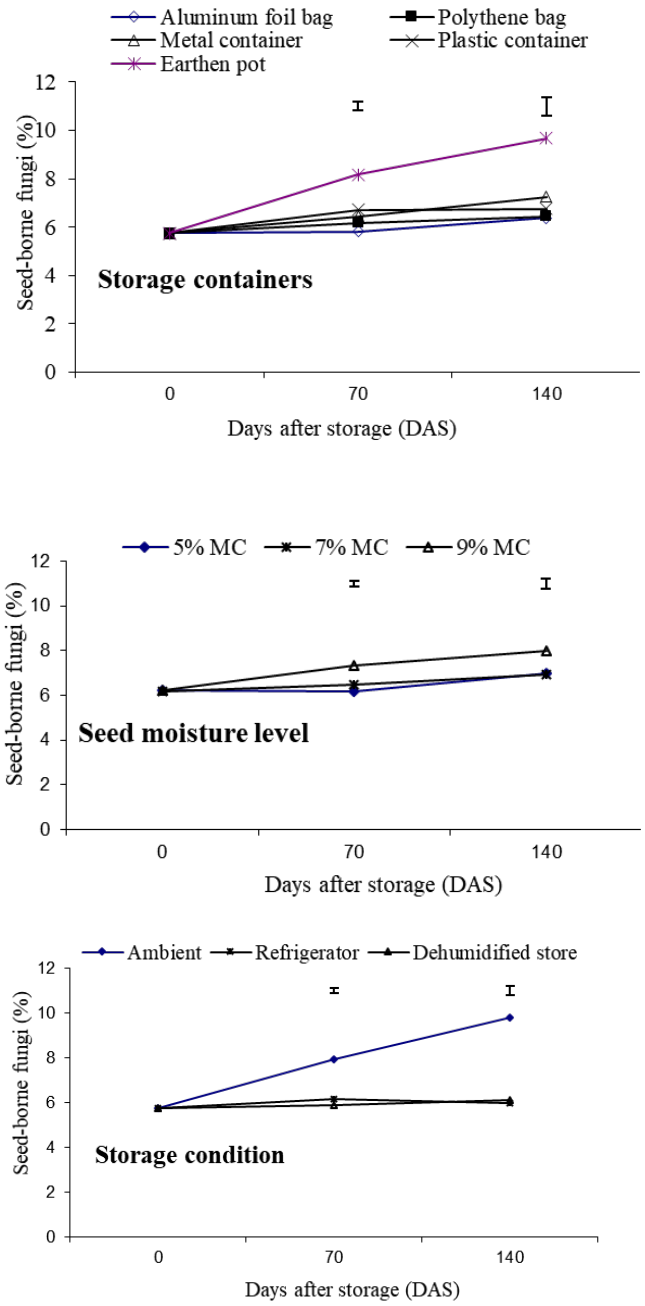


Fig. 2: Effect of storage container, seed moisture level and storage condition on prevalence of seed-borne fungi of onion seed. Vertical bar indicates LSD $_{(0.05)}$ value

IV. Discussion

Quality of seeds in respect of germination and prevalence of seed-borne fungi were studied in the experiment by using five different types of storage containers, three seed moisture levels and three different storage conditions. Results suggested that storage containers, seed moisture levels and storage conditions play an important role on seed germination and infection of seed-borne fungi. Among the five containers germination loss and infection of seed-borne fungi was lower when the seeds were stored in sealed container like aluminum foil bag, polythene bag and plastic container. On the other hand, seed stored in earthen pot yielded higher fungal infection and lower germination. In ambient condition, air tight containers gave better results than purported containers of which aluminum foil bag was the best followed by polythene bag and plastic container. In contrast, earthen pot showed the lowest performance in respect of germination percentage and seed-borne fungi under ambient condition as a purported container. This type container affects moisture absorbance and deteriorated seed quality during storage of seeds. The rate of moisture absorbance was higher in earthen pot. Higher moisture content in the seed is the main reason of quick

deterioration of seed quality in earthen pot. Higher germination and lower prevalence of fungi were also reported in sealed container by other authors (Rahman and Rahman 1997; Roknuzzaman *et al*., 2008; Khalequzzaman *et al*. 2012; Lambat *et al*., 2015; Mollah *et al*., 2016; Sultana *et al*., 2016). Ellis and Roberts (1981) suggested that commercial onion seed may be dried to about 6.3% moisture content and sealed into moisture proof cans or foil packets. They also observed that in these conditions onion seed could remain fully viable for at best three years. Charjan and Tarar (1992) reported that seeds stored in polythene bags germinated better and had less fungal contamination than that stored in cloth bags. Seeds when stored with 5 and 7% seed moisture content maintained good germination. The seed quality deteriorated drastically when seeds stored with 9% seed moisture content. The incidence of fungi was also lower in seeds stored with lower moisture content (5% and 7%). It reveals that lower moisture content of seeds decreases fungal activity. Results suggested that high moisture content (9% moisture) in seeds were responsible for decrease of germination and increase of seed-borne infection. The high moisture accelerates the respiration rate of seeds and microorganism and may produce heat thus the quality of seeds deteriorate rapidly. Moreover high moisture initiates incomplete physiological process of seed germination resulting loss of viability of seeds (Harrington, 1973). Ellis and Roberts (1981) suggested that commercial onion seed may be dried to about 6.3% moisture content during store. Athley (1990) observed that onion seed stored with 5% moisture content maintained quality for long term preservation. The results of the present experiment agreed well with the findings of Ellis and Roberts (1981) and Athley (1990).

The results of the experiment revealed that storage conditions have great impact on the quality of seeds in storage. Refrigerator and dehumidified condition maintained better seed quality than ambient condition. All types of containers under controlled condition gave better results and among the containers aluminum foil bag performed best followed by polythene bag and plastic container in maintaining seed quality. But, all packing materials under ambient condition performed inferior and gave lower germination percentage and higher fungal infection. This is due to temperature is lower in controlled condition resulting slow rate of deterioration of seeds under controlled condition and it was high under ambient condition. Malaker *et al*. (2008), Monera *et al*. (1994) and Nakagawa *et al*. (1991) observed similar results in wheat, pea, and okra seed, respectively.

V. Conclusion

Higher germination and lower prevalence of seed-borne was recorded in seeds stored in aluminum foil bag, polythene bag, and plastic container in refrigerator or dehumidified condition. Initial moisture content of seed 5 to 7% also influenced positively on seed germination and prevalence of fungi. Thus, it is suggested that onion seeds may be stored in sealed container and cool condition. The initial moisture content of seed should also be minimum (5 to 7%) for maintaining good quality and health of onion seeds.

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Table 1: Interaction effect of storage containers and seed moisture level on germination and prevalence of seed-borne fungi of onion seed at different period of storage

Treatment combination		Germination (%)			Seed-borne fungi (%)		
Container	Moisture (%)	0 DAS	70 DAS	140 DAS	0 DAS	70 DAS	140 DAS
Aluminum foil bag	5	90	81	77	5.75	5.25	6.00
	7	90	84	82	5.75	5.42	5.50
	9	90	75	63	5.75	6.75	7.67
Polythene bag	5	90	84	81	5.75	5.50	5.92
	7	90	83	81	5.75	5.67	5.58
	9	90	75	56	5.75	7.33	7.83
Metal container	5	90	81	70	5.75	6.25	7.00
	7	90	81	70	5.75	6.50	7.33
	9	90	77	59	5.75	6.58	7.42
Plastic container	5	90	82	80	5.75	6.33	6.67
	7	90	82	78	5.75	6.25	5.92
	9	90	75	57	5.75	7.58	7.67
Earthen pot	5	90	79	61	5.75	7.58	9.25
	7	90	78	62	5.75	8.33	9.33
	9	90	77	50	5.75	8.58	10.42
CV (%)			4.04	5.08		15.14	14.22
LSD (0.05)			2.594	2.800		0.814	0.837

DAS= Days after storage

Table 2: Interaction effect of storage containers and storage condition on germination and prevalence of seed-borne fungi of onion seed at different period of storage

Treatment combination		Germination (%)			Seed-borne fungi (%)		
Container	Storage condition	0 DAS	70 DAS	140 DAS	0 DAS	70 DAS	140 DAS
Aluminum foil bag	Ambient	90	76	69	5.75	7.00	8.83
	Refrigerator	90	83	77	5.75	5.25	5.08
	Dehumidifier	90	81	75	5.75	5.17	5.25
Polythene bag	Ambient	90	78	69	5.75	6.67	7.25
	Refrigerator	90	82	72	5.75	6.17	6.00
	Dehumidifier	90	82	72	5.75	5.60	6.08
Metal container	Ambient	90	77	64	5.75	8.33	10.67
	Refrigerator	90	82	68	5.75	5.67	5.58
	Dehumidifier	90	80	66	5.75	5.33	5.50
Plastic container	Ambient	90	78	67	5.75	8.33	9.67
	Refrigerator	90	80	73	5.75	6.00	5.33
	Dehumidifier	90	81	74	5.75	5.83	5.25
Earthen pot	Ambient	90	79	57	5.75	9.33	12.58
	Refrigerator	90	78	60	5.75	7.75	7.92
	Dehumidifier	90	78	61	5.75	7.42	8.50
CV (%)			4.04	5.08		15.14	14.22
LSD (0.05)			2.594	2.80		0.814	0.837

DAS = Days after storage

Table 3: Interaction effect of seed moisture level and storage condition on germination and prevalence of seed-borne fungi of onion seed at different period of storage

Treatment combination		Germination (%)			Seed-borne fungi (%)		
Moisture (%)	Storage condition	0 DAS	70 DAS	140 DAS	0 DAS	70 DAS	140 DAS
5	Ambient	90	80	72	5.75	7.45	9.50
	Refrigerator	90	83	75	5.75	5.70	5.75
	Dehumidifier	90	81	74	5.75	5.40	5.65
7	Ambient	90	82	73	5.75	7.70	9.10
	Refrigerator	90	83	76	5.75	5.95	5.55
	Dehumidifier	90	81	74	5.75	5.80	6.20
9	Ambient	90	71	50	5.75	8.65	10.80
	Refrigerator	90	77	61	5.75	6.85	6.65
	Dehumidifier	90	79	60	5.75	6.45	6.50
CV %			4.04	5.08		15.14	14.22
LSD (0.05)			2.009	2.169		0.604	0.648

DAS= Days after storage