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Longevity of Maize Seed (Zea mays L.) under Different Storage Conditions

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This study focuses om the changes in viability and chemical composition of maize hybrid SC168 during storage conditions. This study was conducted at theSeed Technology Department, at Sakha Agricultural Research Station, ARC, Egypt during November-2018 to April-2020. Storage conditions were two storage periods 6 and 18 months, four regimes of relative humidity, 46%, 65%, 72% and 80% and three package materials i.e. jute bags, low density polyethylene and hermetic bags.The results revealed that increasing storage period from after harvest to 6 and 18 months led to the increasing in deterioration of the viability and quality of the seeds and caused the highest of electrical conductivity, acidity% and moisture content in the seeds storage.Increasing relative humidity from 46 to 80 % significantly increased the mean value of electrical conductivity of the seed soak water (from 5.12 to 11.41 mS m-١), moisture content and acidity%, and significantly decreased the mean seed germination %, shoot length, root length, seedling dry weight, oil% and crude protein %. Hermetic bags gived high seed germination, seedling vigor and oil % and low seed moisture content, electrical conductivity and acidity %, and therefore they could delay seed quality deterioration compared with low density polyethylene and jute bags and that in conditions of high relative humidity for a period longer than six months.Finally, we can recommend the use of hermetic bags to maintain the vitality and quality of maize seeds under high relative humidity conditions for a period of up to 18 months.

Keywords: humidity, packages, periods, storage, viability, chemical composition, maize.

Introduction

Longevity of seeds is to maintain high seed germination percentage and high vitality of seeds under various conditions before and after harvest. Deterioration is evident as a reduction in percentage germination, produce weak seedlings, loss of vigor, become less viable and ultimately seed death Jyoti and Malik (2013). And because the seed represents the beginning of the production of each plant, and therefore ensuring its quality is the priority of modern seed science and a prerequisite for obtaining high yields of all plant species. Healthy seeds will produce high strength seedlings. On the contrary, irregular seeds give poor performance when grown in the field. Therefore, it is necessary to preserve the seeds and their viability to increase the life of the seedsWati and Aqil (2020). Deterioration of seed during storage is a major problem in agricultural production. Quantitative relation between storage factors and seed viability deterioration were investigated in various papers. High moisture level during the process of storing is unfavorable due to diminishing preservation ability of seed viability. The process of intensive respiration allows the activity of fungi and bacteria, producing a suitable medium (high temperature, raising humidity and releasing heat) for storage pests such as insects and mites. A balance of seed moisture content and relative humidity is essential for seed storage. Harington (1972) found out two principles still in use that decrease influence of the moisture and temperature to the seed deterioration. The first stated that each decreased

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percentage of grain moisture content prolongs life of stored seed twice. The second stated that each decreased 5°C of the seed temperature prolongs life of the stored seed twice. High moisture level during the process of storing is unfavorable due to diminishing preservation ability of seed viability. The process of intensive respiration allows the activity of fungi and bacteria, producing a suitable medium (high temperature, raising humidity and releasing heat) for storage pests such as insects and mites. A balance of seed moisture content and relative humidity is essential for seed storage. High moisture level during the process of storing is unfavorable due to diminishing preservation ability of seed viability. The process of intensive respiration allows the activity of fungi and bacteria, producing a suitable medium (high temperature, raising humidity and releasing heat) for storage pests such as insects and mites. A balance of seed moisture content and relative humidity is essential for seed storage.

One of the first authors who tried to confirm this quantitative relation was Nagel and Borner (2010), concerning most species of seed crops could be stored safely avoiding the bad conditions by control of temperature and relative humidity in various locations around the world, air-conditioned storage is very urgent to maintain the viability of some seeds that remain high and not significantly affected from the time of harvest during one season to the time of sowing in another season. Several researchers have confirmed that conditions of high temperature and relative humidity of storage accelerate seed deterioration and thus cause ageing. Seed deterioration would occur relatively slowly if seed moisture is low. The moisture content of the harvested seed is influenced by the surrounding relative humidity and the temperature conditions, the two major factors that control the longevity of the seed in processing and storage Suma et al. (2013). Oyekale et al. (2012) reported that in order to maintain the viability of corn during storage, the seed must be protected from high relative humidity, temperature, growth of microorganisms and pest attacks. When the seed storage is carried out for a long period, the seed must be dried until the moisture content falls below 11% and the storage room temperature is preferred below 10oC and 50% humidity. Wati and Aqil (2020) studies have shown that the use of low temperature and relative humidity can keep the viability of seeds even though it has deteriorated.

There are many studies conducted on the effect of storage periods and new packages, as they are important in maintaining the viability of the seeds and seed germination percentage, and are suitable as seeds for cultivation.Shahein and Mohamed (2016) and El-Sayed et al. (2017) who found the results indicates that increasing storage period from (6 and 18 months) significantly reduced seed germination, shoot and radical length, seedling dry weight, 1000-seed weight, oil %, crude protein, while increased electrical conductivity, moisture% and acidity %. Ziegleret al. (2016) showed that the increase in storage time leads to changes in chemical and technological parameters. Dieudonne and Cristine (2020) reported that the rapid increase in the use of hermetic bags is due to preserving the seeds from deterioration and insect infestation many of these hermetic bags have several benefits including (1) preserving grain without the use of insecticides and (2) keeping grain in good quality from several months to at least two years.Negasa et al. (2020) found that hermetic bags kept significantly higher seed germination percentage with 94.2 % at six 6 months in storage. Proper packing and storage methods are essential for good seed storage stability. Traditionally, jute was used for bulk packing of seed crops. Plastics such as high density polyethylene and polypropylene, woven bags, multi-layer extruded films, three-layer bags and aluminum foil are very widely used for grain and seed storage due to their excellent barrier to moisture, air, odors and microorganisms.Polyethylene liner in jute bag or in polypropylene, woven bags is also useful to protect products from moisture. Over the past decade, airtight storage bags have been used to store corn and other vulnerable crops De Groote et al. (2013) and Baoua et al. (2014).

The objective of this research was to study the effect of some storage conditions on the viability and chemical composition of seed of maize (SC 168) stored for 6 and 18 months using four relative humidity and three different packages. And find out the best package preserves the viability and quality of the seeds for a period of storage of up to 18 months under high relative humidity conditions.

Materials and Methods

A laboratory experiment was carried out under the laboratory conditions between November 2018 and April 2020 in Seed Technology Research Unit in Sakha, Kafr El-Sheikh Governorate, Field Crops Research Institute, Agricultural Research

Center, Egypt. The freshly harvest and uniformly matured formaize seeds (Single Cross (SC) 168) were used. The seeds were then cleaned by hand to remove extraneous materials such as dirt, dust, stones, straw, immature seeds, infected and damaged seeds. Samples seeds were dried using hot air dried methods and packaged in 3 types of packages made from different materials i.e., jute bags (pure jute fiber), low density polyethylene (LDP) (single-layer 50 kg LDP bags from Egyptian local market) and Purdue Improved Crop Storage (the triple-layer 50 kg PICS bagsfrom Egyptian local market). Each package was filled with one kg of tested maize seeds and stored under four regimes of relative humidity.These were calcium chloride (46%), Sodium Nitrite 65%, Sodium chloride 72% and H_2o80% for six and eighteen months. The temperature of the laboratory during the storage period is 25±5°C. Seed germination percentage, seedling vigor, electrical conductivity (EC), moisture content%, 100-seed weight (g), acidity%, fat % and crude protein were determined before storage in Table1.

Viability tests were included

Standard germination test

Germination percentage was expressed by the laying 50 seeds on filter papers in 4 replicates using petry dishes and the percentage of normal seedlingswere counted at the end of testing period according to International Seed Testing Association (Elsayed et al.,2018).

Seedling vigor

Ten normal seedlings from each replicate were taken to measure shoot length (cm), root length (cm) and seedling dry weight (mg) according to (Elsayed et al., 2018).

Electrical conductivity (EC)

Three replicates of 50 weighted seeds from each treatment were incubated for 24 h in a 250 ml beaker containing 200 ml deionized water at 20 °C. After that period, the conductivity of the solution was measured immediately with a CMD 830 WPA conductance meter and is expressed as mS m^{-1} per centimeter per gram of seed (Elsayed et al., 2018).

Physical properties

100-seed weight (g)

This was carried out according to the (Elsayed et al., 2018) Regulations. This is of course to establish an indication for the specific weight of maize seed.

Chemical composition test

Crude protein: - Known weight of the fine powdered seeds (ca 0.1g) was digested using a micro kjeldahl apparatus by (98% H_2So4) and (30% H_2o_2). The crude protein was calculated by multiplying the total nitrogen by 5.85 (Amira et al., 2019).Oil content was extracted by (98% hexane) as a solvent using Soxhlet apparatus (Amira et al., 2019). Acidity percentage and moisture content were determined according to the methods of (Elsayed et al., 2018).Collected data were analyzed according to the factorial completely randomized design with three replicates. Analysis of variance computed according to Snedecor and Cochran (1982) and treatment means was compared by Duncan Multiple Range Test, Duncan (1955).All the treatments were compared at 0.05% level of significance using the critical difference test. All statistical analyses were performed using analysis of variance technique by "MSTAT-C"(1990) computer software package.

Results and Discussion

The storage period under study showed significant differences in the seed viability and seedling vigor parameters as presented in Tables (2 and 3).Storage period had a negative influence on seed germination percentage and seedling vigor. After 6 and 18 months from storage, seed

TABLE 1. Means of germination (%), electrical conductivity (µ mhos), seedling vigor, moisture(%), 100- seed weight (g), acidity (%), fat (%) and crude protein (%) of maize hybrid SC168 from combined analysis before storage periods

Seed germin-ation %	Electrical conductivity (mS m^{-1})	Seedling vigor			Moist-ure(%)	100-seed weight (g)	Acidity (%)	Fat (%)	Crude protein (%)
		Shoot length (cm)	Root length (cm)	Seedling dry weight (g)					
100	6.19	24.67	25.47	0.420	12.30	23.23	7.08	4.48	9.98

germination percentage, shoot length, root length and seedling dry weight declined from (78.36 to 61.81%), (21.13 to 17.28 cm), from (21.12 to 16.85 cm) and from (0.379 to 0.279 g), respectively in Table (2). Increasing storage period from after harvest to 6 and 18 month increased electrical conductivity by from (6.19 to 6.51 and 8.58 mS m^{-1}), respectively. Thus, the viability of the seeds decreases with an increase in the storage period, and that is through a decrease in the percentage of germination and an increase in electrical conductivity.The decline in seed germination with storage period was associated with a increase in 100- seed weight, moisture content, crude protein and decrease seed viability (by increasing E.C and acidity percentage). Increased storage period from after harvest to 6 and 18 months lead to increasing in moisture content from (12.30 to 13.89 and 14.36%), 100-seed weight from (23.23 to 23.60 and 35.69 g) and acidity % from (7.08 to 8.83 and 9.94 %) in Table 2. While, the oil and protein content was decreased by increasing storage period from after harvest to 6 and 18 months from (4.48 to 4.13 and 3.87 %) and (9.98 to 9.86 and 9.44 %), respectively. Wati and Aqil (2020) mentioned that seed quality during storage period is strongly influenced by initial seed quality before storage, moisture content, temperature and humidity during storage period. El-Sayed et al. (2017) reported that increasing storage period after harvest until 9 month decreased significantly seed germination, seedling vigor, moisture content, oil% and crude protein. On the contrary, increasing storage period increasing significantly moistur % and acidity%.El-Abadi (2014) showed that seed germination, shoot length, root length, seedling dry weight, and electrical conductivity were affected by storage after three and six months of storage.

Theresults showed also that increasing relative humidity from 46 to 80 % significantly increased the mean electrical conductivity (Ec) in the seed from 5.12 to 11.41mS m^{-1}.Badawi et al. (2017) reported that the increase in relative humidity in the storage conditions induced deterioration in seed quality. The means of seed germination percentage value was decreased from 88.39 % with 46 % RH to less than 38.56 % with 80 % relative humidity. These findings agreed with those obtained by Rashid et al.(2013), Suma et al.(2013) and Elsayed et al. (2018) who found that storage at medium relative humidity caused a negligible decrease in viability but storage at high relative humidity declined in viability and decreased the seed germination percentage. Assefa and Srinivasan (2016) showed that seed germination and seedling vigor declined significantly when seeds were stored at very high (95%) to high (75%) RH and 35°C temperature while the electrical conductivity recorded a steep increase at these conditions implying their usefulness as indices for seed quality loss. Increasing in relative humidity led to activate fungus growth and it is a suitable media for bacterial growthand thus caused decreased in the seed germination percentage and the increased in electrical conduction of the seeds, which led to a decrease in the viability of the seeds. Concerning the seedling vigor due to relative humidity, there was a high reduction in (shoot length, root length and seedling dry weight) as the relative humidity increased Table (2). Wati and Aqil (2020) showed that the use of lower air humidity can limit the deterioration in seed viability and seedling vigor despite. The results showed in Table (3) that the moisture content, 100-seed weight and acidity significantly increased with increasing relative humidity. While, seeds was storage at 46% humidity recorded the high viability [by decline EC value, Moisture content and Acidity percentage].Rapid decline in viability parameter (by increase E.C value, moisture content and acidity percentage) at storage of 80% humidity (11.41mS m^{-1}, 17.52 % and 13.81 %) compared with 46% and (5.12 mS m^{-1}, 10.96 % and 7.05 %), respectively. Similar results were observed by Suma et al. (2013) and Elsayed et al. (2018). In contrast, oil and crude protein content significantly decreased with increasing relative humidity. These results are in harmony with those reported by Suma et al. (2013) and Elsayed et al. (2018).

The three package materials used in the study had highly significant effects on seed viability and seedling vigor in Table (2). Seeds stored in PICS bags recorded the high seed germination and vigor parameters followed by LDP bags. In contrast, jute bags showed the low values for all parameters (vigor).The results are in agreement with Lane and Woloshuk(2017) and Jay et al.(2018)who showed that PICS hermetic bags are effective in preventing the effects of external moisture fluctuations as well as the spread of fungi to uninfected kernels.Negasa et al. (2020) reported that hermetic bag kept significantly higher germination percentage with 94.2 % at six 6 months in storage, respectively as compared to the rest of the two storage containers.

TABLE 2. The general effect of storage period, relative humidity and package material on seed germination, electrical conductivity and seedling vigor (root length, shoot length and seedling dry weight) of SC168.

Treatment	Seed germination (%)	Electrical conductivity (mS m^{-1})	Seedling vigor		
			Shoot length (cm)	Root length (cm)	Seedling dry weight (g)
Storage period					
6 months	78.36 a	6.51 b	21.13 a	21.12 a	0.379 a
18 months	61.81 b	8.58 a	17.28 b	16.85 b	0.279 b
F-test	**	**	**	**	**
Relative humidity					
46%	88.39 a	5.12 d	24.44 a	24.98 a	0.423 a
65 %	84.94 a	6.16 c	21.19 b	21.65 b	0.374 b
72 %	68.44 b	7.49 b	18.44 c	17.12 c	0.326 c
80%	38.56 c	11.41 a	12.76 d	12.19 d	0.194 d
F-test	**	**	**	**	**
Package material					
Jute	60.29 b	8.02 a	17.72 b	16.90 b	0.281 b
LDP	68.96 b	7.43 b	18.95 b	19.03 ab	0.339 ab
PICS	81.00 a	7.18 b	20.95 a	21.04 a	0.367 a
F-test	**	**	**	**	**

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively

TABLE 3. The general effect of storage period, relative humidity and package material on moisture, 100-seed weight, acidity, oil(%) and crude protein (%) of SC168.

Treatment	Moisture (%)	100-seed weight (g)	Acidity (%)	Oil(%)	Crude protein (%)
Storage period					
6 months	13.89 b	23.60 b	8.83 b	4.13 a	9.86 a
18 months	14.36 a	35.69 a	9.94 a	3.87 b	9.44 b
F-test	**	**	**	**	**
Relative humidity					
46%	10.96 d	28.39 d	7.05 d	5.07 a	9.88 a
65 %	13.71 c	29.19 c	7.54 c	4.15 b	9.68 b
72 %	14.29 b	30.16 b	9.14 b	3.53 c	9.62 c
80%	17.52 a	30.83 a	13.81 a	3.26 d	9.42 d
F-test	**	**	**	**	**
Package material					
Jute	15.00 a	30.00 a	10.34 a	3.78 c	9.57 b
LDP	14.09 b	29.68 ab	9.43 b	4.00 b	9.62 b
PICS	13.27 c	29.25 b	8.39 c	4.21 a	9.76 a
F-test	**	**	**	**	**

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

There were highly significantly differences among moisture content %¸ 100-seed weight, acidity %, oil % and crude protein% of maize seed within various packaging materials in Table (3). The moisture content of the seed decreased drastically for PICS followed by LDP and jute was found 13.27 %, 14.09 % and 15.00 %. The increase in moisture content of the seed up to six months of storage period might be due to hygroscopic nature of the seed and moisture exchange in a previous material during high RH in season Harrington (1972). At the meantime storage within PICS package recorded the low value of 100-seed weight (29.25 g), acidity (8.39 %) and the high oilcontent (4.21 %). While, jute package was recorded the high100-seed weight (30.00 g) and acidity %(10.34 %).PICS hermetic bags are effective in preventing the effects of external moisture fluctuations as well as the spread of fungi to uninfected kernels and maintain the moisture content of the seed and thus preserve the maize seeds from damage, which leads to increased seed germination, increased seed vitality and preservation of the chemical properties of the seed.

Regarding the interaction between storage period and relative humidity in Tables (4 and 5), the increase in seed germination %, seedling vigor, oil % and protein contentwere observed in 46% relative humidity with 6 months and the low values were 80 % relative humidity with 18 months. In addition, the storage in 80% humidity was affected by the increase of grain E.C, moisture content, 100-seed weight and acidity percentage under 18 months. Storage in lower humidity had generally a better preserving effect on germination percentage, seedling vigor, oil and protein content and decreasing EC value, moisture content and acidity percentage than storage in higher relative humidity.

A significant interaction effect between storage period and package materials is shown in Tables (6 and 7). Increase in germination %, was much greater for use hermetic package at seed stored at 6 months (89.00 %). Hermetic package was also the superior in producing strong seedling with taller shoot (23.31 cm), root (23.49cm) and heavier dry weights (0.422 g) than the other package with 6 months. While, decreased in moisture content (12.89 %), acidity (8.05%) and E.C (6.34 mS $m^{-1)}$ with PICS package under 6 months storages. Meanwhile, with seed was storage for 18 months under jute package recorded great decline viability (by increasing EC value, moisture % and acidity %). The high value of oil % and protein were recorded by PICS package with6 months storage (4.31 and 9.97%), respectively.

The interaction effect between relative humidity and package materials are shown in Tables (8 and 9). Increasing seed germination and seedling vigor (shoot and root length and dry seedling weight) was much greater for seeds stored at PICS package with 46% relative humidity. The high seed in viability was by companied with decreasing E.C value, moisture content and acidity when PICS package was used with 46% relative humidity. The high value of oil content was recorded by LDP and PICS packages with 46% relative humidity (5.12 and 5.26%). While, thehigh value of crude protein content (10.04 %) was recorded by PICS with 46% relative humidity of storage.

TABLE 4. Interaction effect of storage period and relative humidity on seed germination (%), electrical conductivity and seedlingvigor of stored seeds.

Storage period	Relative humidity	Seed germination (%)	Electrical conductivity(mS m^{-1})	Seedling vigor		
				Shoot length (cm)	Root length (cm)	Seedling dry weight (g)
6 months	46%	94.22 a	3.86 f	27.15 a	26.61 a	0.453 a
6 months	65%	90.22 ab	5.49 e	23.02 b	25.02 ab	0.415 ab
6 months	72%	80.67 b	6.38 d	20.08 c	19.60 c	0.367 bc
6 months	80%	48.33 c	10.30 b	14.27 e	13.24 de	0.280 d
18 months	46%	82.56 b	6.38 d	21.73 b	23.36 b	0.393 ab
18 months	65%	79.67 b	6.83 d	19.35 c	18.28 c	0.332 cd
18 months	72%	56.22 c	8.59 c	16.80 d	14.64 d	0.285 d
18 months	80%	28.78 d	12.53 a	11.25 f	11.14 e	0.107 e
F. test		**	**	*	*	*

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

TABLE 5. Interaction effect of storage period and relative humidity on moisture (%), 100-seed weight (g), acidity (%), oil (%) and crude protein (%) of stored seeds.

Storage period	Relative humidity	Moisture (%)	100-seed weight (g)	Acidity (%)	Oil(%)	Protein (%)
6 months	46%	10.66 f	22.50 g	6.94 g	5.24 a	10.07 a
6 months	65%	13.28 d	23.24 f	7.42 f	4.34 c	9.89 b
6 months	72%	14.11 c	23.89 e	8.61 d	3.61 e	9.83 b
6 months	80%	17.51 a	24.75 d	12.33 b	3.32 fg	9.64 c
18 months	46%	11.27 e	34.27 c	7.15 g	4.90 b	9.68 c
18 months	65%	14.15 c	35.14 b	7.67 e	3.95 d	9.47 d
18 months	72%	14.48 b	36.43 a	9.67 c	3.44 f	9.41 d
18 months	80%	17.53 a	36.91 a	15.28 a	3.20 g	9.21 e
F. test		**	*	**	**	*

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

TABLE 6. Interaction effect of storage period and package material on germination, electrical conductivity and seedling vigor of stored seeds.

Storage period	Package material	Seed germination (%)	Electrical conductivity(mS m^{-1})	Seedling vigor		
				Shoot length (cm)	Root length (cm)	Seedling dry weight (g)
6 months	Jute	66.92 cd	6.55 c	19.35 c	18.59 c	0.330 c
6 months	LDP	79.17 b	6.64 c	20.74 b	21.28 b	0.385 b
6 months	PICS	89.00 a	6.34 c	23.31 a	23.49 a	0.422 a
18 months	Jute	53.67 e	9.49 a	16.08 d	15.21 d	0.233 e
18 months	LDP	58.75 de	8.23 b	17.17 d	16.78 cd	0.293 d
18 months	PICS	73.00 bc	8.02 b	18.60 c	18.58 c	0.312 c
F. test		*	**	*	*	*

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

TABLE 7. Interaction effect of storage period and package material on moisture (%), 100-seed weight (g), acidity (%) and oil (%) of stored seeds.

Storage period	Package material	Moisture (%)	100-seed weight (g)	Acidity (%)	Oil(%)	Protein (%)
6 months	Jute	14.98 a	23.87 c	9.75 c	3.91 c	9.79 b
6 months	LDP	13.80 c	23.60 cd	8.68 d	4.15 b	9.82 b
6 months	PICS	12.89 e	23.32 d	8.05 e	4.31 a	9.97 a
18 months	Jute	15.02 a	36.14 a	10.94 a	3.65 d	9.36 d
18 months	LDP	14.39 b	35.76 a	10.18 b	3.86 c	9.42 d
18 months	PICS	13.66 d	35.17 b	8.72 d	4.11 b	9.55 c
F. test		**	*	**	*	*
L.S.D 0.01						

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

TABLE 8. Interaction effect of relative humidity and package materialon seed germination (%), electrical conductivity (mS m-1) and seedling vigor of stored seeds.

Relative humidity	Package material	Seed germination (%)	Electrical conductivity (mS m^{-1})	Seedling vigor		
				Shoot length (cm)	Root length (cm)	Seedling dry weight (g)
46%	Jute	85.50 ab	4.73 h	24.46 a	23.12bc	0.401
46%	LDP	88.17 a	5.38 g	24.20 a	25.16 ab	0.433
46%	PICS	91.50 a	5.25gh	24.67 a	26.67 a	0.436
65%	Jute	83.83 ab	6.34 f	20.23 c	20.12 de	0.351
65%	LDP	84.83 ab	6.13 f	21.14bc	21.40 cd	0.371
65%	PICS	86.17 ab	6.01 f	22.18 b	23.44bc	0.399
72%	Jute	56.33 d	8.24 d	16.75 e	14.48fg	0.274
72%	LDP	68.17bcd	7.18 e	18.34 d	17.24ef	0.332
72%	PICS	80.83abc	7.04 e	20.24 c	19.64 de	0.373
80%	Jute	15.50 f	12.78 a	9.43 g	9.88 h	0.100
80%	LDP	34.67 e	11.05 b	12.13 f	12.31gh	0.220
80%	PICS	65.50 cd	10.41 c	16.73 e	14.38fg	0.260
F. test		**	**	**	*	*

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

TABLE 9. Interaction effect of relative humidity and package materialon moisture (%), 100-seed weight (g), acidity (%), oil (%) and crude protein (%) of stored seeds.

Relative humidity	Package materials	Moisture (%)	100-seed weight (g)	Acidity(%)	Oil(%)	Protein(%)
46%	Jute	11.62i	28.81ef	7.53h	4.83 b	9.75bc
46%	LDP	10.85 j	28.48fg	7.10i	5.12 a	9.83 b
46%	PICS	10.42 k	27.88 g	6.53 j	5.26 a	10.04 a
65%	Jute	14.04 f	29.73 cd	7.80 g	4.05 d	9.65 de
65%	LDP	13.58 h	29.27 de	7.40 h	4.10 d	9.68cde
65%	PICS	13.52 h	28.57 f	7.44 h	4.29 c	9.73bcd
72%	Jute	14.55 d	30.55 ab	10.03 d	3.23 g	9.53 f
72%	LDP	14.43 e	30.13bc	8.91 e	3.59 f	9.58ef
72%	PICS	13.91 g	29.82 cd	8.48 f	3.76 e	9.75bcd
80%	Jute	19.80 a	30.94 a	16.01 a	3.03 h	9.36 g
80%	LDP	17.52 b	30.85 a	14.31 b	3.21 g	9.40 g
80%	PICS	15.25c	30.71 ab	11.10 c	3.54 f	9.51 f
F. test		**	*	**	**	**

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

The interaction among storage period, relative humidity and package material on moisture% and acidity% in seed maize storage are shown in Fig. 1 and 2.Storage at seed maize at 46% relative humidity to 6 month gave the lowest moisture% and acidity% for hermetic bags. Hermetic bag storage showed better result with lower moisture% and acidity% throughout the storage periods and relative humidity.

Conclusion

Increasing the storage period causes changes in chemical composition of seed maize, which varies depending on the relative humidity and package materials at which they are stored. During storage, there are decreases in seed germination, seedling vigor, crude protein and fat % with increases in the electrical conductivity, 100-grain weight, moisture % and acidity.From the previous results

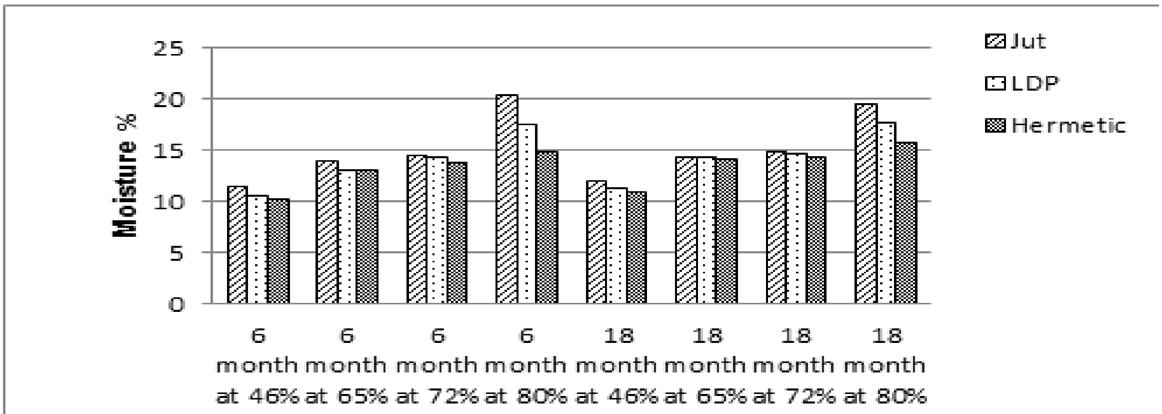

Fig. 1. The interaction among storage period, relative humidity and package material on moisture %.

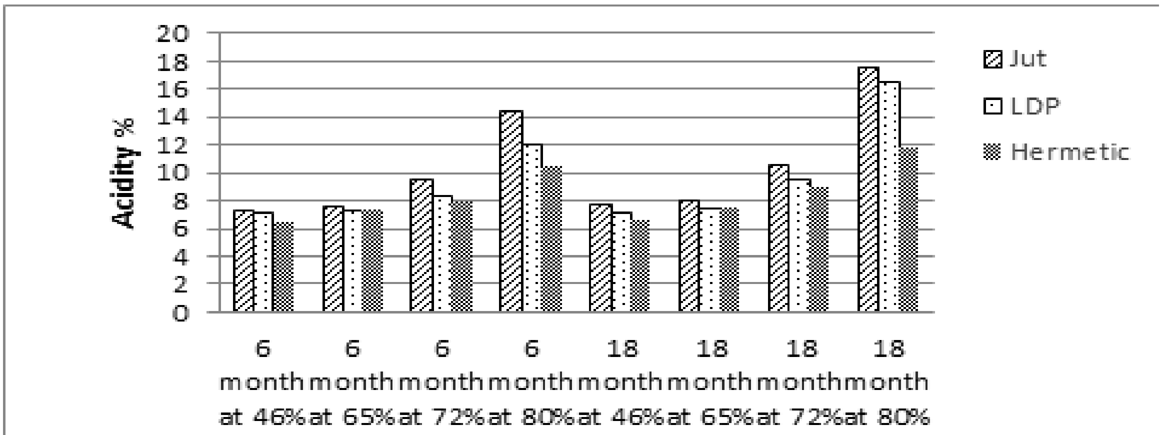

Fig. 2. The interactions among storage period, relative humidity and package material on acidity%

showed, lower relative humidity in storage can limit the deterioration in seed viability.Hermetic was observed to be best packaging material as compared with other packages showed better results with higher seed germination and seedling vigor, insect population, seed damage for 6 months of storage and up to 18 months in high air humidity for up to 80% throughout the storage periods.This is to preserve the seed maize during storage time and use them in cultivation in the next season, thus aiming to reduce the costs of producing new seeds.

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بقاء حيويه بذور الذرةالشامية تحت ظروف التخزين المختلفة

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تمت دراسة التغيرات في حيوية البذور والتركيب الكيميائي لهجين الذرة لفردي ١٦٨ تحت ظروف تخزين مختلف هو ذلك فيقسم بحوث تكنولوجيا البذور- محطة البحوث الزراعية بسخا، مصر- خلال الفترة من نوفمبر ٢٠١٨ إلى أبريل ٢٠٢٠. كانت ظروف التخزين هي عبارةعن فترتي تخزين ٦ ، ١٨ شهرًا، وأربعة مستويات من الرطوبة النسبية هي ٤٦٪ ، ٦٥٪ ، ٧٢٪ و ٨٠٪،و ثلاث انواع من العبوات وهي الجوت، بولي إيثيلين منخفض الكثافة وأكياس محكمة الغلق. أدت زيادة فترة التخزين من صفرإلى ٦ و ١٨ شهرًا إلى زيادة تدهورجودة البذوروتسببت في أعلى نسبة توصيل كهربائي ونسبة حموضة ومحتوى رطوبي في البذور المخزنه. و أدت زيادة الرطوبة النسبية من ٤٦ إلى ٨٠٪ إلى زيادة معنوية في متوسط قيمة التوصيل الكهربائي لماء نقع البذورومحتوى الرطوبة والحموضة٪ ،وانخفاض معنوي في متوسط إنبات البذور وطول الريشه وطول الجذيروالوزن الجاف البادرات والنسبه المئويه للزيت ونسبه البروتين. أظهرتبذورالذرة المخزنة في أكياس محكمة الغلق أعلي نسبه إنبات وحيوية للبادراتوأعلي نسبةزيتوادت إلي انخفاض محتوى الرطوبة والتوصيل الكهربي ونسبة الحموضة للبذره ،وبالتالي يمكن أن تؤخر تدهور جودة البذورمقارنة بأكياس البولي إيثيلين والجوت منخفضة الكثافة و ذلك في ظروف الرطوبه النسبيه المرتفعه لفتره أطول من سته شهور. ويمكن أن نوصي باستخدام الأكياس محكمه الغلق للحفاظ علي حيويه و جوده بذور الذرة وذلك خلال ظروف الرطوبة النسبية المرتفعه لمده تصل الي ١٨ شهر.