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Original Research

Effects of Plant Extracts on Quality and Viability of Wheat Seeds during Storage

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Abstract

The objective of this research was to study the effect of plant extracts on wheat seeds during storage periods (3, 6, 12 and 18 months). Plant extracts used were: *Azadirachta indica (Neem), Ocimum basilicum L. (Basil)* and *Datura* stramonium (Datura) at concentrations of 8%, 10% and 12% concentrations. The results showed that increasing storage time after harvest to 3, 6, 12 and 18 months significantly decreased the mean germination percentage, seedling parameter [root length, shoot length and seedling dry weight], relative density (R.D), seedling vigour index (S.V.I), field emergence (F.G), field survival (F.S), relative field emergence (R.F.E) and relative field survival (R.F.S).On the other hand, the decline in germination percentage was associated with the increase in electrical conductivity (E.C) value, acidity and moisture content. The maximum germination percentage, seedling parameters [root length, shoot length and seedling dry weight] and R.D were recorded in the treatment where neem extract was applied at 10% concentrations. However, the treatment with neem extract (8%) concentration gave the lowest viability by increasing EC value and acidity percentage.

Keywords: storage wheat, plant extracts, Neem, Basil, Datura

Introduction

Wheat (*Triticum aestivum* L.) is considered as a strategic cereal crop and the main food for the human. In Egypt, the total cultivated area of wheat reached about 1.425 million hectares and the total production exceeded 9.279 million tons with an average of 6.511 t/ha [1]. Many studies were carried out to improve the grain yield of cereal crops under normal and stressful conditions [2-10]. Soil seed banks play a significant role in the establishment, maintenance

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and regeneration of vegetation in several plant communities [11-13].

Seed storage under suitable conditions is a very important practice in order to extend its viability. Both storage duration and conditions can affect seeds quality, viability, and germination [14, 15]. The purpose of seed storage is to preserve planting stocks from one season to the next. In some cases, the objective of seed quality for the longest possible duration to utilize for nutritional consumption. Seed storage enables the maintenance of germplasm over time for improving plant breeding programs [16]. Seed quality usually deteriorates with passage of time but it is minimized for certain period of time. Seed deterioration occurs during storage, leading to reduction of vigour, germination percent, and decreased seedling growth. Temperature and moisture content are the major important factors, which influence the viability of seeds during storage. In most cases, it has been shown that lowering the temperature of the warehouse and the moisture content of the seeds leads to the increase in the period of viability [11]. In the study on Milk Thistle (*Silybum marianum* (L.) Gaertn.) seeds, the highest germination % and germination indexes were recorded for seeds that were stored for 5 months at room temperature, while long-term storage of seeds led to decreased the germination% and germination indexes [16].

Plant extracts can be used to improve seed germination and growth characters. The effect of aqueous leaves extract of *Clotropis procera* on seeds germination and early growth of Groundnut and Millet was investigated, final germination percentage after ten days was increased by increasing the extract concentration especially on Millet [17]. Seed of most species may be safely stored for several years by careful control of temperature and relative humidity. Although such conditions are too costly for most agriculture seed lots, yet they may be extremely valuable for preserving germplasm and certain high- value of seeds stocks. In some parts of the world, especially in the tropic conditions, storage is necessary in order to maintain high viability of some seed from harvest to planting [18]. The speed with which seeds lose vigour and viability depends on several factors: a) initial seed quality; b) storage conditions; c) presence of microorganisms and insects when relative humidity allows their development and d) the genetic constitution of the cultivar [19].

The objective of this research was to study the effect of plant extracts on wheat seeds during storage periods (3, 6, 12 and 18 months). Plant extracts used were: *Azadirachta indica* (Neem), *Ocimum basilicum* L. (Basil) and *Datura stramonium* (Datura) at concentrations of 8%, 10% and 12% concentrations to investigate the effect of some storage conditions on viability (germination), seedling vigour, some seed quality, chemical composition and quality characters of wheat seeds.

Experimental

This experiment was setup at Seed Technology Research Department at Sakha Agricultural Research Station, ARC, Egypt during 2018 to 2020 seasons to investigate the efficiency of plant extracts on the germination and viability parameters of wheat seeds during storage periods. Plant aqueous extracts used were 1- *Azadirachta indica* (Neem), 2- *Ocimum basilicum* L. (Basil) and 3- *Datura stramonium* (Datura) at concentrations of 8%, 10 % and 12% concentrations of each plant extract. Analysis of variance was computed according to Snedecor and Chochran [20] and treatment means were compared by Duncan,s multiple range test [21]. Correlation was performed according to Singh and Chaudhary [22].

Source of seeds: Wheat grains (Sakha 94) were obtained from Department of Wheat Crop Research, Agricultural Research centre, Egypt.

Preparation of leaf plant extracts: The aqueous extracts of each plant material was prepared by soaking 10 g of powdered leaf plant samples in 200 ml of sterile distilled water in 500 ml Erlenmeyer flask at room temperature for 24 h. The supernatant was filleter through double layered muslin cloth and centrifuged at 4000 g for 30 min. It was filtered through Whatman No.1 filter paper. The extract was preserved aseptically in a brown bottle at 5ºC prior to use [23]. Seed treatment: samples of seeds were soaked in the different concentration of plant extracts for 2 h. After soaking, the seeds were surface – dried in an incubator with forced air circulation for 48 h on filter paper at a temperature of 25ºC to return to their original moisture of 12-14% on dry weight basis. The seeds of all treatments were stored in woven polyethylene bags and kept at ambient conditions for 3, 6, 12 and 18 months. Eight replications of 50 seeds from each treatment (400 seeds) were planted in plastic boxes of 40×20×20 cm dimensions and contained sterilized sand. The boxes were watered and kept at 25ºC±2 in annulated and the following parameters were evaluated.

Germination Percentage (G.P): This was calculated by counting only normal seedlings 8 days after planting according to ISTA [24].

Germination Percentage (G.P):

$$\text{(Number of normal seedling)/ (Number of seed tested)} \times 100$$

Parameters were evaluated using the following formula outlined by Krishnasamy and Seshu [25], where seedling vigour as measured by the length of normal seedling and dry weight which was made on 10 seedlings per replicate at the end of germination test and after removal the seed attached. The seedlings were oven- dried at 70ºC for 24 hours and weighted.

Seedling vigour: = root length (cm), shoot length (cm), seedling dry weight (mg).

Seedling Vigour Index: Seedling vigour index was calculated using the following formula [26]: Seedling vigour index = S.D.W × G.P

Where S.D.W = seedling dry weight. G.P= germination percentage

Field Emergence (F.E): This was recorded on the 4th day after planting; it is the percentage of germinated seeds 4 days after planting relative to the total number of seeds tested [26].

Relative Field Emergence (R.F.E): denote to the percentage of viable seeds produced plants in the field / seed germination as determined in the laboratory.

$$R.F.E = (F.E.)/(G.P.) \times 100$$

Field Survival % (F.S): Field Survival % (F.S) were recorded at time intervals until constant (30 days from seed sowing) and the highest figures were used.

Relative Field Survival (R.F.S): Denote to the percentage of viable seeds produced plants survived/ seed germination as determined in the laboratory.

$$R.F.S = (F.S.)/(G.P.) \times 100$$

Electrical Conductivity (E.C.): The electrical conductivity of the leachate was determined according to procedures described by AOSA [27]. Four sub-samples of 50 seeds of each replicate were weighed and placed in Erlenmeyer flaks were then placed in an incubator chamber at 25ºC for 24 hours. The conductivity of the steep water was measured immediately after removal of samples from the incubator with a pipette-type conductivity cell attached to a bulk conductivity meter the conductivity values were expressed as M mos. /gm. seed weight.

E.C. = (Reading of replicate 1)/(Weight of 50 seeds in replicate 1) + (Reading of replicate 2)/(Weight of 50 seeds in replicate 2)

Relative Density (R.D.): Relative density of one seed was calculated according to Kramer and Twigg [28] as follows: Relative density (g/mm^3) = (100-seed weight (g))/(100-seed volume (mm^3))

Table 1. Effect of storage period, Extracts, and Concentration on germination, seedling vigour and relative density.

Treatment	Germination %	Seedling vigour			R.D
		Radical Length (cm)	Shoot length (cm)	Dry weight (mg)	
Effect of period (A)					
3 months	93.33 a	16.79 a	14.44 a	174.59 a	1.56 a
6 months	85.22 b	15.45 b	10.85 b	165.00 b	1.43 b
12 months	19.07 c	9.11 c	5.25 c	75.93 c	1.22 c
18 months	7.63 d	3.12 d	2.65 d	34.07 d	1.10 d
F .test	**	**	**	**	**
Effect of extracts (B)					
Neem	53.00 a	11.42 a	8.82 a	118.44 a	1.37 a
Basil	51.86 b	11.09 ab	8.11 b	111.67 b	1.33 a
Datura	49.08 c	10.86 b	7.96 b	107.08 b	1.28 b
F.test	**	**	**	**	**
Effect of Concentration (C)					
8 %	49.97 b	10.92	8.13	109.03 b	1.28 b
10 %	52.17 a	11.29	8.54	115.00 a	1.37 a
12 %	51.81 a	11.15	8.23	113.17 a-c	1.33 a
F.test	**	N.S.	N.S.	*	**
	Effect of Interaction (D)				
AB	**	N.S.	N.S.	N.S.	N.S.
AC	N.S.	N.S.	N.S.	N.S.	N.S.
BC	**	**	**	**	**
ABC	**	N.S.	N.S.	N.S.	*

** indicated P<0.05 and not significant, respectively. Means designated by the same letter are significantly different at 5 % level according to Duncan's Multiple Range Test.

Moisture percentage: The moisture percentage of the seed was calculated according to International Seed Testing Association ISTA [24] rules (16) by hot air oven method maintaining 103ºC±2ºC for 17 hr. and then at 105ºC till constant dry weight. The moisture content was calculated on wet basis and expressed in percentage by using the following formula.

$$\text{Moisture percentage} = (M2-M3)/(M2-M1) \times 100$$

Where M1 = weight of empty moisture tin in (g), M2 = weight of moisture tin and seed material before drying (g), M3 = weight of moisture tin and seed material after drying (g).

Results and Discussion

Effect of Storage Period

Results of germination percentage, seedling parameter (root length, shoot length and seedling dry weight) and relative density (R.D.) as affected by storage period, type of plant extract and extracts concentration under study are presented in Table 1. The general effect of storage time on the germination percentage, seedling parameter (root length, shoot length and seedling dry weight) and relative density (R.D.) of wheat grain lots are given in Table 1. Increasing storage time after harvest to 3, 6, 12 and 18 months significantly decreased the mean germination percentage from 99% to 93.33%, 85.22%, 19.07% and 7.63%, respectively. The decline in germination percentage with storage time was associated with a decrease in seedling parameter (root length, shoot length and seedling dry weight) as shown in Table 1. Increasing storage time after harvest to 3, 6, 12 and 18 months significantly decreased the seedling parameter from (16.79 cm, 14.44 cm and 174.59 mg), (15.45 cm, 10.85 cm and 165 mg), (9.11 cm, 5.25 cm and 75.93 mg) and (3.12 cm, 2.65 cm and 34.07 mg), respectively. Also, the decline in germination percentage with storage time was associated with a decrease in relative density (R.D.) as shown in Table 1. Increasing storage time after

Table 2. Effect of storage period, extracts and concentration on seedling vigour index, field emergence, relative field emergence, field survival and relative field survival.

Treatments	S.V.I %	F.E %	R.F.E %	F.S %	R.F.S %
Effect of period (A)					
3 months	16.28 a	86.33 a	92.50 a	84.26 a	90.26 a
6 months	14.11 b	77.56 b	90.93 a	75.07 b	88.02 b
12 months	1.52 c	10.30 c	47.41 b	7.70 c	33.18 c
18 months	0.279 d	0.926 d	9.77 c	0.00 d	0.00 d
F.test	**	**	**	**	**
Effect of Extracts (B)					
Neem	8.44 a	45.28 a	69.43 a	43.03 a	55.51 a
Basil	8.12 a	44.25 a	59.07 b	42.17 a	52.17 b
Datura	7.59 b	41.81 b	56.96 b	40.08 b	50.91 c
F.test	**	**	**	**	**
Effect of Concentration (C)					
8 %	7.81	42.69	56.42 b	40.89 b	49.68 c
10 %	8.24	44.53	62.68 a	42.42 a	55.00 a
12 %	8.09	44.11	61.35 a	41.97 a	53.91 b
F.test	N.S.	**	**	**	**
		Effectof Interaction	(D)		
AB	N.S.	**	**	**	**
AC	N.S.	N.S.	**	N.S.	**
BC	**	**	**	**	**
ABC	**	**	**	**	**

** indicated P<0.05 and not significant, respectively. Means designated by the same letter are significantly different at 5 % level according to Duncan's Multiple Range Test

Table 3. Effect of storage period, extracts and concentration on electrical conductivity, Acidity and Moisture.

Treatments	E.C (mhos/g)	Acidity %	Moisture %
Effect of period (A)			
3 months	4.87 d	3.27 d	12.29 c
6 months	5.93 c	4.15 c	12.53 c
12 months	8.53 b	7.04 b	13.14 b
18 months	14.24 a	9.83 a	15.92 a
F.test	**	**	**
Effect of Extracts (B)			
Neem	8.22 c	5.93 c	13.49
Basil	8.37 b	6.06 b	13.37
Datura	8.60 a	6.22 a	13.54
F.test	**	**	N
Effect of Concentration (C)			
8 %	8.45	6.17 a	13.43
10 %	8.37	5.98 b	13.49
12 %	8.37	6.07 ab	13.48
F.test	N.S.	**	N.S.
	Effect of Interaction	(D)	
AB	N.S.	N.S.	N.S.
AC	N.S.	N.S.	N.S.
BC	**	**	N.S.
ABC	N.S.	N.S.	N.S.

**indicated P<0.05 and not significant, respectively. Means designated by the same letter are significantly different at 5% level according to Duncan's Multiple Range Test.

harvest to 3, 6, 12 to 18 months significantly decreased relative density (R.D.) from (1.56, 1.43, 1.22 and 1.10), respectively. The deterioration in germination percentage due to storage time resulted in decreasing the relative density (R.D.). The decline in germination percentage with storage time was associated with a decrease in seedling vigour index (S.V.I.), field emergence (F.E.), field survival (F.S.), relative field emergence (R.F.E.) and relative field survival (R.F.S.) as shown in Table 2. Increasing storage time after harvest to 3, 6, 12 and 18 months significantly decreased seedling vigour index (S.V.I.), field emergence (F.E.), field survival (F.S.), relative field emergence (R.F.E.) and relative field survival (R.F.S.) from (16.28, 86.33%, 84.26%, 92.50 and 90.26), (14.11, 77.56%, 75.07%, 90.93 and 88.02), (1.52, 10.30%, 7.70%, 47.41 and 33.18) and (0.249, 0.926%, 0.0%, 9.77 and 0.0), respectively. On the other hand, the decline in germination percentage with storage time was associated with increase in electrical conductivity (E.C.) value, acidity percentage and moisture content as shown in Table 3. Increasing storage time after harvest to 3, 6, 12 and 18 months significantly increased the electrical conductivity (E.C) value, acidity percentage and moisture content from (4.87 value, 3.27% and 12.29%), (5.93 value, 4.14 and 12.53), (8.53 value, 7.04 and 13.14) and (14.24 value, 9.83 and 15.92%), respectively. Similar results were recorded with some researchers [29-32].

Effect of Extracts

The presented results of the germination percentage, seedling parameters (root length, shoot length and seedling dry weight) and R.D showed significant effect of different extracts (Table 1). The maximum germination percentage, seedling parameters (root length, shoot length and seedling dry weight) and R.D 53%, (11.42 cm, 8.82 cm and 118.44 mg) and 1.37 were recorded in the treatment where neem extract was applied, respectively. On the other hand, the lowest final germination percentage, seedling parameters (root length, shoot length and seedling dry weight) and R.D 49.08%, (10.86 cm, 7.96 cm and 107.08 mg) and 1.28 were recorded in the treatment of datura. However, no significant differences were observed between neem and basil extracts on relative density (R.D.). Similarity the effectiveness different plant extract was reported by Abo El-Dahab et al. [29], Asghar et al. [30], Parmar et al. [31]. The different plant extracts had significant effects on seedling vigour index (S.V.I.), field emergence (F.E.), relative field emergence (R.F.E.), field survival (F.S.) and relative field survival (R.F.S.) (Table 2). Neem extract has superiority in term of (S.V.I.), (F.E.), (R.F.E.), (F.S.) and (R.F.S.) compared with other treatments evaluated in this study. However, the maximum (S.V.I.), (F.E.), (R.F.E.), (F.S.) and (R.F.S.) 8.44, 45.28, 69.43, 43.03 and 55.51 respectively were recorded with neem treatment. On the other hand, the lowest final (S.V.I.), (F.E.), (R.F.E.), (F.S.) and (R.F.S.) 7.59, 41.81%, 56.96, 40.08% and 50.91 were recorded in the treatment where datura extract was applied, respectively. No significant differences were observed between neem and basil extracts on (S.V.I.), (F.E.) and (F.S.). These findings agree with the results of Abo El-Dahab et al. [29]. The general effect of plant extracts on E.C., acidity percentage and moisture content are given in Table 3. The highest viability by decreasing E.C. value, acidity percentage and moisture content were recorded in the treatment where neem extract was applied 8.22 m, 5.93% and 13.49%, respectively. On the other hand, the lowest viability by increasing E.C. value, acidity % and moisture content was recorded in the treatment where datura extract was applied 8.60, 6.22% and 13.54%, respectively. Application of seaweed extracts led to enhance the growth of amaranth sprouts and total polyphenols, flavonoids, chlorophylls, carotenoids and the antioxidant of sprouts [32].

Effect of Concentrated Plant Extracts

Statistical analysis of data further showed that concentrated plant extracts from different species had significant effect on germination percentage, seedling dry weight and R.D. (Table 1). The effect of concentration of plant extracts demonstrated the treated with 10% concentration gave the highest germination percentage, seedling dry weight and R.D. 52.17%, 115 mg and 1.37, respectively. On the other hand, the treated with 8% concentration gave the lowest germination percentage, seedling dry weight and R.D 49.97%, 109.03 mg and 1.28. The general effect of concentrated plant extracts on (S.V.I.), (F.E.) %, (F.S.) %, (R.F.E.) and (R.F.S.) are given in Table 2. The effect of concentration of plant extracts demonstrated that treated with 10% concentration gave the highest values of (S.V.I.), (F.E.), (F.S.), (R.F.E.) and (R.F.S.) 8.24, 44.53%, 42.42%, 62.68 and 55, respectively. On the other hand, treated with 8% concentration gave the lowest values of (S.V.I.), (F.E.), (F.S.) %, (R.F.E.) and (R.F.S.) 7.81, 42.69%, 40.89%, 56.42, 49.08, respectively. From the data recorded in the Table 3 showed that the highest viability by decreasing E.C. value, acidity % 8.37 and 5.98% by treated with 10% concentration. However, treated with 8 % concentration gave the lowest viability by increasing E.C value, acidity percentage 8.45 and 6.17%, respectively. Similarity the effectiveness of different plant extracts concentration was reported by Adesina et al. [32].

The Interaction between Storage Period and Plant Extracts

The interaction between storage period and plant extracts has significant effects on germination percentage, field emergence (F.E.), field survival (F.S.), relative field emergence (R.F.E.) and relative field survival (R.F.S.) (Fig. 1). The highest percentage of (F.E.), (F.S.), (R.F.E.) and (R.F.S.) were recorded when wheat seeds were treated with basil extract after storage period 3 months while, the highest germination percentage, (F.E.), (F.S)., (R.F.E.) and (R.F.S.) were recorded when wheat seeds were treated with neem extract after 6 months up to 18 months storage. On the other hand, the lowest germination percentage, (F.E.), (F.S.), (R.F.E.) and (R.F.S.) were recorded when wheat

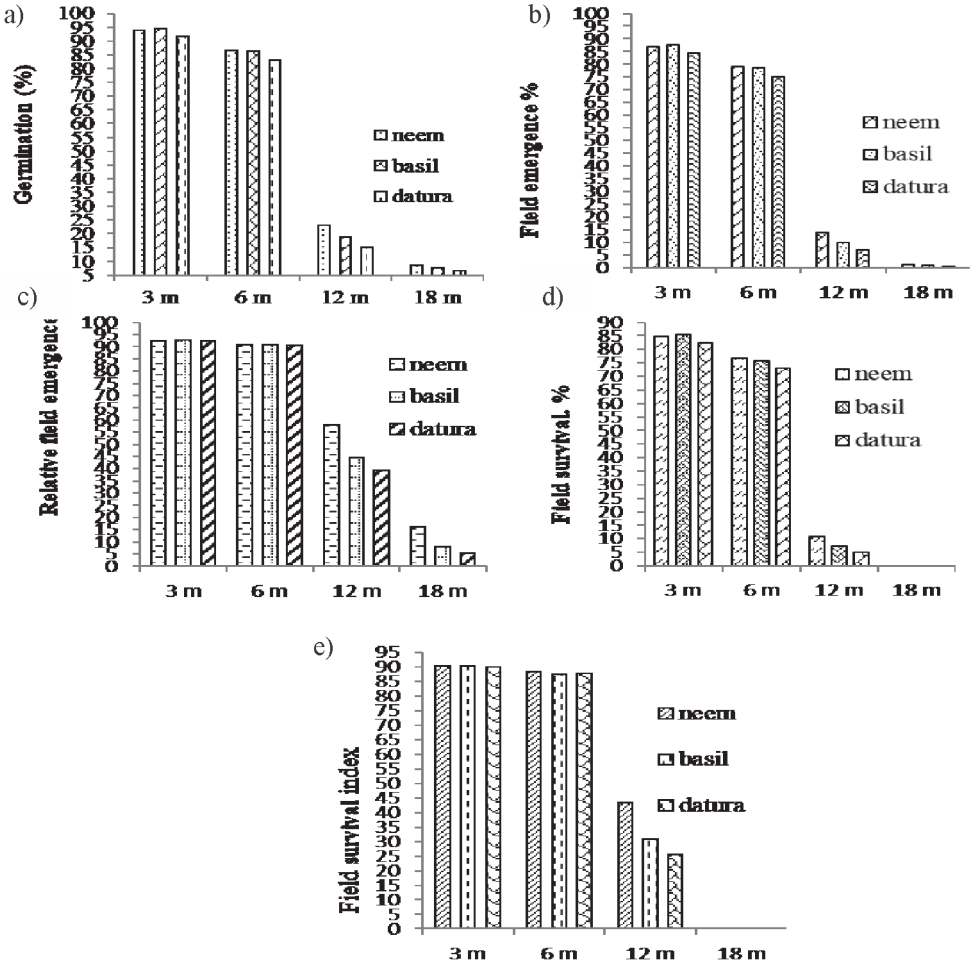

Fig. 1. Effect of interaction between storage period and plant extracts on: a) Germination %, b) field emergence, c) relative field emergence, d) field survival, e) field survival index.

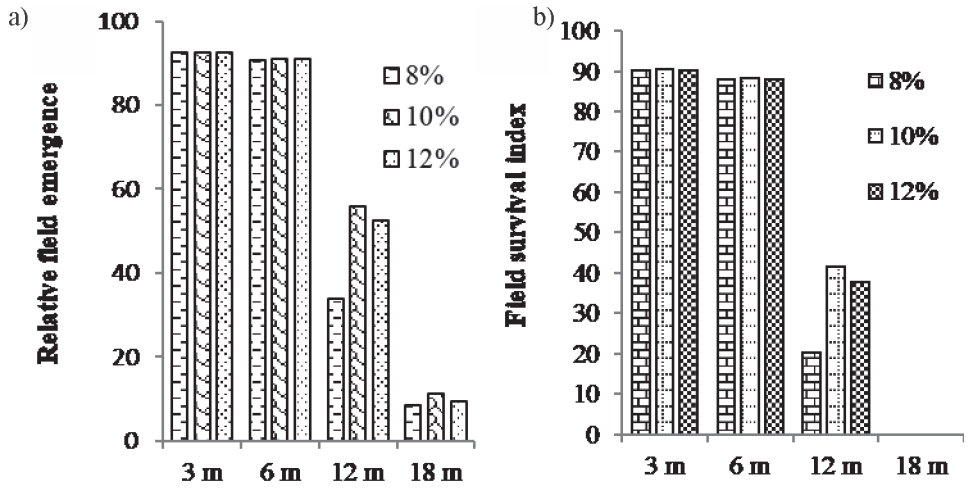

Fig. 2. Effect of interaction between storage period and concentration on a) relative field emergence, b) field survival index.

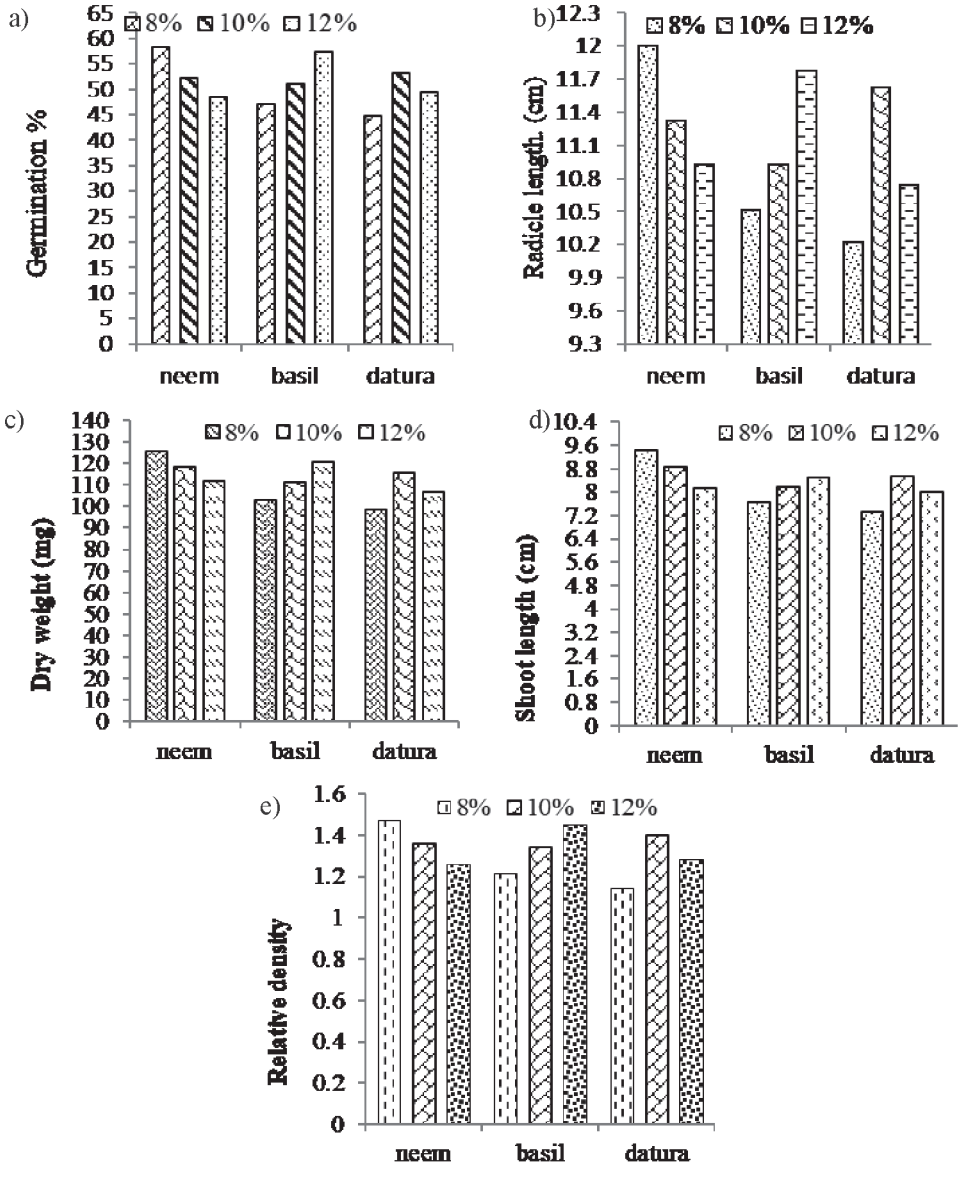

Fig. 3. Effect of interaction between extracts and concentration on: a) germination %, b) radicle length, c) dry weight, d) shoot length, e) Relative density.

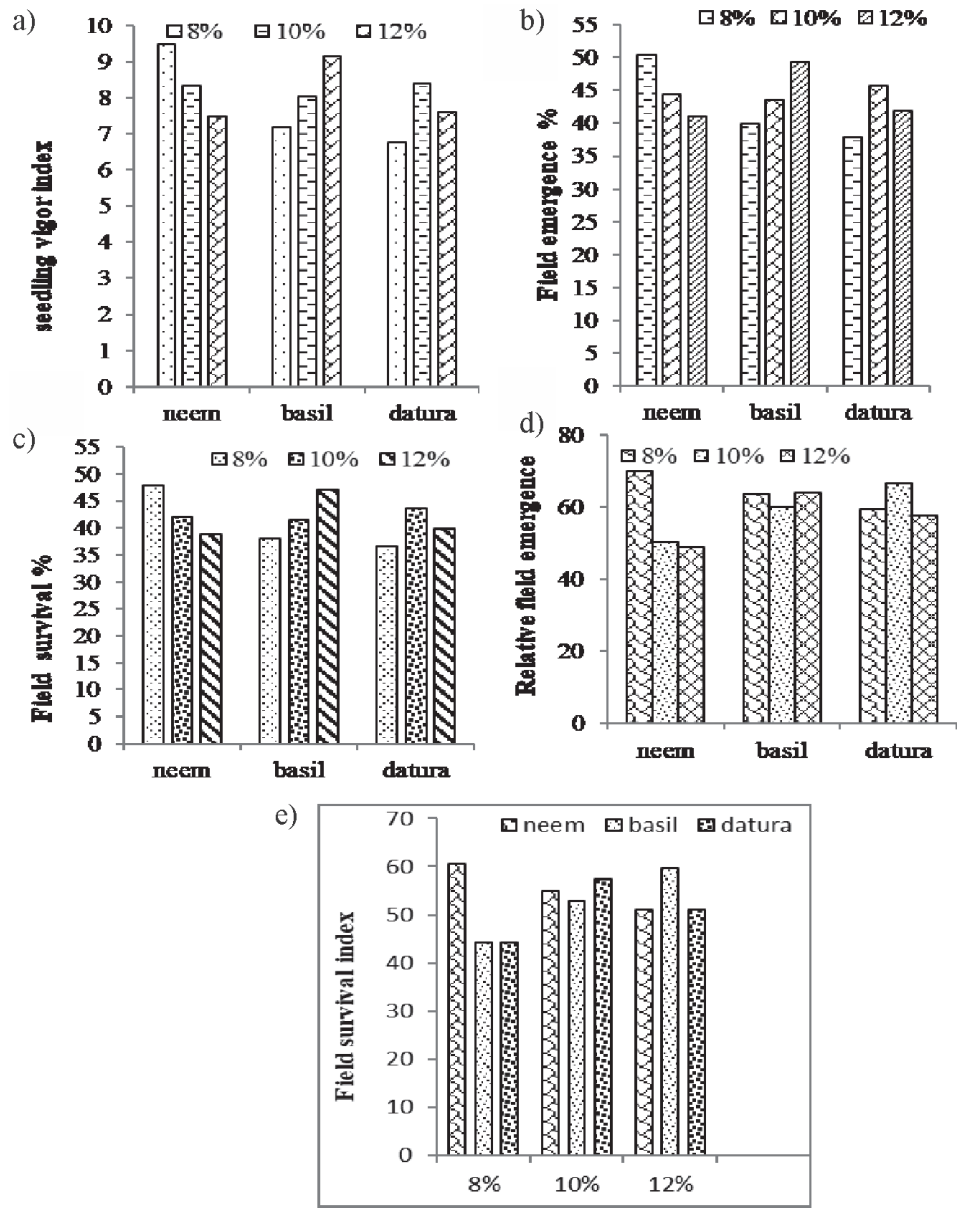

Fig. 4. Effect of interaction between extracts and concentration on: a) seedling vigour index, b) field emergence, c) field survival, d) relative field emergence e) Field survival index.

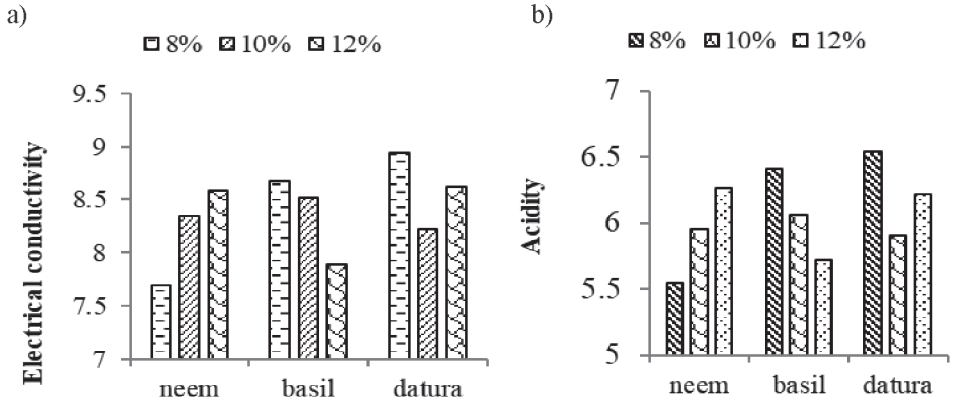

Fig. 5. Effect of interaction between extracts and concentration on a) E.C. b) Acidity.

seeds were treated with datura extract after storage period 3 months up to 18 months storage.

The Interaction between Storage Period and Plant Extracts Concentration

The interaction between storage period and plant extracts concentration has a significant effect on Relative Field Emergence (R.F.E.) and Relative Field Survival (R.F.S.) (Fig. 2). The highest value of (R.F.E) and (R.F.S.) were recorded when wheat seeds were treated with basil extract concentration (8%, 10%, 12%) after storage period 3 months up to 18 months storage.

The Interaction between Plant Extracts and Plant Concentration

The interaction between extracts and their concentrations has significant effects on germination percentage, seedling parameters (root length, shoot length and seedling dry weight) and relative density (R.D.) (Fig. 3). The highest germination percentage, seedling parameter and R.D were recorded when wheat seeds were treated with neem extracts at 8% concentration followed by basil extracts at 12% then datura extracts at 10% concentration. However, the lowest germination percentage, seedling parameter (root length, shoot length and seedling dry weight) and relative density (R.D) were recorded when wheat seeds were treated with datura extracts at 8% concentration.

The data presented in Fig. 4 revealed that the highest seedling vigor index (S.V.I.), field emergence (F.E.), field survival (F.S.), relative field emergence (R.F.E.) and relative field survival (R.F.S.) recorded when seeds were treated with neem extract at 8% concentration followed by basil extracts at 12% concentration then datura extract at 10 %. On the other hand, maximum viability by decreasing E.C value and acidity percentage were recorded in the seed treated with neem extracts at 8% concentration followed by basil extract at 12% concentration then datura extract at 10%, while, the lowest viability by increasing E.C value and acidity percentage were recorded in the seed treated with datura extract at 8% concentration. The present findings are almost in agreement with those of Adesina et al. [32], they reported that the plant extracts strengthen the non-phytotoxic nature of plant products against seed viability and germination. Seeds treated with extracts (50-400 µg $seed^{-1}$) did not lose their viability as it resulted in successful and normal germination within the range of 90-97.67% irrespective of the extracts concentration. Also, seed treatment with seaweed extracts led to improve seed germination of wheat and amaranth seeds [33, 34].

Conclusion

Generally, it can be concluded that increasing storage period to 3,6,12 and 18 months significantly reduced root length, shoot length, seedling dry weight, relative density, seedling vigour index and Relative field emergence. However, application of plant extracts of *Azadirachta indica* (Neem), *Ocimum basilicum* L. (Basil) and *Datura stramonium* (Datura) at concentrations of 8%,10% and 12% can be used to increase storage period of wheat seeds after harvest.

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Conflict of Interest

The authors declare no conflict of interest.

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