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Studying the Possibility of Improving the Germination Characteristics of Old And New Harvested Sesame Seeds by Using Some Natural and Chemical Substances

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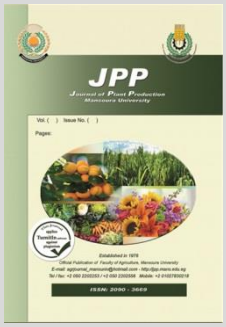

ABSTRACT

At Laboratory of Seed Testing, Faculty of Agriculture, Department of Agronomy, Mansoura University Egypt, an experiment was conducted in a lab during the month of May 2022 to improve both old and new harvested sesame crop Shandawel-3 cultivar seed germination by using some natural (without, soaking in distilled water, yeast extract at 150 and 200 ml/L, algas extract at 100 and 150 ml/L and humic acid (HA) at 200 and 300 mg/L) and chemical (without, soaking in distilled water, chitosan at 0.25 and 0.50 %, ascorbic acid (AA) at 100 and 200 mg/L and salicylic acid (SA) at 100 and 200 mg/L) substances. A unique laboratory experiment was conducted for each type of sesame seed (seed age, including both old and newly harvested seeds). Every experiment involving different seed types was conducted using a factorial experiment with a completely randomized design (CRD). Maximum values of all most studies of germination parameters were resulted from the new harvested, soaking sesame seeds in humic acid (HA) at the rate of 300 mg/L and soaking sesame seeds in ascorbic acid (AA) at the rate of 200 mg/L. Intended for enhancing germination parameters of sesame, it could be recommended that soaking seeds in humic acid at the rate of 300 mg/L and ascorbic acid at the rate of 200 mg/L for 12 hours in either old or new harvested seeds.

Keywords: Sesame, old and new harvested seeds, natural substances, chemical substances, germination parameters.

INTRODUCTION

One of the first oil crops utilised by humans was sesame (*Sesamum indicum* L.). It is extensively cultivated, has a pleasant flavour, and is quite nutritious, making it a favourite in the diet. According to Shyu and Hwang (2002), sesame seeds are a good source of protein (15–25%) and oil (48–60%) and provide a number of health advantages. Due to Egypt's severe edible oil deficit, further study is required to boost sesame production through improved seed germination and seedling characteristics utilising both natural and synthetic materials.

In the life cycle of a plant species, seed germination plays a crucial biological role. Successful plant establishment is a result of good seed germination, and this, in most situations, yields a final product that is both acceptable and affordable. In contrast, inadequate germination led to worse plant establishment, which reduced plant output in dry and semi-arid regions (Harris and Hollington, 2001).

The only way to increase crop yield and productivity is to employ high-quality seeds and effective management techniques. Aside from their genetic and physical purity, high quality seeds also have strength, uniformity, and structural soundness. Numerous researchers have created new "Seed Enhancement Techniques" technologies in order to produce seeds of higher quality. This method's primary goal is to increase the technical quality of seeds in order to maximise the application of seed treatment products.

Temperature and seed moisture content have major roles in how much seed viability is lost (McDonald, 2004). According to research by Adebisi *et al.* (2008), maintaining the short-term quality of sesame seed is possible when sesame seed is stored in appropriate ambient conditions. According to Adam *et al.* (2018), storage circumstances have a significant impact on germination parameters of sesame, which decreases with longer storage times in all storage settings. Once the storage period exceeded six months, the amount of deterioration became noticeable. According to Vijaya *et al.* (2021), sesame seeds were stored in super grain bags were more vigorous and viable for up to 10 months than seeds stored in conventional containers under ambient conditions. After 10 months of storage, the sesame maintained an 85% germination rate.

Many field crops benefit greatly from the seed soaking approach, which has been shown to increase germination rate, enhance uniformity of germination, enhance seedling establishment, and promote vegetative growth. Any material or microbe that is provided to apply to plants, seeds, or roots with the goal of stimulating natural plant processes will boost nutrient usage efficiency and increase a plant's ability to withstand biotic stress. These compounds are known as plant bio-stimulants. The naturally occurring nutrients thiamine, riboflavin, niacin, pyridoxine, and vitamins B_1, B_2, B_3, and B_{12} are all present in yeast extract together with a wide range of other nutrients and growth factors. It also contains organic molecules including protein, carbohydrates, nucleic acid, and lipids. In addition to being used as a plant fertiliser, yeast extract is also used to increase soil microbial activity, encourage the rapid proliferation of advantageous microorganisms to improve soil enzyme activity, boost plant resistance (particularly the resistance to saline-alkali), stimulate seed enzyme activity, and speed up seed germination (Barnett *et al.*, 1990 and Nagodawithana, 1991).

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Algae extract was regarded as a significant source of nourishment for sustainable agriculture, particularly in recently recovered soil, due to its organic and biodegradable nature. A wide range of plant growth regulators have been found in algal extract after chemical analysis, which is known to boost the establishment, elongation rate, and increase in number of root hairs. Gibberellins also enhance lateral growth (Zhang and Ervin, 2004).

Chelators and the main ingredient in humic compounds, is humic acid. Humic substances to form organic molecules that are simpler for plants to consume combine minerals. Among their many functions that are essential for fostering plant growth are enhancing root cell elongation, phosphate and nutrient uptake, oxygen uptake, respiration (especially in roots), and photosynthesis (Chen *et al*., 1994). They can also increase cell membrane permeability, which is important for the transport and availability of micronutrients. In respect to Souguir and Hannachi (2017), humic acid treated at 1000 mg L^{-1} had the greatest speed germination index and coefficient of germination for sesame, as well as a reduction in the mean germination time. Humic acid utilisation has to be maximized, since it can quickly change into an abiotic stress that threatens plant production.

A naturally occurring polymer created when chitin is deacetylated is chitosan. Chitin is easily accessible in shellfish byproducts used in food preparation. Chitosan is a high molecular weight polymer that is non-toxic and bioactive. Because of its fungicidal properties and ability to trigger defense systems in plant tissues, chitosan has gained recognition as a valuable chemical. Chitosan creates a semi-permeable coating that slows down the ripening process, lowers respiration and transpiration rates, and controls gas exchange (Terry and Joyce, 2004). Godinez-Garrido *et al.* (2022) showed that coated sesame seeds with chitosan-increased germination by 16%, germination speed index by 58% and length of the root by 77% as compared with the control.

One of the most significant antioxidants is ascorbic acid (AA), which is crucial for cellular functions such as cell division, expansion, metabolic activity when germination began, cell detoxification, protection from reactive oxygen species, and cell survival In regarding to Afzal *et al.* (2005), presowing treatment with (AA) enhances performance and stand establishment under various environmental conditions, such as high salinity.

Salicylic acid (SA) is regarded as a hormone-like compound that regulates a variety of physiological processes, including ion absorption and transport, suppression of ethylene production, transpiration, photosynthesis, growth, nitrate metabolism, and stress tolerance. As a result, SA treatment was increased plant tolerance to a variety of biotic and abiotic stressors, including cold, salt, drought, and heat (Khan *et al.,* 2010). In this contest, Sedghiet (2010) was showed that salicylic acid priming method-improved germination underneath short temperature situation and upgraded alarming tolerance faster, conservation of tissue water substances synchronous, emergence of sesame by stimulation of antioxidants and lessen permeability of membrane. Also, in the same respect, Safari *et al.* (2018), mentioned that salicylic acid seed pretreatment has a significant ameliorative impact on sesame seeds' capacity to germinate in salt, however seedling development may be slowed, which is likely a transient adaptation to salinity stress.

Therefore, this investigation was established to improve both old and new harvested sesame crop Shandawel-3 cultivar seed germination parameters using some natural and chemical substances under laboratory conditions.

MATERIALS AND METHODS

A laboratory experiment was performed during the month of May 2022, in the Agron. Dept. Lab. of Seed Testing, Fac. of Agric. Mansoura Univ. Egypt. The main purpose of this laboratory experiment was to improve both old and new harvested sesame crop Shandawel-3 cultivar seed germination parameters using some natural and chemical substances. A unique laboratory experiment was conducted for each kind of sesame seeds (seed age, including both old and newly harvested seeds). The current crop of sesame seeds came from the yield of 2021 growing season, while the old harvest came from the yield of 2020 season.

A factorial experiment with a completely randomised design (CRD) was used for every experiment involving different seed kinds. The first factor included eight seed treatments that were soaked for 12 hours in various natural substances in addition to the control treatment as follows: distilled water, no soaking (the untreated "control treatment"), yeast extract (YE) at rates of 150 and 200 ml/L, algal extract (AE) at rates of 100 and 150 ml/L, and humic acid (HA) at rates of 200 and 300 mg/L.

By employing a technology that allowed yeast cells (pure dry yeast) to grow and multiply effectively under favorable aerobic and nutritional circumstances, yeast extract (YE) as natural biostimulants was created. This process made it possible to create new, advantageous bioconstituents including carbohydrates, amino acids, sugars, proteins, fatty acids, hormones, *etc*., which could then easily release from yeast cells. For the purpose of activation and reproduction, active dry yeast was dissolved in water at a rate of 1 g/L, followed by the addition of sugar at a ratio of 1:1. The mixture was then left overnight, and two cycles of freezing and thawing were used to break apart the yeast cells and release the contents. Spencer *et al.* (1983) modified this method of yeast production.

The first blue-green alga, Spirulinaplatensis, was isolated from Wadi El-Natrun in the El-Buhira Governorate, and it was grown up to a vast scale at the National Research Center's Algal Biotechnology Unit in three open ponds (75 m^3 of a final capacity). Algal bulk that includes 75–80% moisture was harvested using a continuous centrifuge (Westifalia Separator), and it was then frozen for 48 hours at 25 ºC. Algal slurry was severely stressed by high nutritional dosages prior to centrifugation in order to satisfy the requirements for nutrient accumulation within algal cells. The frozen mass was then homogenised, re-melted at room temperature, and aerobically fermented for 72 hours. Following fermentation, the biomass was homogenised and filtered until it was used. Table 1 lists the main elements of the utilised algae extract.

Table 1. Chemical composition of algas extract (AE).

Elements	N	P	K	Mg	Ca	Fe	Zn	Mn	Cu
	%					mg/L			
Concentration	8.00	2.45	0.68	0.20	0.93	1986	31	58	88

Humic acid (HA) in the form of Humi-Sum which contains humic acid 60% fulvic acid 15%, nitrogen 0.7%, phosphorus 0.06%, potassium 8.0%, calcium 3.98%,

magnesium 0.29%, iron 1.89%, manganese 0.04%, zinc 0.013%, cupper 0.05% and boron 0.04% was used.

The second factor included eight soaking seed treatments in some chemical substances for 12 hours beside control treatment as follows; without soaking (untreated "control treatment"), soaking in distilled water, chitosan at the rates of 0.25 and 0.50 %, ascorbic acid (AA) at the rates of 100 and 200 mg/L and salicylic acid (SA) at the rates of 100 and 200 mg/L.

In this respect, El-Nasr Pharmaceutical Chemicals Co. manufactured ascorbic acid (AA) and salicylic acid (SA) as antioxidants as well as chitosan in Egypt. It was purchased from El-Gomhouria Company for Trading Pharmaceutical Chemical & Medical. Chitosan powder was created by dissolving the necessary quantity in a 5% acetic acid solution to create poly-(1.4-B-D-glucopyranosamine) and 2-amino-2-deoxy-(1-4)-B-D-glucopyranan.

Standard germination test:

In sterile foam dishes (20×30 cm), 400 sesame seeds for each treatment were planted on top of filter paper. Each Foam-dish contains 50 sesame seeds, and two foam-dishes kept close together are evaluated as if they were one 100-seed replication in accordance with the guidelines of the International Seed Testing Association (ISTA, 1996). Every day, foam dishes were checked, and extra distilled water was added as needed. When the radical pierced the coleorhiza and the seed reached a length of 2 to 3 mm, it was considered to have physiologically germinated. The number of seeds that sprouted on the third day was the initial count, which was made up of all the seeds that had germinated. Once the germination test was complete (6 days later), the number of seeds that had sprouted was counted every 24 hours. According to ISTA (1996), sesame seeds were divided into three categories: viable (abnormal, dead, or diseased seeds), hard (no imbibitions or swelling), and germinated (radical 2 mm long).

- Parameters of germination:

1- Germination percentage (G %). After six days from planting G% determined using the formula given by ISTA (1996):

$$\text{Germination percentage (\%)} = \frac{\text{Number of normal seedlings}}{\text{Number of total seeds}} \times 100$$

2- Speed germination index (SGI). The formula used to determine it is as follows (ISTA, 1996):

$$SGI = \frac{\text{No. of germinated grains}}{\text{Days to first count}} + \cdots\cdots + \frac{\text{No. of germinated grains}}{\text{Days to final count}}$$

3- Germination index (GI). The following equation was used to compute it (Karim *et al.*, 1992):

$$GI = \frac{\textbf{Germination percentage in each treatment}}{\textbf{Germination percentage in control treatment}}$$

4- Co-efficient of germination (CG). The formula used to determine it is as follows, Copeland (1976):

$$CG = \frac{100\ (A_1 + A_2 + \ldots\ldots + A_n)}{A_1\,T_1 + A_2\,T_2 + \ldots\ldots\ A_n\,T_n}$$

Where A is the total number of seeds that germinated, T is the number of days that correspond to A, and n is the no. of days till the end of tally.

5- Mean germination time (MGT). The equation used to determine it is as follows, Ellis and Roberts (1981):

$$MGT = \frac{\sum Dn}{\sum n}$$

The number of seeds that germinated on a given day is denoted by (n), and the number of days from the start of germination is denoted by (D).

6- Energy of germination (EG). It was calculated using the ratio of the number of tested seeds to the percentage of seeds that germinated at the first count (3 days after planting) according to Ruan *et al.* (2002).

7- Abnormal seedlings percentage (%). Regarding to ISTA (1996), it was measured and represented as the proportion of aberrant seedlings after 6 days.

8- Hard seeds percentage (%). In respect to ISTA (1996), it was measured and represented as a percentage of hard seeds after six days.

9- Rotten seeds percentage (%). According to ISTA (1996), the number of rotting seeds was measured and given as a percentage after six days.

STATISTICAL ANALYSIS

Using the Statistix-9 computer software programme, data from each experiment involving sesame seeds were statistically analysed in accordance with the analysis of variance (ANOVA) approach for the factorial totally randomised design as described by Gomez and Gomez (1984). degree of probability of 5% to compare the means of the treatments, Duncan's multiple range tests, as specified by Duncan (1955), were utilised.

RESULTS AND DISCUSSION

1- Effect of sesame seeds type (old & new harvested seeds):

According to the findings in Tables 2, through 10, there were significant differences in G%, SGI, GI, CG, MGT, EG, abnormal seedlings, hard seeds, and rotten seeds percentage) between different types of sesame seeds, whether they were harvested recently or not. For newly harvested seeds to achieve their maximum values, G%, SGI, GI, CG, MGT, EG all considerably increased (Tables 2 through 10). On the other hand, old harvested sesame seeds had the lowest G%, SGI, GI, CG, MGT, EG values. Furthermore, for newly collected sesame seeds to meet minimal values, abnormal seedling, hard seed, and rotten seed percentages were dramatically reduced. However, the highest percentages of abnormal seedlings, hard seeds, and rotten seeds were found in old harvested sesame seeds. These characters were possessed (13.90%), (31.16%) and (1.47%) values in respectively. The decrease in germination parameters caused by using old harvested seeds may be the result of a number of metabolic defects that affect the embryonic & non-embryonic parts of the seeds, beginning respiration & subsequently decrease in seed matter, functional & nutritional properties of the seeds (Woltz and Tekrony, 2001), as well as a decrease in total carbohydrates and an increase in lipid peroxidation (Sukesh and Chandrashekar, 2011). The findings of Adebisi *et al.* (2008), Adam *et al.* (2018) and Vijaya *et al.* (2021) are well supported by these current findings in this research.

2. Effect of soaking seed treatments in some natural substances:

Averages of germination parameters (G%, SGI, GI, CG, MGT, EG, abnormal seedlings, hard seeds and rotten seeds percentage) were significantly affected by soaking

sesame seed treatments in some natural substances *i.e.* without soaking (control treatment), soaking in distilled water, yeast extract (YE) at the rates of 150 and 200 ml/L, algas extract (AE) at the rates of 100 and 150 ml/L and humic acid (HA) at the rates of 200 and 300 mg/L (Tables 2 through 10). The obtained results clearly indicated that soaking sesame seeds in humic acid (HA) at the rate of 300 mg/L were surpassed the other studied seed treatments in some natural substances in G%, SG, GI, CG, MGT & EG, with scored (89.80 and 93.9%),(27.79 & 43.80), (11.39 & 11.47), (33.05 & 33.08), (48,81 & 49.38) and 97.00 & 98.38) in both old or new harvested seeds in respectively (Tables 2 through 10). It was followed by soaking sesame seeds in humic acid (HA) at the rate of 200 mg/L in either old or new harvested sesame seeds. The arrangement of other studied soaking seed treatments in some natural substances was as follows; soaking in algas extract (AE) at the rate of 150 ml/L, algas extract (AE) at the rate of 100 ml/L, yeast extract (YE) at the rate of 200 ml/L, yeast extract (YE) at the rate of 150 ml/L and distilled water in both old or new harvested seeds. While, the lowest values of G%, (24.70 & 25.10) SGI (11.96 & 15.05) GI (2.86 & 3.65), CG (25.25 & 28.90), MGT (15.58 & 25.85) and EG (28.37 & 42.02) were produced under without soaking (untreated "control treatment"), respectively in both old and new harvested seeds. The lowest percentages of abnormal seedlings (5.79 & 3.50), hard seeds (2.75 & 0.38) and rotten seeds (0.13 & 0.00) were produced from soaking sesame seeds with humic acid (HA) at the rate of 300 mg/L, respectively in either old or new harvested seeds. Soaking sesame seeds in humic acid (HA) at the rate of 200 mg/L came in the second rank after humic acid at the rate of 300 mg/L treatment and followed by soaking sesame seeds in algas extract (AE) at the rate of 150 ml/L, then algas extract (AE) at the rate of 100 ml/L, yeast extract (YE) at the rate of 200 ml/L, yeast extract (YE) at the rate of 150 ml/L and distilled water in both old or new harvested seeds. While, the highest percentages of abnormal seedlings, hard seeds and rotten seeds were obtained from the control treatment (without soaking) in either old or new harvested seeds. These effects can be attributed to humic acid's role in promoting plant growth, which includes raising cell membrane permeability, which is crucial for the movement and availability of micronutrients. Also, root cell elongation, stimulating nutrient uptake, seed germination and viability, oxygen uptake, respiration (especially in roots), and photosynthesis, as well as the uptake of phosphate & nutrients plays a major role in improving plant growth. This is according to what the researcher indicated in his results (Chen *et al.*, 1994). Additionally, the role of algae extract is increasing cell membrane permeability and plant efficiency in nutrient uptake, such as N, which is directly related to leaf chlorophyll content. In the same context, the presence of cytokinins in algae extract may help delay the ageing of leaves by slowing down the breakdown of chlorophyll. The balance between photosynthetic and respiration activities in plants is influenced by algal extract as a bio-regulator (Raupp and Oltmanns, 2006). According to Wanas (2002), yeast extract has a positive effects could be explained by a stimulatory effect on cell growth and division as well as protein and nucleic acid synthesis. These outcomes concur with those mentioned by Barnett *et al.* (1990), Nagodawithana (1991), Chen *et al.* (1994), Zhang and Ervin (2004) and Souguir and Hannachi (2017).

3. Effect of soaking seed treatments in some chemical substances:

With regards to soaking sesame seeds in various chemical solutions, such as distilled water, chitosan at rates of 0.25 and 0.50%, ascorbic acid (AA) at rates of 100 and 200 mg/L, and salicylic acid (SA) at rates of 100 and 200 mg/L for 12 hours prior to germination testing. These obtained results were indicated that there were significant differences in germination parameters (G%, SG, GI, CG, MGT & EG, abnormal seedlings, hard seeds and rotten seeds percentage) among all studied soaking seed treatment in some chemical substances and the control treatment (untreated seeds) as presented in (Tables 2 through 10). Sesame seeds soaked in ascorbic acid (AA) at a rate of 200 mg/L prior to the start of the germination test increased G%, SG , GI , CG , MGT & EG with possessed the highest values (86.90 & 87.90), (27.30 & 41.21), (10.73 & 10.98), (32.05 & 33.19), (49.31 & 50.31) and (89.75 & 96.13) occurring in both old or new harvested seeds (Tables 2 through 10). But, after the aforementioned treatment, soaking sesame seeds in salicylic acid (SA) at a rate of 200 mg/L came in second (81.00 & 85.10), 26.45 & 40.14), (10.06 & 10.56), (31.92 & 33.06), (46.06 & 49.44) and (86.63 & 49.75), followed by soaking sesame seeds in ascorbic acid (AA) at a rate of 100 mg/L, salicylic acid at a rate of 100 ppm, chitosan at a rate of 0.50%, chitosan at 0.25%, and distilled water in both old and new harvested seeds, respectively. While, the lowest values of G% (26.10 & 56.60), SG (7.15 & 10.98), GI (2.91 & 3.05), CG (24.75 & 28.39), MGT (6.71 & 15.19) and EG (25.75 & 25.29) were obtained with (untreated "control treatment") on both old and new harvested seeds, respectively. It could be observed that soaking sesame seeds in 200 mg/L of (AA) significantly decreased the percent of abnormal seedlings, hard seeds and rotten seeds percentages and resulted in the lowest percentages in either old or new harvested seeds. Whist, soaking sesame seeds (SA) at the rate of 200 mg/L came in the second rank after previously mentioned treatment in both old or new harvested seeds. However, soaking sesame seeds in (AA) at the rate of 100 mg/L came in the third place after abovementioned treatment in either old or new harvested seeds. The remaining seed soaking arrangements might be set up as follows; soaking sesame seeds in (SA) at the rate of 100 mg/L, chitosan at the rate of 0.50 %, chitosan at the rate of 0.25 % and distilled water concerning in both old or new harvested seeds, in respectively. Although, the highest percentages of abnormal seedlings, hard seeds and rotten seeds were obtained from the control treatment (without soaking) in both old and new harvested seeds. Sesame seeds were soaked with (AA) before the germination may have had a positive outcome since AA is a crucial metabolite involved in several cellular activities, *i.e.* cell elongation. Both zygotic and somatic embryos also use AA during the early phases of germination (Arrigoni *et al*., 1997). Additionally, salicylic acid significantly increased the activities of enzymes involved in germination, regeneration, and other physiological processes in plants, which may be the cause of salicylic acid's beneficial effects. SA is a prime ingredient that works well and raises several germination characteristics, according to Eastmond and Graham (2001), the use of chitosan improves physiological reactions to abiotic stresses and lessens their negative effects by activating secondary messengers in the stress transduction pathway. The findings from each of Terry and Joyce (2004), Afzal *et al.* (2005), Sedghiet (2010), Safari *et al.* (2018), and Godinez-Garrido *et al.* (2022) are all in good agreement with the finding results, which reported in this research.

Table 2. Germination percentage as affected by type of sesame seeds (old or new harvested seeds) and soaking seed treatments in some natural and chemical substances as well as their interaction.

Character	Germination (%)								
	Soaking in naturals								
Soaking in chemicals	Without	Distilled water	Yeast extract (150 ml/L)	Yeast extract (200 ml/L)	Algas extract (100 ml/L)	Algas extract (150 ml/L)	Humic acid (200 mg/L)	Humic acid (300 mg/L)	Means of chemicals
Old harvested seeds (2020 growing season)									
Without	3.00 v	6.67 uv	10.6 tuv	13.0 s-v	12.0 s-v	28.6 o-s	34.6 n-r	62.0 g-k	26.1 f
Distilled water	4.0 uv	10.0 tuv	12.0 s-v	15.6 stu	18.6 q-u	40.0 l-p	69.0 g-j	81.0 c-g	36.6 e
Chitosan (0.25 %)	6.6 u	11.3 stu	14.0 stu	18.0 r-u	26.0 p-t	48.0 j-n	76.0 c-g	91.0 a-d	43.7 ef
Chitosan (0.50 %)	8.6 tuv	26.0 p-s	30.0 opq	51.0 i-n	38.0 nop	54.0 kl	85.0 b-f	93.0 a-d	53.7 d
Ascorbic acid (100 mg/L)	22.0 q-t	41.0 l-o	51.0 k-n	65.0 h-k	86.0 a-f	92.0 a-d	94.0 abc	97.0 ab	66.0 b
Ascorbic acid (200 mg/L)	57.0 jk	75.0 e-i	86.0 a-f	87.0 a-e	94.0 abc	95.0 abc	97.0 ab	100.0 a	86.9 a
Salicylic acid (100 mg/L)	39.0 m-p	41.0 l-o	45.0 k-o	63.0 ijk	72.0 f-i	90.0 a-d	93.0 a-d	96.0 ab	65.6 c
Salicylic acid (200 mg/L)	53.0 klm	53.0 klm	75.0 e-i	85.0 b-f	93.0 a-d	94.0 abc	95.0 abc	98.0 ab	81.0 ab
Means of naturals	24.2 f	33.0 e	40.5 d	49.7 d	55.0 c	67.70 b	80.5 a	89.8 a	55.0 b
New harvested seeds (2021 growing season)									
Without	4.0 uv	9.3 tu	11.3 s-v	12.6 s-v	14.6 r-v	17.3 q-v	69.0 fgh	75.0 c-g	56.6 f
Distilled water	5.0 uv	10.6 tuv	13.0 stu	15.0 stu	38.0 m-q	43.0 l-p	79.0 d-h	91.0 a-d	36.8 e
Chitosan (0.25 %)	8.0 u	11.3 stu	14.3 stu	20.0 r-u	49.0 i-n	66.0 f-i	91.0 abc	94.0 abc	44.2 de
Chitosan (0.50 %)	11.0 stu	14.0 stu	20.6 q-u	28.0 o-r	56.0 h-l	72.0 d-h	91.0 abc	95.0 ab	48.5 d
Ascorbic acid (100 mg/L)	50.0 i-n	64.0 g-j	75.0 c-g	76.0 c-g	71.0 e-h	88.0 a-e	94.0 ab	96.0 ab	76.8 b
Ascorbic acid (200 mg/L)	61.0g-k	74.0 c-g	88.0 a-e	90.0 abc	94.0 ab	98.0 ab	98.0 ab	100.0 a	87.9 a
Salicylic acid (100 mg/L)	39.0 l-p	49.0 i-n	63.0 g-j	71.0 e-h	64.0 ijk	85.0 b-f	92.0 a-d	96.0 ab	69.9 c
Salicylic acid (200 mg/L)	55.0 h-m	72.0 d-h	82.0 b-f	90.0 abc	89.0 a-d	97.0 ab	97.0 ab	99.0ab	85.1 ab
Means of naturals	29.1 g	38.0 f	45.9 ef	50.3 de	59.5 d	70.8 c	88.9 b	93.9 a	59.5 a

Table 3. Speed germination index (SGI) as affected by type of sesame seeds (old or new harvested seeds) and soaking seed treatments in some natural and chemical substances as well as their interaction.

Character	Speed germination index (SGI)								
	Soaking in naturals								
Soaking in chemicals	Without	Distilled water	Yeast extract (150 ml/L)	Yeast extract (200 ml/L)	Algas extract (100 ml/L)	Algas extract (150 ml/L)	Humic acid (200 mg/L)	Humic acid (300 mg/L)	Means of chemicals
Old harvested seeds (2020 growing season)									
Without	0.10 g	0.11 g	0.24 g	0.56 g	1.61 fg	2.10 efg	25.26 ab	27.20 a	7.15 c
Distilled water	0.11 g	0.11 g	0.92 fg	1.93 fg	2.19 efg	7.04 efg	26.71 a	27.44 a	8.31 c
Chitosan (0.25 %)	0.32 g	0.81 g	2.26 efg	2.43 efg	9.65 de	16.31 cd	26.71 a	27.44 a	10.74 c
Chitosan (0.50 %)	0.89 fg	1.21 fg	7.22 efg	8.44 ef	18.98 bc	25.26 ab	27.85 a	27.68 a	14.69 b
Ascorbic acid (100 mg/L)	23.23 abc	25.74 ab	26.22 ab	26.31 ab	27.11 a	27.36 a	27.52 a	28.09 a	26.17 a
Ascorbic acid (200 mg/L)	25.18 ab	27.04 a	27.36 a	27.44 a	27.44 a	27.61 a	28.01 a	28.33 a	27.30 a
Salicylic acid (100 mg/L)	21.21 abc	25.26 ab	25.33 ab	26.22 ab	26.87 a	27.11 a	27.52 a	28.01 a	25.93 a
Salicylic acid (200 mg/L)	24.61 ab	25.98 ab	26.31 ab	26.79 a	27.20 a	27.44 a	27.76 a	28.10 a	26.45 a
Means of naturals	11.96 d	13.28 cd	14.48 c	15.02 c	17.63 b	20.03 b	27.17 a	27.79 a	18.42 b
New harvested seeds (2021 growing season)									
Without	0.44 r	0.45 r	0.48 r	0.45 r	1.39 r	15.11 o	27.41 mn	42.12 a-e	10.98 e
Distilled water	0.45 r	0.50 r	2.71 qr	4.47 pqr	7.11 pq	18.42 o	38.12 c-j	42.78 a-d	14.32 d
Chitosan (0.25 %)	0.47 r	1.31 r	8.02 p	6.46 pq	9.01 p	18.60 o	37.64 e-j	42.87 a-d	15.55 d
Chitosan (0.50 %)	0.80 r	4.68 pqr	17.73 o	8.96 p	26.47 n	28.89 l-n	43.31 ab	44.30 ab	21.89 c
Ascorbic acid (100 mg/L)	27.06 mn	34.80 ijk	36.08 g-k	36.57 f-k	41.26 a-f	42.91 a-d	43.55 ab	44.54 a	38.37 ab
Ascorbic acid (200 mg/L)	34.42 ijk	38.13 c-j	39.36 b-i	40.87 a-g	43.16 abc	44.05 ab	43.77 ab	45.32 a	41.21 a
Salicylic acid (100 mg/L)	25.31 n	33.16 jkl	35.73 h-k	35.02 ijk	40.59 a-h	43.41 ab	43.36 ab	44.36 ab	37.64 b
Salicylic acid (200 mg/L)	31.61 klm	36.85 f-j	38.06 d-j	40.75 a-h	42.25 a-e	43.70 ab	44.21 ab	44.72 a	40.15 ab
Means of naturals	15.07 g	18.74 f	22.27 e	21.69 e	26.41 d	31.89 c	40.25 b	43.80 a	27.51 a

Table 4. Germination index (GI) as affected by type of sesame seeds (old or new harvested seeds) and soaking seed treatments in some natural and chemical substances as well as their interaction.

Character	Germination index (GI)								
	Soaking in naturals								
Soaking in chemicals	Without	Distilled water	Yeast extract (150 ml/L)	Yeast extract (200 ml/L)	Algas extract (100 ml/L)	Algas extract (150 ml/L)	Humic acid (200 mg/L)	Humic acid (300 mg/L)	Means of chemicals
Old harvested seeds (2020 growing season)									
Without	0.50 uv	1.03 u	1.58 s-v	1.41 s-v	1.50 s-v	3.58 o-s	4.33 n-r	9.37 c-g	2.91 f
Distilled water	0.62 uv	1.25 tuv	1.87 stu	1.62 stu	2.33 q-u	5.00 l-p	8.62 g-j	9.87 d-h	3.90 e
Chitosan (0.25 %)	1.00 u	1.41 stu	2.25 r-u	1.79 stu	2.50 r-u	6.00 j-n	9.50 c-g	11.37 abc	4.48 ef
Chitosan (0.50 %)	1.37 stu	3.25 p-s	4.75 nop	3.50 o-r	6.12 i-n	6.75 kl	10.62 b-f	11.75 abc	6.01 d
Ascorbic acid (100 mg/L)	4.87 l-p	6.12 i-n	6.62 klm	8.87 e-h	10.75 a-f	11.37 abc	11.87 abc	12.00 ab	9.06 b
Ascorbic acid (200 mg/L)	6.62 klm	9.37 e-i	10.75 a-f	11.00 a-e	11.75 abc	11.87 abc	12.00 ab	12.50 a	10.73 a
Salicylic acid (100 mg/L)	2.75 q-t	4.87 m-p	5.12 l-o	8.12 h-k	8.25 f-i	9.37 c-g	11.25 a-d	11.87 ab	7.70 c
Salicylic acid (200 mg/L)	5.12 l-o	8.00 g-j	9.37 e-i	10.62 b-f	11.62 a-d	11.62 a-d	11.75 abc	12.38 ab	10.06 ab
Means of naturals	2.86 f	4.41 e	5.29 d	5.87 ef	6.85 d	8.20 c	9.99 b	11.39 a	6.86 ab
New harvested seeds (2021 growing season)									
Without	0.50 uv	0.57 v	1.33 tuv	1.62 s-v	1.83 r-v	2.16 q-v	8.62 fgh	7.75 g-k	3.05 f
Distilled water	0.83 u	1.16 tu	1.50 s-v	1.96 stu	4.75 m-q	5.37 l-p	10.12 c-g	11.37 a-d	4.63 e
Chitosan (0.25 %)	1.08 tuv	1.33 tuv	1.75 stu	3.25 p-t	7.00 h-l	9.00 d-h	11.37 a-d	11.62 a-d	5.80 de
Chitosan (0.50 %)	1.41 stu	1.75 stu	2.58 q-u	5.62 k-o	8.00 ijk	10.62 b-f	11.50 a-d	12.00 ab	6.69 d
Ascorbic acid (100 mg/L)	6.87 h-m	7.87 g-j	7.87 ijk	9.00 f-i	9.50c-g	11.50 a-d	11.75 ab	12.12 ab	9.56 b
Ascorbic acid (200 mg/L)	7.62 g-k	9.25 c-g	10.87 a-e	11.25 abc	11.75 ab	12.25 ab	12.37 ab	12.50 a	10.98 a
Salicylic acid (100 mg/L)	3.75 opq	6.25 i-n	6.37 i-n	6.37 k-n	8.87 e-h	11.00 a-e	11.75 abc	12.12 ab	8.31 c
Salicylic acid (200 mg/L)	7.12 jk	9.00 d-h	10.25 b-f	11.12 a-d	11.25 abc	12.12 ab	12.12 ab	12.25 ab	10.65 ab
Means of naturals	3.65 g	4.65 f	5.32 d	6.27 de	7.87 c	9.25 b	11.20 a	11.47 a	7.28 a

Table 5. Co-efficient of germination (CG) as affected by type of sesame seeds (old or new harvested seeds) and soaking seed treatments in some natural and chemical substances as well as their interaction.

Character	Co-efficient of germination (CG)								
	Soaking in naturals								
Soaking in chemicals	Without	Distilled water	Yeast extract (150 ml/L)	Yeast extract (200 ml/L)	Algas extract (100 ml/L)	Algas extract (150 ml/L)	Humic acid (200 mg/L)	Humic acid (300 mg/L)	Means of chemicals
Old harvested seeds (2020 growing season)									
Without	19.15 s	21.48 qrs	21.48 qrs	21.48 qrs	22.67 pqr	29.48 d-m	29.87 c-m	32.39 a-d	24.75 d
Distilled water	19.68 rs	23.34 pq	23.67 pq	24.09 opq	27.47 lmn	30.23 b-l	30.93 a-i	32.60 abc	26.50 c
Chitosan (0.25 %)	21.48 qrs	25.51 nop	26.94 m-o	27.73 j-n	28.40 h-n	31.09 a-i	31.68 a-g	33.01 ab	28.23 c
Chitosan (0.50 %)	23.33 pq	26.98 m-o	27.66 k-n	29.18 e-m	28.79 g-m	31.30 a-h	31.85 a-f	33.10 ab	29.02 bc
Ascorbic acid (100 mg/L)	29.12 e-m	29.55 d-m	30.40 a-l	30.95 a-i	31.31 a-h	32.71 abc	33.11 ab	33.33 a	31.31 bc
Ascorbic acid (200 mg/L)	30.51 a-k	30.79 a-i	31.98 a-f	31.46 a-g	32.09 a	32.89 abc	33.33 a	33.33 a	32.05 a
Salicylic acid (100 mg/L)	28.22 i-n	28.31 h-n	29.01 f-m	30.39 a-l	30.55 a-k	32.13 a-e	33.00 ab	33.33 a	30.62 bc
Salicylic acid (200 mg/L)	30.51 a-k	30.74 a-j	31.13 a-i	31.75 a-g	31.77 a-g	32.80 abc	33.33 a	33.33 a	31.92 ab
Means of naturals	25.25 f	27.09 cd	27.78 ef	28.38 de	29.13 c	31.58 b	32.14 ab	33.05 a	29.30 b
New harvested seeds (2021 growing season)									
Without	19.87 h	26.54 fg	26.83 fg	28.12 d-g	30.58 a-e	30.94 a-e	31.82 abc	32.40 ab	28.39 c
Distilled water	25.92 g	26.85 fg	27.77 efg	31.12 a-e	31.71 abc	32.36 abc	31.72 abc	32.80 ab	30.03 bc
Chitosan (0.25 %)	26.11 g	27.77 efg	31.30 a-d	31.62 abc	33.03 ab	33.00 ab	32.39 ab	33.01 ab	31.03 c
Chitosan (0.50 %)	28.96 c-g	29.78 b-f	31.38 a-d	31.83 abc	33.07 ab	33.06 ab	33.21 a	33.11 ab	31.80 c
Ascorbic acid (100 mg/L)	32.51 ab	32.27 abc	32.59 ab	32.97 ab	33.33 a	33.33 a	33.33 a	33.33 a	32.96 ab
Ascorbic acid (200 mg/L)	33.10 ab	33.10 ab	32.64 ab	33.33 a	33.33 a	33.33 a	33.33 a	33.33 a	33.19 a
Salicylic acid (100 mg/L)	32.35 abc	31.63 abc	31.78 abc	31.87 abc	33.33 a	33.33 a	33.33 a	33.33 a	32.62 ab
Salicylic acid (200 mg/L)	32.38 ab	32.59 ab	32.98 ab	33.33 a	33.33 a	33.33 a	33.22 a	33.33 a	33.06 a
Means of naturals	28.90 de	30.07 e	30.97 cd	31.77 ab	32.71 bc	32.84 ab	32.79 a	33.08 a	31.63 a

Table 6. Mean germination time (MGT) as affected by type of sesame seeds (old or new harvested seeds) and soaking seed treatments in some natural and chemical substances as well as their interaction.

Character	Mean germination time (MGT)								
	Soaking in naturals								
Soaking in chemicals	Without	Distilled water	Yeast extract (150 ml/L)	Yeast extract (200 ml/L)	Algas extract (100 ml/L)	Algas extract (150 ml/L)	Humic acid (200 mg/L)	Humic acid (300 mg/L)	Means of chemicals
Old harvested seeds (2020 growing season)									
Without	0.83 m	0.85 m	1.50 w	3.00 uvw	3.00 uvw	3.50 m	4.50 m	44.00 hi	6.71 e
Distilled water	1.00 m	2.50 m	3.00 uvw	3.00 uvw	8.00 t-w	12.50 l	21.50 pqr	47.50 e-k	10.63 d
Chitosan (0.25 %)	2.00 m	3.00 m	6.50 uvw	12.00 stu	16.50 l	22.00 pqr	31.50 k	48.50 e-i	16.94 d
Chitosan (0.50 %)	2.33 m	3.50 m	11.50 s-v	12.00 stu	32.50 m-o	33.00 m-o	44.50 ghi	49.00 de	23.54 c
Ascorbic acid (100 mg/L)	29.00 nop	41.00 ij	43.00 ab	46.50 e-i	49.50 b-h	50.00 b	50.00 b	50.00 b	44.88 b
Ascorbic acid (200 mg/L)	44.50 ghi	48.50 b-e	49.00 d-g	49.50 d-g	50.50 b	50.50 b	50.50 b	51.00 a	49.31 a
Salicylic acid (100 mg/L)	17.50 qrs	27.00 nop	37.50 jk	38.50 klm	48.50 c-h	49.00 b-h	50.00 b	49.50 d-h	39.69 b
Salicylic acid (200 mg/L)	27.50 nop	44.50 ghi	46.50 e-i	49.00 e-i	50.00 b	50.00 b	50.50 b	50.50 b	46.06 ab
Means of naturals	15.58 f	21.36 e	23.44 d	25.94 d	30.94 c	33.81 b	37.88 a	48.81 a	29.72 b
New harvested seeds (2021 growing season)									
Without	1.00 m	1.50 m	1.50 w	2.50 vw	3.50 uvw	28.50 nop	42.50 g-l	48.00 c-h	15.19 g
Distilled water	2.33 m	3.50 uvw	4.50 m	5.00 m	10.50 s-w	39.00 j-m	47.00 d-i	48.50 c-h	18.29 fg
Chitosan (0.25 %)	4.00 m	5.00 m	10.50 s-w	16.50 rst	26.00 opq	40.00 i-m	47.50 d-h	48.50 c-h	23.44 f
Chitosan (0.50 %)	11.50 l	15.00 l	28.50 nop	31.50 k	36.00 lmn	47.50 e-k	48.50 c-h	48.50 c-h	33.38 e
Ascorbic acid (100 mg/L)	48.00 e-j	48.00 e-j	49.50 b-h	49.50 e-h	46.50 f-k	49.00 e-i	49.50 bc	50.00 b	48.75 c
Ascorbic acid (200 mg/L)	49.50 d-h	50.00 b	50.00 b	50.00 b	50.50 d-h	50.50 a	51.00 d-g	51.50 a	50.31 a
Salicylic acid (100 mg/L)	41.50 h-m	44.50 g-l	45.50 f-k	47.50 d-h	46.00 f-i	47.50 e-k	49.00 b-h	50.00 b	46.44 d
Salicylic acid (200 mg/L)	49.00 cd	50.00 b	50.00 b	50.00 b	49.50 d-g	50.00 d-h	50.50 b-g	50.50 b	49.44 b
Means of naturals	25.85 f	26.75 e	28.50 d	31.25 c	31.81 c	44.00 b	48.19 a	49.38 a	35.72 a

Table 7. Energy of germination (EG) as affected by type of sesame seeds (old or new harvested seeds) and soaking seed treatments in some natural and chemical substances as well as their interaction.

Character	Energy of germination (EG)								
	Soaking in naturals								
Soaking in chemicals	Without	Distilled water	Yeast extract (150 ml/L)	Yeast extract (200 ml/L)	Algas extract (100 ml/L)	Algas extract (150 ml/L)	Humic acid (200 mg/L)	Humic acid (300 mg/L)	Means of chemicals
Old harvested seeds (2020 growing season)									
Without	0.60 u	0.66 u	1.00 tu	1.00 tu	1.33 tu	29.00 pq	78.00 d-i	93.00 a-d	25.57 e
Distilled water	0.66 u	1.33 tu	5.00 stu	11.00 r-u	14.00 q-u	40.00 op	49.66m-o	95.00 abc	27.08 de
Chitosan (0.25 %)	1.33 tu	3.00 tu	20.00 qrs	21.00 qrs	23.00 qr	51.0 m-o	83.00 b-h	95.00 abc	37.17 c
Chitosan (0.50 %)	1.33 tu	14.00 q-u	17.00 q-t	55.00 l-o	56.00 k-o	46.00 no	97.00 ab	97.00 abc	47.92 c
Ascorbic acid (100 mg/L)	46.00 no	72.00 g-k	74.00 e-j	74.00 e-j	90.00 a-e	96.00 abc	97.00 ab	99.00 ab	81.00 ab
Ascorbic acid (200 mg/L)	71.00 h-l	78.00 d-i	86.00 a-h	90.00 a-e	95.00 abc	98.00 ab	99.00 ab	100.0 a	89.75 a
Salicylic acid (100 mg/L)	45.00 nop	63.00 i-m	71.00 h-l	73.00 f-j	88.00 a-g	95.00 abc	95.00 abc	98.00 ab	78.50 b
Salicylic acid (200 mg/L)	61.00 j-n	76.00 e-j	80.00 c-h	89.00 a-f	93.00 a-d	97.00 ab	98.00 ab	100.0 a	86.63 ab
Means of naturals	28.37 g	38.50 f	44.25 e	51.75 e	57.54 d	69.00 c	87.21 b	97.00 a	59.20 b
New harvested seeds (2021 growing season)									
Without	0.65 h	0.66 h	1.00 h	2.00 h	6.00 h	8.00 h	88.00 bcd	96.00 abc	25.29 d
Distilled water	0.66 h	0.66 h	3.66 h	7.00 h	8.00 h	25.00 g	94.00 abc	97.00 abc	29.50 c
Chitosan (0.25 %)	1.00 h	3.00 h	8.00 h	8.00 h	32.00 g	62.00 f	94.00 abc	97.00 abc	38.13 d
Chitosan (0.50 %)	3.00 h	4.00 h	23.00 g	27.00 g	62.00 f	89.00 a-d	97.00 abc	98.00 ab	50.38 b
Ascorbic acid (100 mg/L)	75.00 e	91.00 a-d	93.00 a-d	93.00 a-d	96.00 abc	97.00 abc	98.00 ab	99.00 a	92.88 a
Ascorbic acid (200 mg/L)	88.00 bcd	95.00 abc	96.00 abc	97.00 abc	97.00 abc	97.00 abc	99.00 ab	100.00 a	96.13 a
Salicylic acid (100 mg/L)	82.00 de	89.00 a-d	90.00 a-d	93.00 a-d	95.00 abc	96.00 abc	98.00 ab	99.00 ab	92.75 a
Salicylic acid (200 mg/L)	86.00 cde	92.00 a-d	93.00 a-d	95.00 abc	96.00 abc	97.00 abc	99.00 ab	100.0 a	94.75 a
Means of naturals	42.04 f	46.92 e	50.96 d	52.75 d	61.50 c	71.38 b	95.88 a	98.38 a	64.97 a

Table 8. Abnormal seedlings percentage (%) as affected by type of sesame seeds (old or new harvested seeds) and soaking seed treatments in some natural and chemical substances as well as their interaction.

Character	Abnormal seedlings percentage (%)								
	Soaking in naturals								
Soaking in chemicals	Without	Distilled water	Yeast extract (150 ml/L)	Yeast extract (200 ml/L)	Algas extract (100 ml/L)	Algas extract (150 ml/L)	Humic acid (200 mg/L)	Humic acid (300 mg/L)	Means of chemicals
Old harvested seeds (2020 growing season)									
Without	59.00 a	41.00 b	40.00 b	31.00 a-d	28.00 a-e	27.00 a-f	24.33 c-g	22.33 c-h	34.08 a
Distilled water	57.00 a	39.00 bc	36.00 bcd	21.00 c-i	19.00 d-i	18.00 e-j	18.00 e-j	13.00 g-m	27.63 ab
Chitosan (0.25 %)	34.00 bcd	33.00 bcd	29.00 de	19.00 d-i	17.00 e-k	13.00 g-m	13.00 g-m	5.00 k-n	20.38 b
Chitosan (0.50 %)	30.00 cde	29.00 de	23.00 ef	13.00 g-m	12.00 g-n	11.00 h-n	5.00 k-n	3.00 lmn	15.75 bc
Ascorbic acid (100 mg/L)	14.66 f-l	10.00 h-n	5.00 k-n	2.00 jkl	0.00 l	0.00 l	0.00 l	0.00 l	4.08 bc
Ascorbic acid (200 mg/L)	5.00 k-n	1.00 mn	1.00 kl	1.00 kl	0.00 l	0.00 l	0.00 n	0.00 l	1.00 c
Salicylic acid (100 mg/L)	17.00 e-k	10.00 h-n	10.00 h-n	3.00 i-l	3.00 i-l	2.00 jkl	2.00 jkl	2.00 jkl	6.13 bc
Salicylic acid (200 mg/L)	10.00 h-n	6.00 j-n	1.00 mn	1.00 kl	0.00 l	0.00 l	0.00 l	0.00 l	2.31 bc
Means of naturals	28.33 a	21.13 ab	18.00 ab	11.13 b	10.00 c	9.00 c	7.79 cd	5.79 d	13.90 a
New harvested seeds (2021 growing season)									
Without	39.00 a	38.00 ab	33.00 abc	28.00 de	23.00 ef	18.00 fgh	18.00 fgh	12.00 ghi	26.13 a
Distilled water	31.00 a-d	27.00 a-f	26.00 b-f	21.00 efg	18.00 fgh	10.00 h-k	9.00 h-l	9.00 h-l	18.88 b
Chitosan (0.25 %)	22.33 c-h	21.00 c-i	19.00 d-i	11.00 hij	9.00 h-l	7.00i-l	7.00 i-l	3.00 i-l	12.42 bc
Chitosan (0.50 %)	22.00 c-h	20.00 d-i	16.00 e-k	8.00 i-l	6.00 i-l	6.00 i-l	3.00 i-l	2.00 jkl	10.38 c
Ascorbic acid (100 mg/L)	5.00 i-l	3.00 i-l	2.00 jkl	2.00 mn	0.00 n	0.00 n	0.00 n	0.00 n	2.13 de
Ascorbic acid (200 mg/L)	1.00 mn	1.00 mn	1.00 mn	1.00 mn	0.00 n	0.00 n	0.00 n	0.00 n	0.37 e
Salicylic acid (100 mg/L)	5.00 i-l	5.00 i-l	4.00 i-l	10.00 h-n	9.00 i-n	6.00 j-n	2.00mn	1.00 mn	5.25 d
Salicylic acid (200 mg/L)	4.00 i-l	1.00 kl	1.00 kl	1.00 mn	0.00 n	0.00 n	0.00 n	0.00 n	0.88 e
Means of naturals	16.04 a	14.38 ab	12.63 ab	10.13 b	8.38 bc	6.00 c	5.00 d	3.50 d	9.51 b

Table 9. Hard seeds percentage (%) as affected by type of sesame seeds (old or new harvested seeds) and soaking seed treatments in some natural and chemical substances as well as their interaction.

Character	Hard seeds percentage (%)								
	Soaking in naturals								
Soaking in chemicals	Without	Distilled water	Yeast extract (150 ml/L)	Yeast extract (200 ml/L)	Algas extract (100 ml/L)	Algas extract (150 ml/L)	Humic acid (200 mg/L)	Humic acid (300 mg/L)	Means of chemicals
Old harvested seeds (2020 growing season)									
Without	92.33 a	90.0 a	90.0 a	81.00 cd	80.00 ab	80.00 de	51.00 gh	6.00 m	71.29 a
Distilled water	88.00 ab	87.00 ab	86.00 ab	84.00 cd	83.00 cd	51.00 hij	8.00 m	4.00 opq	61.38 b
Chitosan (0.25 %)	85.00 bc	86.00 bc	77.00 de	70.00 ef	53.00 hi	42.00 ijk	7.00 m	3.00 opq	52.88 c
Chitosan (0.50 %)	67.00 fg	62.00 gh	50.00 hi	39.00 jk	36.00 k	11.0 m	6.00 m	3.00 opq	34.25 c
Ascorbic acid (100 mg/L)	19.00 lm	12.00 m	7.00 m	5.00 n	5.00 n-q	3.00 opq	4.00 opq	2.00 pq	7.13 e
Ascorbic acid (200 mg/L)	14.00 m	4.00 opq	4.00 opq	2.00 p	2.00 pq	1.00 pq	1.00 pq	0.00 q	3.50 e
Salicylic acid (100 mg/L)	37.00 k	29.00 kl	16.00 l	9.00 m	6.00 m	5.00 no	4.00 opq	2.00 pq	13.50 d
Salicylic acid (200 mg/L)	18.00 lm	8.00 m	5.00 n	4.00 opq	2.00 p	2.00 pq	2.00 pq	2.00 pq	5.38 e
Means of naturals	52.54 a	47.25 b	41.88 c	36.75 c	33.38 c	24.38 d	10.38 e	2.75 f	31.16 a
New harvested seeds (2021 growing season)									
Without	91.00 a	88.0 a	88.00 ab	88.00 ab	88.00 ab	88.00 ab	13.0 m	1.00 l	68.00 a
Distilled water	90.00 a	85.00 bc	81.00 cd	70.00 ef	65.00 f	33.00 ij	2.00 l	1.00 l	53.38 b
Chitosan (0.25 %)	90.00 a	83.00 ab	62.00 fg	44.00 hi	30.00 j	20.00 jk	1.00 l	1.00 l	41.38 b
Chitosan (0.50 %)	85.00 bc	30.00 j	28.00 j	10.00 kl	4.00 l	2.00 l	1.00 l	1.00 l	20.00 c
Ascorbic acid (100 mg/L)	2.00 l	2.00 l	1.00 l	1.00 l	0.00 l	0.00 l	0.00 l	0.00 l	1.00 d
Ascorbic acid (200 mg/L)	1.00 l	1.00 l	1.00 l	1.00 l	0.00 l	0.00 l	0.00 l	0.00 l	0.50 d
Salicylic acid (100 mg/L)	8.00 j	4.00 l	2.00 l	2.00 l	2.00 l	1.00 l	1.00 l	0.00 l	2.50 d
Salicylic acid (200 mg/L)	2.00 l	1.00 l	1.00 l	1.00 l	0.00 l	0.000 l	0.00 l	0.00 l	0.63 d
Means of naturals	45.88 a	36.63 b	32.88 b	27.00 b	23.75 c	18.13 d	2.25 e	0.38 e	23.36 b

Table 10. Rotten seeds percentage (%) as affected by type of sesame seeds (old or new harvested seeds) and soaking seed treatments in some natural and chemical substances as well as their interaction.

Character	Rotten seeds percentage (%)								
	Soaking in naturals								
Soaking in chemicals	Without	Distilled water	Yeast extract (150 ml/L)	Yeast extract (200 ml/L)	Algas extract (100 ml/L)	Algas extract (150 ml/L)	Humic acid (200 mg/L)	Humic acid (300 mg/L)	Means of chemicals
Old harvested seeds (2020 growing season)									
Without	35.00 a	10.00 c	6.00 d	4.00 b	2.00 fg	2.00 cd	1.00 de	1.00 de	7.63 a
Distilled water	25.00 b	3.00 ef	1.00 gh	2.00 cd	0.00 h	0.00 e	0.00 e	0.00 e	3.88 ab
Chitosan (0.25 %)	1.00 de	1.00 de	0.00 e	0.00 h	0.00 e	0.00 h	0.00 h	0.00 h	0.25 b
Chitosan (0.50 %)	0.00 h	0.00 h	0.00 h	0.00 e	0.00 h	0.00 e	0.00 e	0.00 e	0.00 b
Ascorbic acid (100 mg/L)	0.00 h	0.00 h	0.00 h	0.00 e	0.00 h	0.00 e	0.00 e	0.00 e	0.00 b
Ascorbic acid (200 mg/L)	0.00 h	0.00 h	0.00 h	0.00 e	0.00 h	0.00 e	0.00 e	0.00 e	0.00 b
Salicylic acid (100 mg/L)	0.00 h	0.00 h	0.00 h	0.00 e	0.00 h	0.00 e	0.00 e	0.00 e	0.00 b
Salicylic acid (200 mg/L)	0.00 h	0.00 h	0.00 h	0.00 e	0.00 h	0.00 e	0.00 e	0.00 e	0.00 b
Means of naturals	7.63 a	1.75 b	0.88 bc	0.75 bcd	0.25 d	0.25 d	0.13 d	0.13 d	1.47 a
New harvested seeds (2021 growing season)									
Without	12.00 a	4.00 b	4.00 e	3.00 bc	2.00 cd	0.00 h	0.00 h	0.00 h	3.13 a
Distilled water	3.00 bc	2.00 cd	1.00 gh	2.00 cd	0.00 e	0.00 h	0.00 h	0.00 h	1.00 b
Chitosan (0.25 %)	1.00 de	0.00 h	0.00 h	0.00 h	0.00 h	0.00 e	0.00 e	0.00 e	0.13 bc
Chitosan (0.50 %)	0.00 e	0.00 e	0.00 h	0.00 e	0.00 e	0.00 h	0.00 h	0.00 h	0.00 c
Ascorbic acid (100 mg/L)	0.00 e	0.00 e	0.00 h	0.00 e	0.00 e	0.00 h	0.00 h	0.00 h	0.00 c
Ascorbic acid (200 mg/L)	0.00 e	0.00 e	0.00 h	0.00 e	0.00 e	0.00 h	0.00 h	0.00 h	0.00 c
Salicylic acid (100 mg/L)	0.00 e	0.00 e	0.00 h	0.00 e	0.00 e	0.00 h	0.00 h	0.00 h	0.00 c
Salicylic acid (200 mg/L)	0.00 e	0.00 e	0.00 h	0.00 e	0.00 e	0.00 h	0.00 h	0.00 h	0.00 c
Means of naturals	2.00 a	0.75 b	0.63 b	0.63 b	0.25 c	0.00 c	0.00 c	0.00 c	0.53 b

4. Effect of interactions:

Regarding how soaking seed treatments in some natural and chemical substances interacts, it were presented in Tables 2 through 10. The obtained results clearly showed that the germination parameters (G %, SGI, GI, CG, MGT, EG, percentage of abnormal seedlings, hard seeds and rotten seeds percentages) were significantly affected by the interaction between soaking seed treatments in some natural and chemical substances in both old or new harvested seeds. From the obtained results, the highest values of G %, (100.00 & 100.00), SGI (28.33 & 45.32), GI (12.50 & 12.50), CG (33.33 & 33.33), MGT (51.00 & 51.50), and EG (100.00 & 100.00) were resulted from soaking sesame seeds in 300 mg/L of (HA) and 200 mg/L of (AA) for 12 hours in both old or new harvested seeds (Tables 2 to 10). However, soaking sesame seeds in 300 mg/L of (HA) and 200 mg/L of (SA) came after the previously mention interaction treatment, and followed the interaction of 200 mg/L of (HA) and 200 mg/L of (AA) in both old and /or new harvested seeds. In contrast, the control treatment (without soaking seeds in natural or chemical substances) produced the lowest values of G %, SGI, GI, CG, MGT, EG, in both old and new harvested seeds. The sesame seeds soaked in 200 or 300 mg/L of (HA), 100 or 150 ml/L of algal extract, 100 or 200 mg/L of (AA) or 200 mg/L of (SA) produced the lowest percentages of abnormal seedlings, hard seeds, and rotten seeds (Tables 2 through 10). These results were obtained from both old and new harvested sesame seeds. In contrast, the largest percentages of abnormal seedlings, hard seeds, and rotting seeds were seen when seeds were not pretreated with any natural or artificial agents (control treatment), whether they were gathered from old or young plants.

CONCLUSION

In order to improve the germination characteristics of some old and harvested sesame seeds it should be soaked in solution containing 300 mg/L of humic acid (HA) and 200 mg/L of ascorbic acid (AA) for about 12 hours.

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دراسة أمكانية تحسين صفات إنبات بذور السمسم القديمة والحديثة الحصاد باستخدام بعض المواد الطبيعية والكيميائية

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الملخص

أجريت تجربة معملية بقسم المحاصيل، بكلية الزراعة، جامعة المنصورة، مصر، خلال شهر مايو 2022م بهدف تحسين صفات إنبات بذور السمسم قديمة وحديثة الحصاد لصنف شندويل-3 باستخدام بعض المواد الطبيعية (بدون، النقع فى الماء المقطر، مستخلص الخميرة بمعدل 150 و 200مل / لتر، مستخلص الطحالب بمعدل 100 و200 مل / لتر وحمض الهيوميك بمعدل 200 و300 ملجم / لتر) والكيميائية (بدون، النقع فى الماء المقطر، الشيتوزان بمعدل 0.25 و0.50 ٪، حمض الأسكوربيك بمعدل 100 و200 ملجم / لتر وحمض الساليسيليك بمعدل 100 و200 ملجم / لتر. تم زراعة كل نوع من أنواع بذور السمسم (البذور القديمة أو حديثة الحصاد) في تجربة منفصلة. تم إجراء كل تجربة لنوعي البذور في تجربة عاملية ذات تصميم تام العشوائية. تضمن العامل الأول ثمانية معاملات لنقع البذور في بعض المواد الطبيعية. أما العامل الثاني فقد اشتمل على ثمانية معاملات لنقع البذور في بعض المواد الكيميائية. وقد تم الحصول على أعلى القيم لصفات النسبة المئوية للإنبات، معدل سرعة الإنبات، معدل الإنبات، معامل الإنبات، متوسط زمن الإنبات، طاقة الإنبات، وأقل القيم لصفات النسبة المئوية للبادرات الغير طبيعية، البذور الصلدة والبذور العفنة من بذور السمسم حديثة الحصاد، نقع بذور السمسم في حمض الهيوميك بمعدل 300 ملجم / لتر ونقع بذور السمسم فى حمض الهيوميك بمعدل 300 ملجم / لتر. هذا ولقد تم التوصية أنه لتحسين صفات الإنبات لتقاوي السمسم، يمكن التوصية يجب نقع البذور في حمض الهيوميك بمعدل 300 ملجم / لتر وحمض الأسكوربيك بمعدل 200 ملجم / لتر لمدة 12 ساعة لكل من البذور القديمة وحديثة الحصاد.