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Responding Oil Seeds Germination Indices to Ultrasonic Waves

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ABSTRACT

According the reduction of edible oil produced in Egypt. It can be used the ultrasound encouragement as a biophysical factor, for seed vitality stimulating. Seeds of soybean and sunflower, were treated by calibrated ultrasound generator, designed and assembled locally, varying two factors, different levels of ultrasonic waves frequency "USF"(20, 30 and 40 kHz) and different exposer time "ET" (0, 10, 20 and 30 min). Seeds were grown till germination ceased, under laboratory conditions to determine their response to USF& ET. Results, were evaluated in terms of the final germination percentage "FGP" (%), germination speed "GRI" (seed day^{-1}), germination energy "GE" (%), and seedling vigor index I (SVI) using split plot design. Results affirmed that ultrasonic treatments have a bio-positive significant effect on measuring indices. The germination period for all treated seeds reduce about 33.34% compared with the control. The USF had direct relations with all parameters, while, the ET has a constrictive effect on all parameters till 20min. Except GE, prolonged ET more than 20 min. reduced all other indices. The highest FGP, GR and GE for soybean and sunflower seeds were (94 and 90%), (50.20 and18.75 seed d^{-1}), and (89.36 and 93.33%) followed 20 min. & 40 kHz. While, the maximum values for SVI (655.20 and 490.20) was obtained at 30min. & 40 kHz. This study confirms that ultrasound applied in agriculture may contribute to the improvement of agro-biological indicators, i.e., FGP, GRI, GE, and SVI for soybean and sunflower seeds.

Keywords: Ultrasound, frequencies, exposure time, germination indices, soybean, sunflower.

INTRODUCTION

In Egypt it is inevitable to use new technologies in order to expand and raise the oil crops productivity. In orded to, counter the massive deficit in the edible oil production. Where, the self-sufficiency of edible oils is only about 2%.

Globally, the soybeans or "Golden bean" and sunflower are ranked the second and fourth most important oil seed crop after cotton and rapeseed, as the most profitable and economic oil seed crop. This, beside they are entry into the components of the several food and feed industries, as well as, they are well cultivated in new (reclaimed) lands (Adeleke and Babalola, 2020).

For high yields and to reduce toxin contamination of food production's raw materials along the supply chain, the agro-environmental farming system replaces chemical amelioration with physical one, i.e., magnetic fields, ultrasound waves "USW", and radiations of microwave, laser, and gamma (El- Bialee and Nawito, 2020). This increases food safety (Aladjadjiyan, 2011).

The sound wave is a type of biotic stress for plants since sound waves are one of the physical signals (Jaime et al., 2014). According to Yusaf and Al-Juboori (2014), the technology known as ultra-sonication uses ultrasound to interact with the materials. According to Nazari and Eteghadipour (2017), the USW is a mechanical wave (longitudinal pressure wave) that falls inside the threshold of human hearing (F 20 kHz). It has numerous applications in the fields of industry, biotechnology, medicine, and materials science (Kwiatkowska et al., 2011). It is also a revolutionary processing technique used in a variety of agricultural and food-related industries, such as food processing (Miano et al., 2016) and improving drying rates (Jambrak et al., 2007).

On the one hand, seed germination is the vital period of plant survival (Sharififar et al., 2015), and on the other hand, under unfavorable conditions, particularly under the drought conditions present in arid and semi-arid regions, rapid germination and seedling emergence were the most important stages for plant establishment (Shekari et al., 2015).

The positive benefits of sonication on encouraging the final germination percentage "FGP", the accelerating of germination speed "GRI", the length of plumule, and other traits have been addressed in a number of earlier definitive investigations. Researchers recommended using ultrasonic waves with a frequency "USF" of 10–100 kHz and exposure duration "ET" of 1–60 min (Rokhina et al., 2009 and Aladjadjiyan, 2012). According to these recommendations, Bird's-foot trefoil (*Lotus corniculatus* L.), switch grass (*Panicum virgatum* L.), and sesame (*Sesamum indicum* L.) seeds' germination performance was enhanced by the "USW" application (Toth, 2012; Wang et al., 2012; and Shekari et al., 2015). Furthermore, Liu et al. (2016) demonstrated that the USW had a favourable impact on the FGP of Russian wild rye (*Psathyrostaehys juncea Nevski*) and aged tall fescue (*Festuca arundinacea*). Other research (Risca et al., 2007, Shin et al., 2011, and Ciu and Song, 2014) revealed that the USW promoted faster GRI in Norway spruce (*Picea abies* L.), orchids (*Calanthe hybrids*), and pea (*Pisum Sativum*).

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The effectiveness of the USW in boosting the GRI of great saltbush (*Atriplex lenti*), cumin (*Cuminum cyminum*), and caper beans (*Zygophyllum eurypterum*) was demonstrated by Sharififar et al., 2015. Similar to this, Miano et al., 2016 found that sonication can boost mung bean (*Vigna radiata*) seed GRI by 25%. To sum up, sonication considerably raises both the FGP and the GRI in all of the species that have been examined thus far. In this respect, Aladjadjiyan 2012 reported that, the effects of USW on seeds FGP and GRI depend on USF and ET, as well as, seem to differ significantly between various plant species and cultivars.

According to many researshes, poor germination resulted from hard coate seeds (Sharififar et al., 2015). Therefore, exposing seeds by the USW alters the seed's characteristics, resulting in enhancing imbibition (Nazari and Eteghadipour, 2017), followed by it release of plant growth hormones from the cell wall (Babaei- Ghaghelestany et al., 2020), biochemical metabolism (Chiu, 2021), and transport (Zeid and Shedeed, 2006), increasing the rate of starch hydrolysis (Kratovalieva et al., 2012). Consequently, it is followed by promoting cell growth and increases in the seed FGP and GRI (Yaldagard et al., 2008b). In connection with obvious conclusion, Tabatabaie and Mortazavi, 2008 showed that sonication caused micro-pores in plant cell walls, micro-cracks and micro-voids were formed on bacterial cell walls leading to increasing cell volume and size. Also, Lahijanian and Nazari, 2017 found that, the sonication led to enlargement cotyledon cell area of common bean seeds.

In view of the foregoing, the purpose of this work was to show the responding of some germination indices, such as seedling vigour index I, and the final percentage, speed, and energy of germination for soybean and sunflower seeds, responded to the effects of ultrasonic waves at different levels of waves frequency and exposure time).

MATERIALS AND METHODS

The experiments were performed in November, 2022 at one of the laboratories of Field Crop Research Institute, Agricultural Research Center (ARC), Giza. Egypt.

1. Ultrasonic generator:

Samples of seed were pretreated with USW, which was produced through local ultrasonic generator. The circuit was designed, assembled, and calibrated by Abd El-Rahman, 2019. The circuit specifications are; the operating volt is 12V/DC. Current consumption < 60 mA. Max. sound pressure: 100dB. Maxim. louds peaker's beam angle:140°. Vision range: 40 m. It is capable to produce USW at different frequency levels of 20, 30, and 40 kHz, with a constant power ≈ 40 W (Fig.1).

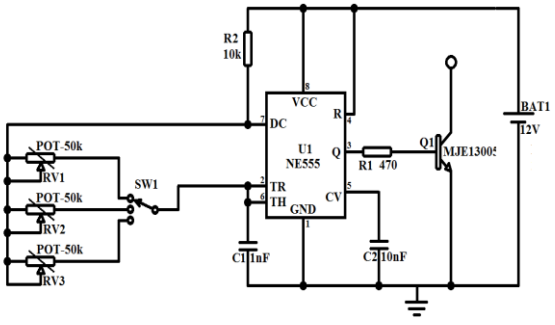

Fig. 1. Ultrasonic generator circuit

2. Seed materials and preparation:

Two different dray - oil native seeds of local cultivars, belonging to diverse plant families (Leguminosae and Asteraceae), produced in the same year that investigate was undertaken, denoted by the Agriculture Research Center (ARC). Seeds of soybean (Glycine max) cv. Giza 111 and sunflower (Helianthus annuus) cv. Sakha 53, with a moistures content of about 7.5% and 6.5% for soybean and sunflower seeds. Seeds of the same size were selected, excluding immature and damaged seeds. Then, they were soaked in a solution of one part sodium hypochlorite (NaOCl, 12.5% w/v) and two parts water for 10 minutes, to disinfect them, followed by rinsing with distilled water three times.

3. Pretreated seeds:

The experimental tests were performed with 100 seeds for each treatment (ten replicates of ten seeds per replicate) in sterilized Petri dishes. The seeds of each treatment were independently exposed to ultrasound at different frequencies "USF", of 20, 30 and 40 kHz, with exposure times "ET" of 0, 10, 20 and 30 minutes.

4. Germination tests:

The germination test was conducted immediately after pretreating the seeds under laboratory conditions. After each ultrasound treatment, the seeds were placed between folded germination filter papers (Albet 150, Albet Lab Science, Germany) moistened with 10 mL of distilled water. These papers with the seeds were then placed in labeled and covered 9-cm sterilized Petri dishes to prevent moisture loss. The Petri dishes were kept in a dark incubator at a constant temperature of approximately 20°C (ISTA, 1996). Daily, germinated seeds were counted, and the plumule length was measured using a digital caliper with accuracy of 0.01mm, and recorded, then removed, until germination ceased after (6 days). Germination was considered to have occurred when the radicle tip had grown more than 2.0 mm free of the seed coat (Shekari et al., 2015).

5. Germination performance measurements

So, as to guess the influence of ultrasonic treatment (USF and ET) on the morphology of soybean and sunflower seeds, and explore the possible relations to the early stage development, several germination indices were used, i.e., the final germination percentage "FGP" (%), germination speed "GRI" (seed day^{-1}), germination energy of seeds "GE" (%), and seedling vigor index I (SVI) and calculated as hereinafter equations.

$$FGP = \frac{G}{N} \times 100 \quad \text{……..……(1) } \textit{(Sharififar et al., 2015).,}$$

$$GRI = \frac{G_1}{d_1} + \frac{G_2}{d_2} + \frac{G_3}{d_3} + \cdots + \frac{G_n}{d_n} \quad \text{…..(2) } \textit{(Lahijanian and Nazari, 2017).,}$$

$$GE = \frac{G_1 + G_2 + G_3}{d_3} \quad \text{……(3) } \textit{(Aladjadjiyan, 2011).,}$$

$$SVI = FGP \times SL \quad \text{……(4) } \textit{(Bajji et al., 2002).}$$

Where:

G is the number of germinated seeds in each treatment; N is the number of total seeds used in bioassay (= 100 seed); G_1, to G_n,= number of seeds germinated on first, second and n^{th} day; d_1 to d_n = number of days from sowing to first, second,…and n^{th} count, respectively or number of days after seeding; and SL= the seedling length (mm).

6. Data analysis

Data were subjected to analysis of variance (ANOVA) according to the procedure of Snedecor and Cochran, 1982. The experimental design is a split-plot design in a completely randomized design, with ten replicates and two factors. The main factor was "USF", and the split factor "ET". The Mean comparison between treatments and their

interactions was determined using least significant difference (LSD- test) based on probability level of $P \leq 0.05$.

RESULTS AND DISCUSSION

1. Effects of USF and ET on final germination percentage

The germination period lasted 6 days for untreated seeds of soybean, where, germination did not start within 48 h., of the sowing process. Meanwhile, in the case of treated seeds, the germination process started after 24 h., of sowing. The germination period took only 4 days for the treated seeds at 20 kHz & 10 and 20 min., and at 40 kHz & 10 and 30 min. While, the germination period lasted about 5 days in the rest of the treatments, except in the case of treated seeds at 20 kHz &30 min, where, the germination process was begun after 48h of sowing.

On the other hand, only 5 days is the germination period of untreated sunflower seeds and treated seeds at 20 kHz & 20 min, 30 kHz & 20 and 30min and at 40 kHz &10 min. As for the rest of the treatments, the germination process took about 4 days only. The germination process of sunflower seeds began 24h after the sowing process, except in the case of treated seeds at 20 kHz & 30 min, which started after 48 h of the sowing process.

All the ultra-sonication treated seeds (USF and ET) of soybean and sunflower showed improved the FGP in comparison to their respective controls. Where, the FGP in the control sample (C) for the soybean and sunflower were the lowest (62 and 70%).

Pretreating seeds of soybean and sunflower with USF increases their FGP (Fig. 2 a and b). However, 40 kHz treated seeds performed better than the 20 and 30 kHz, treated seeds at all ET.

Likewise, the FGP increased with increasing the ET, reaching the maximum limit of ET 20min. Consequently, the highest value of FGP (94 and 90%) was recorded at 40 kHz &20min. for soybean and sunflower seeds. This value of FGP was approximately 51.61 and 28.57% above that of the control seeds.

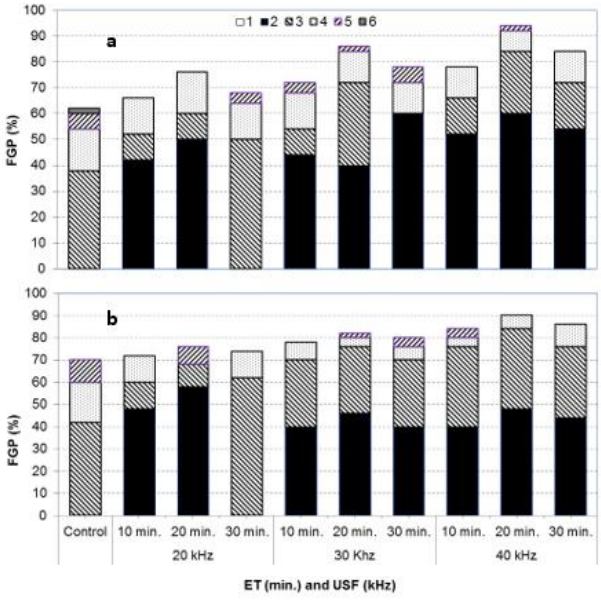

Fig. 2. Relationship between FGP for seeds of; a) soybean, and b) sunflower, Vs. ET and USF during 6 days of germination.

For soybean seeds, the FGP increased 9.09 and 8.33%, 13.16 and 9.30%, and 14.71 and 7.69% by increasing USF from 20 to 30 and from 30 to 40 kHz at ET 10, 20 and 30min. respectively. While, The FGP of treated seeds increased with increasing ET till 20min. Where, it increased from 66 to 76%, 72 to 86%, and 78 to 94% by increasing ET from 10 to 20 min., at 20, 30 and 40 kHz., respectively. These FGP values were approximately 22.58, 38.71, and 51.61% above that of the control treatment. Nevertheless, prolonged ET more than 20min. (≈ 30 min), resulting in reducing the FGP value significantly, nearly 10.52, 10.25, and 10.64% in 20, 30 and 40 kHz respectively. On the other hand, ET for 30 min., encouraged FGP more than the control, but to a lesser extent than 10 or 20 min.

However, sunflower seeds showed a similar germination pattern. Where, the FGP was increased with increasing USF and ET till 20 min., also, reaching the limit (≈ 90%) at 40 kHz & 20 min. This FGP value was approximately 28.57% above that of the control seeds (70% FGP). Furthermore, at all of the USF, long ET (> 20 min.) had lowest FGP compared with ET 20min. but it's steel more than untreated seeds and treated seeds with ET 10min. Where, the FGP reduced about 2.6, 2.4 and 4.44% compared with ET 20 min. at USF 20, 30 and 40 kHz., respectively.

In agreement with these results, the FGP enhanced by USW application had been reported by Aladjadjiyan, 2002 on (*Zea mays* L.), Yaldagard *et al*., 2008 a and b on barley (*Hordeum vulgar L.*), Goussous *et al*., 2010 on chickpea (*Cicer arietinum*), wheat (*Triticum aestivum*), and watermelon (*Citrullus vulgaris*), and Ramteke *et al*., 2015 on *Lycopersicon esculentum* and *Anethum graveolens*. On the other hand, these results have been dissimilar than which reported by Lahijanian and Nazari, 2017, and Ribera and Carlos, 2017. They declared that the FGP of treated Common Bean seeds (*Phaseolus vulgaris) and A. thaliana* L. seeds insignificantly ($P \leq 0.05$) affected by ET (10, 20, and 30min.)

2. Effects of USF and ET on germination speed

In fig. 3. A germination speed "GRI" increase was noted in ultrasound treatments "US". Where, GRI was significantly affected by ultrasound treatments. The highest GRI for soybean and sunflower seeds (50.20 and 18.75 seed d^{-1}) followed 20 min with 40 kHz., while, the control seeds, ranked last in terms of GRI (9.10 and 10.25 seed day^{-1}) with the same arrangement.

Initially, both GRI curves of 10 and 30 min. were lower than 20min., where, seeds exposed for 20min. has the heights GRI at all USF.

For soybean seeds, the GRI accelerates significantly with increasing ET from 10 to 20 min. at all USF levels. This accelerate was slightly (16.16%), at USF 20 kHz and sharply (149.86 and 198.27%) at USF 30 and 40 kHz. Meanwhile, there is a sharp reduction in the GRI with a rose in the ET, from 20 to 30min. and the decline is about 35.18, 53.82, 64.14 % at USF 20, 30, and 40 kHz, respectively. Over and above, GRI has a direct proportion with USF at all ET levels. Where, the relationship can be approximated as;

GRI ≈ $11.39e^{0.0095}$USF at ET 10 minute, with R^2 value ≈ 0.96,

GRI ≈ 49.249 Ln (USF) - 131.11, at ET 20 minute, with R^2 value ≈ 0.99, and

GRI ≈ 11.209 Ln (USF) - 22.489, at ET 30 minute, with R^2 value ≈ 0.90, respectively.

For sunflower seeds, follows the same trend patterns and behavior of soybeans, but lower, smooth, and non –sharp. Alternatively, the positive relation between the GRI and USF at all ET were, GRI $\approx 14.162\ e^{0.0043USF} \approx 15.174\ e^{0.005USF} \approx 8.4503\ln(x) - 13.223$ with R= 0.98, 0.92and 0.93 at the same previous arrangement respectively. At the same time, in contrast to soybean seeds, neither USF nor ET had a significant effect on the GRI of sunflower seeds. Except in the case of, increase ET from 20 to 30min. at 20 kHz. Where, it reduced significantly about 32.94%.

Thirty min., of ET encouraged the GRI more than the control, but to a lesser extent than 10 or 15min. Where, it is possible that ET at long period (30 min.), may have a destructive effect on the cell wall, that allowed greater accessibility of cell tissues to the effects of US, thus increasing their permeability and finally leading to post treatment water leakage (Sharififar *et al*., 2015). These results are in harmony with Shekari *et al*., 2015., Nazari and Eteghadipour 2017, and Chiu, 2021, on sesame *(Sesamum indicum),* on pea (*Pisum Sativum*), and on adzuki bean (*Vigna angularis*) seeds.

Furthermore, Andriamparany and Buerkert, 2019, and Babaei-Ghaghelestany *et al*., 2020 reached the conclusion that application of mild ET till 20 min., enhanced FGP and GRI. Then, they were reduced by increasing ET more than 20min.

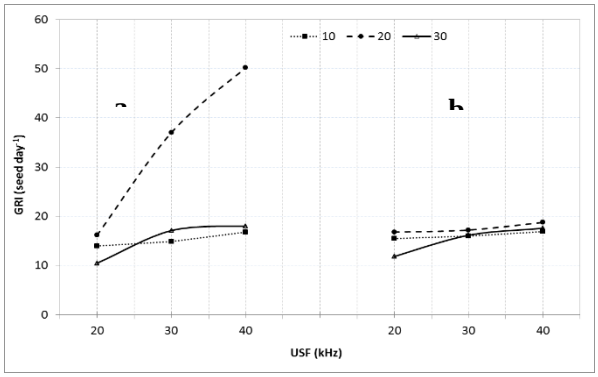

Fig. 3. The Effect of the USF on GRI at different ET for seeds of a) soybean, and b) sunflower.

3. Effects of USF and ET on germination energy and seedling vigor index I

The USF and ET effects on GE (%) and SVI, in two seed type (soybean and sunflower), were represented in Table 1.

From the table 1, it can be noticed that, all the ultra-sonication treated seeds of soybean and sunflower showed improved GE and enhanced SVI in comparison to their respective controls. Where, the non-treated seeds, for the soybean and sunflower seeds were the lowest. They had 61.92 and 60%., of GE, and 111.6 and 210.0 of SVI.

The results show clearly that, increasing USF from 20 to 30 or 40 kHz increased GE by 2.25 and7.40%, 6.04 and13.19%, and 4.61 and 16.56% for soybean seed, as well as, 7.69 and 8.58%, 3.59 and 4.31%, and 4.44 and 5.48% for sunflower seed at ET 10, 20, and 30 min., respectively. At the early times, particularly ET treatment for 10 and 20 min. the GE of seeds was enhanced, while reduction was observed on ET over 20 min. but it's still bigger than the control.

All ultrasonic treatment significantly increased seeds GE. On the other hand, the difference at 20 kHz between ET 10 and 20 min. and at 40 kHz between ET 10 and 30min. for soybean, and only at 10 kHz between 10 and 30min. for sunflower, did not reach to a significant level. While, the best GE (89.36 and 93.33%) for soybean and sunflower seeds were observed at treated seed at USF 40 kHz with ET 20min. For these samples, the rise in GE is 45.8% for soybean and 55.55% for sunflower compared with control.

It was problematic to compare the obtained results in the current work with the previous results published by Yaldagard *et al*., 2008 a and b, which used a USF of 42 kHz, with ET 0,1, 2, and 3 min. on lentil (*Lens culinaris*, Med.) and wheat (*Triticum aestivum*) seeds, as well as, only USF 20 kHz was used on barley (*Hordeum vulgar L.*). However, they confirm the constrictive and the significant effect of USF or ET stimulus on GE of seeds. The weaker effect of ultrasonic treatment detected in GE of soybean seeds compared with sunflower may be due to a difference in seed coat thicknesses and its physical properties (Aladjadjiyan, 2011).

Table 1. Germination energy "GE" and seedling vigor index I "SVI" affected by USF& ET and their interaction for soybean and sunflower seeds.

Characters		GE (%)					SVI				
ET (min) / USF (kHz)		Control	10	20	30	Mean	Control	10	20	30	Mean
Soybean	20	61.92	78.79	78.95	73.53	73.30	111.6	158.4	266.0	292.4	207.1
	30	61.92	80.56	83.72	76.92	75.78	111.6	194.4	473.0	483.6	315.7
	40	61.92	84.62	89.36	85.71	80.40	111.6	374.4	648.6	655.2	447.5
	M	61.92	81.32	84.01	78.72	76.49	111.6	242.4	462.5	477.1	223.4
	LSD Date 0.05										
	USF			*					*		
	USD			*					*		
	USF × USD			*					*		
		Control	10	20	30	Mean	Control	10	20	30	Mean
Sunflower	20	60.00	83.33	89.47	83.78	79.15	210.0	223.2	258.4	266.4	239.5
	30	60.00	89.74	92.68	87.50	82.48	210.0	249.0	328.0	336.0	280.8
	40	60.00	90.48	93.33	88.37	83.05	210.0	378.0	477.0	490.2	388.8
	M	60.00	60.00	87.85	91.83	81.56	210.0	283.4	354.5	364.2	303.0
	LSD Date 0.05										
	USF			*					*		
	USD			*					*		
	USF × USD			*					*		

***: Significant effect at 0.05** **NS: Non significant effect at 0.05**

The SVI is a function on both of FGP and seedling plumule length. Further, it is evident from the data presented that pronounced increases in SVI values compared with control were achieved as a result of increase ET and USF.

Wherein, SVI had a positive direct proportion with them. Furthermore, these results showed that using ultrasonic treatments (USF and ET) lead to increase the means of SVI. Where, SVI means increased by increasing ET from 10 to 20 or 30min. about 90.80 and 96.82%. Meanwhile, the SVI means increased by increasing USF from 20 to 30 or 40 kHz about 52.43 and 130.56%.

Sunflower seeds behaved similarly to soybean seeds. Where, with increased ET from 10 to 20 and from 20 to 30min. the SVI values of these seeds, rose about 15.77 and 3.1%, 31.72 and 2.43%, and 26.19 and 2.77%, at USF 20, 30 and 40 kHz respectively. The highest values of SVI were recorded at 40 kHz & 30min. Where, the pattern for promotion of SVI showed that, its value increased about 1.33-fold and 4.87-fold, in comparison with the untreated seeds of soybean and sunflower With regard to obtained results, demonstrated data indicated clearly that, SVI was affected significantly by using both of USF and ET for two seed types. Wherever, USF effect significantly on SVI from 20 to 30 or 40 kHz. Furthermore, the ET effect on SVI significantly from control seeds or ET = 10 min. to ET 20 or 30 min.

These results, are in harmony with Alvandian *et al*., 2013, and Liu *et al*., 2016 who reported that the ET, caused an increase in plumule length at similar studies conducted on myrtle (*Myrtus communis*) and tall fescue (*Festuca arundinacea*) and Russian wild rye (*Psathyrostaehys juncea* Nevski). Moreover, Aladjadjiyan, 2012 reported that the seedling length of lentil had approximately positive linear relationship with ET. On the other hand, these results are conflicting with Babaei-Ghaghelestany *et al*., 2019, which noted that the highest vigor longitudinal SVI for common lambsquarters was obtained at 15 min of ET treatment, and by increasing ET to 30 min, the SVI decreased. Besides, Fateh *et al*., 2012 showed that ET treatment had an adverse effect on seedling growth on fennel. Furthermore, the results are in contrast with the findings of Risca *et al*., 2007, and Babaei-Ghaghelestany *et al*., 2020.

CONCLUSION

Obtained results in this investigation allow to conclude that, pretreatment of soybean and sunflower seeds with various protocols of USW, including different frequencies and exposure times, effectively enhanced all measured indices, i.e., final germination percentage"FGP", germination speed "GRI", germination energy "GE, and seedling vigor index I "SVI", at varying degrees.

The germination period for all the ultra-sonication treated seeds reduced about 33.34% compared with the control sample. As a result of the analysis, the optimal exposure conditions were 40 kHz & 20 min.

Significant effects have been found between the applied USW, and the measured indices. The indices were significantly enhanced in comparison to their respective control. As well as, the analysis revealed that the optimal exposure conditions were 40 kHz for 20 min.

Where, the FGP, GRI, and GE reaching the limit (94 and 90%),(50.20 and 18.75 seed d^{1}), and (89.36 and 93.33%) respectively. Nerveless, ET for more than 20 min. lead to reduce all traits measure at all USF, except SVI. Values for GE are lower for soybean than for sunflower. The SVI of soybean and sunflower increase quasi linearly with the increase USF and prolong ET.

This study confirms that ultrasound applied in agriculture may contribute to the improvement of agro-biological indicators, i.e., FGP, GRI, GE, and SVI for soybean and sunflower seeds.

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استجابة البذور الزيتية في النمو بالموجات الفوق صوتية

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الملخص

نظرا للنقص التى تعانية مصر من انتاج زيوت الطعام. يمكن استخدام الموجات فوق الصوتية كأحد التطبيقات الفيزيوحيويه لزياده وتشجيع نمو المحاصيل الزيتية. تم معاملة بذور كلا من فول الصويا وعباد الشمس بواسطه مولد موجات فوق صوتية معاير ومصمم ومجمع محليا. عاملي الدراسة كان: أ) ثلاث مستويات من تردد الموجات فوق الصوتية (USF) وهما ٢٠،٣٠، ٤٠ كيلوهيرتز، ب) زمن التعرض (ET) صفر ، ١٠ ، ٢٠ ، ٣٠ دقيقة. تم استنبات البذور حتى تمام الانبات تحت الظروف المعملية لتقدير استجابتها لعاملى الدراسه. تم تقييم نتائج التجربة في صورة نسبة الانبات الكلية (FGP) كنسبة مئوية ، سرعة الانبات (GRI) كبذرة يوميا ، طاقة الإنبات(GE) كنسبة مئوية ، اخيرا مؤشر حيويه البذرة (SVI)، وتم تحليل النتائج إحصائيا وفقا لتصميم القطع المنشقة. أوضحت النتائج ان معاملة البذور بالموجات الفوق صوتية كان لها تأثير ايجابى حيوى ومعنوى على كل الصفات المدروسه. حيث تم تقصير فترة الإنبات لكل البذور المعاملة بحوالى ٣٣,٣٤% بالمقارنة بالبذور الغير معالجه. يوجد علاقة طردية ما بين التردد وكل صفات الانبات. بينما زمن التعرض كان له تأثير بناء على كل صفات الانبات حتى ٢٠ دقيقة ثم تقل قيم تلك الصفات بزياد زمن التعرض عن ٢٠ دقيقة مع إستثناء طاقة الانبات. أعلى قيم من اجمالى نسبه الانبات و سرعة الانبات و طاقة الانبات لكل من بذور فول الصويا و عباد الشمس كانت (٩٤، ٩٠%) ، (٥٠,٢٠ و ١٨,٧٥ بذرة يوم$^{-1}$) ، (٨٩,٣٦ و٩٣,٣٣%) تم تسجيلها عند زمن تعرض ٢٠دقيقه و تردد مقداره ٤٠كيلو هيرتز.في حين أن أعلى قيمه لمؤشر حيويه البذره كان (٦٥٥,٢٠ و ٤٩٠,٢٠) تم تسجيله عند تردد ٤٠ كيلوهيرتز & ٣٠ دقيقه. أكدت الدراسة الحالية أن استخدام الموجات فوق الصوتية في الزراعة قد يساهم في تحسين المؤشرات الزراعية و البيولوجيه مثل اجمالى نسبه الانبات، سرعه الانبات ، طاقة الانبات ، موشر حيويه البذور لكلا من لبذور فول الصويا ، وعباد الشمس.

الكلمات المفتاحيه: الموجات فوق الصوتيه، الترددات ، زمن التعرض، صفات النمو، فول الصويا، عباد الشمس.