IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 10, Issue 10 Ver. II (October 2017), PP 30-36
www.iosrjournals.org

The effect of magnetic field and ultraviolet-C radiation on germination and growth seedling of sorghum (*Sorghum bicolor L. Moench*)

Samir K. Lazim[1*] and Ali F. Nasur[2]
[1]*Machinery and Equipment Department, College of Agricultural, University of Basrah, Basrah, Iraq*
[2]*Department of Field Crops, College of Agricultural, University of Basrah, Basrah, Iraq*
**Corresponding author: Samir K. Lazim[1]*

***Abstract**: In this study, sorghum seeds were exposed to a static magnetic field strength 125 mT for different periods of time (0, 3, 6 and 9) hour, after magnetic treatment, the seeds were immediately irradiated with UV-C radiation at 254 nm for different periods time (0, 30 and 60) minute. The selected germination and growth seedling were Percentage of germinated seeds, a speed of germination, seedling and root length, and the number of leaves.Results showed that the magnetic treatment of sorghum seeds showed a significant effect on all germination and seedling growth parameters, where the 6-hour magnetic treatment showed the significant positive effect on all studied parameters except roots length.The highest value of germination speed and seedling length showed in magnetically treated seeds of 6 hours with a significantly positive effect which increased by 40.50%, 44.94%, respectively compared to control treatment.The treatment for 6 hours showed a significant positive effect on germination percentage which increased by 34.77%, 34.78% compared to a 3 and 9-hour respectively, and in number leaves by 14.38% compared to 9 hours while the lowest value of all parameters studied showed by exposing seeds to 9 hours compared to untreated seed. In UV-C irradiated seeds the results showed no significant effects on germination percentage and the length of the roots seedling, while showed a significantly negative impact on speed germination, seedling length and the number of leaves. The results also showed no significant in combined effect between a magnetic field and UV-C in all studies characteristics except the characteristic about the length of the roots seedling.Where the untreated seeds to the magnetic field with the exposure time 60 minutes of UV-C, gave the highest value with an increase (84.65%) compared with the exposure time 60 minutes to UV-C with the exposure time 9 hours to a magnetic field.The obtained results show that the magnetic field and UV-C radiation may have a positive or negative significant effect on selected germination parameters, which have dependent on the applied exposure time, and we suggested using 6 hours of treatment as the best value for enhancing germination and growth seedling of sorghum.*

***Keywords**: Sorghum, static magnetic field, UV-C radiation, germination, seedling growth*

Date of Submission: 28-09-2017 Date of acceptance: 23-10-2017

I. Introduction

A seed of sorghum (Sorghum bicolor L.Moench) is the fifth most important cereal crop for food security in the world after wheat, maize, rice and barley due to their high nutritional quality. Furthermore the long life cycle of the Sorghum crop it could contribute more to food supplies than at present (Dahlberg et al., 2011).

The influences of physical factors are the seeds treatment with a magnetic field and electromagnetic waves, particularly ultraviolet and microwave radiation, laser irradiation as well as the ultrasound and ionizing radiation. There are several studies related to some physical treatments and their interaction on the seed germination and growth of some plants. Kouchebagh et al. (2014) found that the use of some physical factors (ultrasound, gamma, beta, laser irradiation and magnetic field) on the germination and growth of sunflower seeds gave the highest germination rate of seeds when treated with magnetization and the lowest germination rate when treated with ultrasound.Dziwulska-Hunek A., et al. (2013) observed that the radiation of amaranth seeds with the interaction of laser light and magnetic field induced a significant decrease of the germination in the pot experiment. Aguilar et al. (2015) found that the effects of magnetic, electric and electromagnetic fields on the germination and growth of corn Seeds gave the best germination results. Naeem et al. (2013) observed that okra plants were more resistant to Ultraviolet and microwave radiation than corn plants.

One of the most important factors for seed plant treatment is the effect of magnetic and ultraviolet radiation as a single or combined treatment for the germinating seeds and plant growth enhancement, which appears to have been used by little scientists. Y. Yao et al. (2005) found that the magnetic treatment had the positive effect on plant growth of cucumber seeds, while UV-B radiation gave a negative result, as well as found the seedling growth was significantly decreased by the interaction treatments of UV-B irradiation and magnetic. Elfadil and Abdallah (2013) found out the effect of magnetized water on the Dura Sorghum plant has a positive effect, while light stress and UV gave a significant negative impact.

The magnetic field as a single treatment was used widely as the subject of different research studies as positive effects to improve and acceleration the germination process of seeds and growing plants. (Carbonell et al. ,2000; Aladjadjiyan,2002; Florez et al., 2007; Gholami et al.,2010; Martınez et al. , 2017) found a positive growth response to the static magnetic field ranging between 50 and 250 mT at different periods of time in rice, wheat, maize and barley seeds, and also (Pittman,1977; Kordas,2002; Sagan and Abd El Baset,2015) was found to increase crops and yield of yield.

As well as, some studies reported that the magnetic field has a negative effect on germination process of seeds and growing plants. Martinez et al. (2009) were found a significantly reduced in the mean germination of tomato seeds when exposed to a magnetic field ranging between 125 and 250 mT at different periods of time. A negative impact was obtained by Matwijczuk et al. (2012) for most of the indicators characterizing for sunflower seed germination and plant growth with magnetic field activity and magnetically treated water. Muszynski et al., (2009) show that a negative and positive effect on germination and seedling growth when durum wheat seeds exposed to the low-frequency magnetic field.

Also, the UV-irradiation as a positive and negative effect in a single treatment has been studied by many scientists. Rupiasih and Vidyasagar (2016) showed that a stimulated in the seed germination when wheat seeds exposed to UV-C radiation. Peykarestan and Seify (2012) showed that percent germination and the rates of growth of sprouts of red bean seeds were inversely related to the UV irradiation doses. Torres et al., (1991) was found that the percentage of normal seedlings of sunflower reduced when seeds exposed to UV-C radiation from 5 to 60 min. Siddiqul et al., (2011) observed that an increment in shoot weight, shoot length, root length, root weight and leaf area of groundnut and mung bean when seeds exposed to UV-C radiation for 10, 15, 30 and 60 minutes period.

Because of the little information available about the combined effect of ultraviolet and magnetic radiation on sorghum seeds, the purpose of our study is to measure some of the germination properties and grow seedlings under the combined effect of UV-C and magnetic field.

II. Materials and methods

Seeds of sorghum (Sorghum bicolor L. Moench) selected for uniform size and shape, were soaked for 2hour in distilled water. Following soaking, seeds were placed in the glass tube and magnetically exposed to the static magnetic field of about 125 mT for different time periods (0.0, 3, 6 and 9) hour, 0.0 as untreated seeds (control). The magnetic field determined by gaussmeter produced by Nv.Ltd, India, unit type Nv621. After magnetic treatment, the four sets of magnetic seeds were immediately irradiated separately with UV-C of about 254 nm at different period of exposure for (0.0, 30 and 60) min, 0.0 as untreated seeds (control). The UV-C irradiation provided by a lamp for second wind 4pin model (ZW6S 15W). Ordinary plastic pots, 10 cm in inner diameter, were filled with 500 g of homogeneous soil. In each pot seven of sorghum seed was planted at a constant depth of about 1cm. The germination seed was observed, after four days of planting. The number of germination seed was counted every day, until the tenth day when there were no more germinated seeds. After germination had completed some germination and growth seedling parameters were recorded as follows:

The percentage of germination (G %) represents the total number of seedlings at the end of the test after ten days, calculated as follows:

Speed germination (S.G) calculated as described in the Association of Official Seed Analysts (AOSA1983) by the following formula:

The seedling length determined from the point below the sorghum to the top of Seedling, and roots length determined from the point below the sorghum to the end of the tip of the root.A mean number of leaves calculated by the following formula:

$$\text{mean number of leaves} = \frac{\text{Total number of leafs}}{\text{Total number of normal seedlings}}$$

All tests were carried out in the department of agricultural machinery and equipment, in the laboratory of physics, Agriculture College, University of Basrah. The statistical analyses were used in the experiment study, according to completely randomized design, with three replications, each pot represents one replicate. The results analyzed with SPSS with three replicates. After testing the data distribution, the variance analysis (ANOVA) was used to test the main effects of UV-C radiation, magnetic field, and their interaction. The mean values compared according to L.S.D. test at the level 0.05 for each of the treatments and their interaction.

Results

Germination percentage:

The results presented in Table.1are shown a significant difference in a percentage of germination of the sorghum seeds exposed to the magnetic field. The highest value of percentage germination (98.41) was in 6-hour exposure compared with all treatments and had a significant difference compared with 3 and 9-hour exposures (73.02) and (73.01), respectively with increased by (34.77%) and (34.78 %), respectively. While the lowest values were in 3 and 9-hour exposures and were found a significant negative impact with reduced by (17.95%) and (17.96%), respectively compared to control treatment (89).In UV-C irradiated seeds in the same Table, the results of mean comparison showed no significant effect in germination percentage. Also, in the interaction effect of magnetic field and UV-C radiation on seeds of sorghum plant failed to cause a significant differential effect between all treatments.

Table 1. Effect of sorghum seed treatment by the magnetic field and UV-C radiation and effect of their interactions on the percentage germination seeds (G %).

magnetic field exposure time(hr.)	UV-C radiation exposure time (min)			Mean
	Control	30	60	
Control	90.48	90.47	85.71	89
3	80.95	71.43	66.67	73.02
6	95.24	100	100	98.41
9	76.19	76.19	66.67	73.01
Mean	85.72	84.52	79.76	

$L.S.D_{0.05}$ (magnetic) =14.83, $L.S.D_{0.05}$ (uv-c radiation) =N.S, $L.S.D_{0.05}$ (interaction) =N.S
$L.S.D_{0.05}$=Least significance difference at probability 5%; N.S=Non-significance

Speed germination:

According to the present results of speed germination (S.G %) of magnetically treated sorghum seeds in Table 2, the highest value (6.14) was given in 6-hour exposure and had significant positive effect with increased by (40.50%) compared to control treatment (4.37). While in lowest speed germination (2.90) was observed in seeds which exposed for 9-hour with reduced by (33.63%) compared to control treatment. Also, in the same Table, the results indicated that UV-C radiation had significant negative impact on speed germination, in addition to the lowest value (3.49) was given in 60-minute exposure with reduced by (27.44 %) compared to control treatment (4.81). Also, in the same Table, the results of interaction treatment seeds with a magnetic field and UV-C radiation as shown in Table (2) showed that no significant differences in the speed germination between all treatments.

Table 2. Effect of sorghum seed treatment by the magnetic field and UV-C radiation and effect of their interactions on the speed germination of seeds (S.G)

magnetic field exposure time(hr.)	UV-C radiation exposure time (min)			Mean
	Control	30	60	
Control	4.95	4.88	3.28	4.37
3	4.10	2.58	2.94	3.21
6	6.33	6.68	5.42	6.14
9	3.85	2.55	2.31	2.90
Mean	4.81	4.17	3.49	

$L.S.D_{0.05}$ (magnetic) =0.99, $L.S.D_{0.05}$ (uv-c radiation) =0.84, $L.S.D_{0.05}$ (interaction) =N.S
$L.S.D_{0.05}$=Least significance difference at probability 5%; N.S=Non-significance

Seedling length:

Table 3, shown an increase in seedlingsorghum length in magnetically treated seeds which exposed for 3 and 6 hours compared to the control.The highest value of seedling length (17.48) was in 6-hour exposure compared with all treatments and had a significant difference compared with untreated seeds and (3, 9) hour exposures with increased by 44.94% and (42.11%, 95.96%), respectively. While in lowest seedling length (8.92) was observed in seeds which exposed for 9-hour and had significantly reduced effect compared with all treatments.In UV-C test, the results of seedling length in the same Table indicated that UV-C radiation treated seeds gave a negative impact in all various exposure time compared to untreated seeds (14.60). As well as, 60 minute exposure time had the lowest seedling length (11.09) which reduced by (24.04%) compared to control.

Also, the results of interaction treatment seed showed that there were no significant differences changes in the seedling length between all treatments.

Table 3.Effect of sorghum seed treatment by the magnetic field and UV-C radiation and effect of their interactions on the seedling length (cm)

magnetic field exposure time(hr.)	UV-C radiation exposure time (min)			Mean
	Control	30	60	
Control	12.89	13.22	10.07	12.06
3	12.25	10.29	14.37	12.30
6	20.93	17.81	13.69	17.48
9	12.35	8.17	6.23	8.92
Mean	14.60	12.37	11.09	

$L.S.D_{0.05}$ (magnetic) =2.917, $L.S.D_{0.05}$ (uv-c radiation) =2.526, $L.S.D_{0.05}$ (interaction) =N.S
L.S.D0.05=Least significance difference at probability 5%; N.S=Non-significance

Root length:

Data presented in Table.4 showed that the magnetically treated seeds gave asignificant negative impact on root length of sorghum seeds in all various exposure time except in 6 hours when compared to the control (18.22). Where in 3 hours (14.96) and 9 hours (12.67) magnetic treatment gave a significantly negative impact compared with untreated seeds, which reduced by (17.89%) and (30.46%) respectively.In UV-C irradiated seeds in the same Table, the results of mean comparison showed no significant effect in root length of sorghum seeds between all treatments.The results in the same table also indicated a significant interaction between the magnetic field and UV-C treatment, where 60 minutes of UV-C and untreated magnetic seeds gave the highest effect on root seedling length (19.13) with an increase (84.65%) compared with 60 minute of UV-C and 9houre magnetic (10.36).

Table 4.Effect of sorghum seed treatment by the magnetic field and UV-C radiation and effect of their interactions on the root length (cm)

magnetic field exposure time(hr.)	UV-C radiation exposure time (min)			Mean
	Control	30	60	
Control	17.01	18.51	19.13	18.22
3	15.09	14.40	15.40	14.96
6	18.61	18.61	17.21	18.14
9	16.54	11.11	10.36	12.67
Mean	16.81	15.66	15.52	

$L.S.D_{0.05}$ (magnetic) =1.80, $L.S.D_{0.05}$ (uv-c radiation) =N.S, $L.S.D_{0.05}$ (interaction) =3.13
$L.S.D_{0.05}$=Least significance difference at probability 5%; N.S=Non-significance

Number of leaves:

According to results of number leaves in Table.5, the 3 and 6-hour magnetic exposures on sorghum seeds gave the highest effect (4.24) with significant differences compared to 9hour (3.63) which increased by 14.38%.The 9-hour exposure seeds gave the lowest values of number leaves (3.63) and had a significant negative impact compared to untreated seeds (4.04) with reduced by (11.29%).In UV-C irradiated sorghum seeds in the same Table, the results of leaves number were, in general, less than the corresponding values of untreated seeds (4.29).While the results of interaction treatment seed showed that there were no significant differences changes in the number of leaves between all treatments.

Table 5.Effect of sorghum seed treatment by the magnetic field and UV-C radiation and effect of their interactions on the number of leaves per plant

magnetic field exposure time(hr.)	UV-C radiation exposure time (min)			Mean
	Control	30	60	
Control	4.09	4.10	3.93	4.04
3	4.39	4.11	4.22	4.24
6	4.50	4.23	4	4.24
9	4.19	3.45	3.27	3.63
Mean	4.29	3.98	3.85	x

$L.S.D_{0.05}$ (magnetic) =0.26, $L.S.D_{0.05}$ (uv-c radiation) =0.23, $L.S.D_{0.05}$ (interaction) =N.S
$L.S.D_{0.05}$=Least significance difference at probability 5%; N.S=Non-significance

III. Discussion

Effect of sorghum seed magnetic field treatment ongermination and growth seedling:

Magnetic field treatments are beingused in agriculture to improve thegermination and growth seedling.In this research, general results showed that the magnetically treated sorghum seed gave the significant effect on all germination and growth seedling parameters studied, where the best period to expose the seeds recorded in 6 hour treated seeds in all measurements parameters compared with untreated seed, except root length.These results are consistent with results of Soheil Karimi et al. (2017) where authors found that the best germination percentage appeared when exposing the seeds of sweet corn for 6 hours to a static magnetic field of 150 mT. Also, these results might be parallel to the results of Mousavizadeh et al., 2013 where authors found that an increase in germination percentage when exposing the seeds of Lettuce for 1, 6 and 12 hours to both static magnetic field of 125 and 250 mT.Several authors found an increase in the germination percentage seeds as a positive response to various static magnetic fields for different periods exposure times in rice, wheat, maize and barley seeds (Martınez et al.,2017; Florez et al., 2007 and Carbonell et al., 20000).Also, other authors found to increase the germination percentage of cumin seeds (Samani et al.,2013) and in lentil seeds (Asgharipour and Omrani, 2011).

In speed germination test the highest value was found in 6 hour treated seeds which had a significant positive effect. These results might be consistent with results of previous studies authors which found an increase in the speed germination as a positive response to various static magnetic fields for different periods exposure times in cumin seeds (Samani et al.,2013).And also, these results might be consistent with results of Vashisth and Nagarajan (2008) in chickpea seeds and Hozayn et al.(2015) in onion seeds.

Also, in this study, the highest effect on seedling length was found in 6 hours magnetic treated with a significant positive effect. Several authors found an increase in the seedling ofcumin, Lettuce and Lentil seeds exposed to a different static magnetic field (Samani et al.,2013, Mousavizadeh et al., 2013 and Asgharipour and Omrani, 2011).While Vashisth and Joshi, 2017 found an increase in the seedling length, a speed of germination and percentage germination of maize seeds exposing for 1, 2, 3, and 4 hours to static magnetic fields in a strength of 50, 100,150, 200, and 250 mT.

Results of root length in present study gave a significant negative impact on root length in all various exposure time except in 6 hours when compared to untreated seeds. These results might be found agreement or non-agreement with several studies authors. Several authors found an increase in the length of the roots of cumin and Lettuce seeds exposed to a different static magnetic field (Samani et al., 2013, Mousavizadeh et al., 2013), while Ijaz et al. 2012 found that the magnetic treatment exposure gave a negative impact on root length of wheat seedlings

As well as, the results of present study gave the highest values of leaves number were observed in 3 and 6 hours in magnetically treated seeds.These results might be agreement with that obtained by Tahir and Karim (2010) where authors recorded the increase in a leaves number of magnetically treated chickpea seeds.

The mechanism of magnetically treated seeds on seeds germination and seedling growth has been proposing by some researchers, including different theories of biochemical and physiological processed.The ionic properties theory is one of the mechanisms which might be explained by the abilities of a magnetic field to influence the structure of cell membranes which causes the increasing ion transport in the ion channels and their ionic currents density across the cellular membrane. As a result, the magnetic field affects the abilities of cellular tissues to absorb water and magnetic energy inside the cell and thus leading to make biological changes in the organism (Aladjadjiyan, 2010, Matwijczuk, 2012).Another possible theory was reported by some authors relates to the activities of some enzymes in magnetically exposed seeds which leads to enhanced germination and seedling growth. Samani et al. 2013 observed an increase in germinating of magnetic field treated cumin seeds as a consequence of increased activity of three enzymes, amylase, dehydrogenase, and protease.

Also, Kataria et al. 2015 have found that the higher activities of hydrolytic enzymes in magnetical soybean and maize seeds which might be responsible for increased seeds germination and seedling length.

While Mousavizadeh et al. 2013, have found an increase in peroxidase activity of lettuce seeds under the best time 1 to 6 hours of exposure of seeds to a magnetic field which can be lead to quick the germination seeds and growth seedling.The biochemical mechanism might be occurring in magnetically treated seeds during germination, where shine et al.,2012 reported an increase in reactive oxygen species (ROS) production by soybean treated seeds in a static magnetic field.

Effect of sorghum seed UV-C radiation treatment on germination and growth seedling:

It seemed from our results the effect of sorghum seeds treatment with the UV-C radiation showed no significant effects on germination percentage and the length of the roots seedling, while showed a significant negative impact on speed germination, seedling length and the number of leaves.

Results of seed germination and growth seedling of sorghum seeds in the present study might be found agreement or non-agreement with several studies authors.Peykarestan and Seify 2012 did not find any significant effect on the germination percentage of bean seeds irradiated with 220 to 400 nm UV-C rays, while Siddiqui et al. 2011 found a significant increase in germination of mung bean seeds irradiated with UV-C rays for 30 minutes.Naeem et al. 2013 reported that reduced on germination percentage of okra seeds irradiated with 253.7nm UV-C rays for 30 and 60 min, while Rupiasih and Vidyasagar 2014 observed a stimulation in the germination percentage of wheat seeds treatment with UV-C rays for up to 180 min. Rupiasih and Vidyasagar 2016 observed decreasing in seedling (shoot and root) growth rate of wheat seeds irradiated with UV-C ray at all exposure periods compared to control. Also, Peykarestan and Seify 2012 observed a decrease in shoot and root length of both seeds of Sayad and Derakhshan after UV-C ray at all exposure periods compared to non-irradiated.Whereas Siddiqui et al. 2011 found the highest values with UV-C treated seeds in root length of groundnut seeds and shoot length of mung bean seeds.

It is well known that UV-C exposures can lead to the formation of reactive oxygen species (ROS), which are responsible for causing oxidative stress and secondary damage in a plant cell (Saxena et al., 2011; Maharaj, 2015). In addition to, the antioxidants and peroxidase enzyme activities were well known involved in the mechanisms of inhibition of free radicals which formed in UV irradiation treated seeds (Peykarestan et al., 2012 and Rogozhin et al., 2000). Further data show that biochemical parameters mechanism associated with UV-C as lipid peroxidation and proline enzymes might be involved in resistance and effectiveness of irradiation dose (AboulFotouh et al., 2014).

The combined effect of treatment seeds by UV-C radiation and magnetic field on germination and growth seedling:

The results showed no significant in combined effect between a magnetic field and UV-C in all studies characteristics except the characteristic about the length of the roots seedling.The combined effects of magnetic fields with other types of radiation have become a subject of interest by several studies.Conger et al. 1966 found that no significant effect on the seedling growth of combined treatment barley seeds between a magnetic field and X-radiation, whereas Yao et al. 2005 found that a decrease significant on the seedling growth of combined treatment cucumber seeds between a magnetic field and UV-B radiation. Also, Asghar et al. 2016 found that soybean seed treatments with laser and magnetic field have a potential to enhance soybean biological characteristics.

The combination mechanism of seed magnetic field treatment with UV-C radiation on germination and growth seedling was unknown, but some authors suggested different mechanism about the combination of treated magnetic seeds with some physical factors.Kuzin et al., 1986 suggested that the action of a magnetic field on the level of free radicals causes stimulation of plant seedling, which parallels to that caused by low-level ionizing of gamma radiation exposure. Asghar et al., 2016 reported that the specific activity of enzymes such as protease, amylase, catalyst, superoxide dismutase, and peroxides during germination and early growth of soybean under the effect of both laser and magnetic pre-sowing treatments.

IV. Conclusion:

1- Magnetic sorghum seeds treatments of 125 mT strength and especially in the exposure of 6 hours gave the best results in all measurements of germination parameters, except root length.
2- The treatment of UV-C radiation showed no significant effects on germination percentage and the length of the roots seedling, while showed a significantly negative impact on speed germination, seedling length and the number of leaves.
3- The combination of magnetic field treatment and UV-C radiation had no significant effect on all studies characteristics except the characteristic about the length of the roots seedling.
4- Further experiments are needed to obtain additional results related to combined exposures of magnetic fields with other physical factors treatments as microwave, laser radiation and ultrasound for another crop plant seeds to give best results.

References

[1] AboulFotouh M.M., Moawad F.G., ElNaggar H.A, Tag El-Din M.A., SharafEldeen H.A., 2014.Influence of seed treatment with UV-C on saline stress tolerance in green beans (Phaseolus vulgaris L.). J. Biol. Chem. Environ. Sci. 9 (2): 391-414.

[2] Aguilara J. O, Riverob S.D, Puentesa E.A, Perillaa V.E.P, Navarro S. M.A,2015. Comparison of the Effects in the Germination and Growth of Corn Seeds (Zea Mays L.) by Exposure to Magnetic, Electrical and Electromagnetic Fields. Chemical Engineering Transactions.43:169-174.

[3] Aladjadjiyan A,2010.Influence of stationary magnetic field on lentil seeds.Int. Agrophys. 24:321-324

[4] Aladjadjiyan A,2002. Study of the influence of magnetic field on some biological characteristics of *ZeaMais.*Journal of Central European Agriculture. 3:89-94

[5] Asgharipour M.R, Omrani M.R, 2011 Effects of Seed Pretreatment By Stationary Magnetic Fields on Germination and EarlyGrowth of Lentil. Australian Journal of Basic and Applied Sciences, 5(12): 1650-1654

[6] Asghar T, Jamil Y, Iqbal M, Haq Z, Abbas M, 2016. Laser light and magnetic field stimulation effect on biochemical, enzymes activities and chlorophyll contents in soybean seeds and seedlings during early growth stages. Journal of Photochemistry & Photobiology, B: Biology 165 : 283–290

[7] Association of Official Seed Analysis (AOSA). 1983. Seed vigor Testing Handbook. Contribution No. 32 to the handbook on Seed Testing.Association of Official Seed Analysis. Springfield, IL.

[8] Carbonell M.V, Matineez E, Amaya M.J,2000. Stimulation of germination in rice *(ORYZA SATIVA L.*) by static magnetic field. Electro-and Magnetobiology.19(1):121-128

[9] Conger A.D, A. H. Flasterstein A.H., K. Thompson K., 1966.A test for a magnetic effect in irradiated seeds.Radiation Botany. 6: 105 - 109

[10] Dahlberg J, Berenji J, Sikora V , Latkovic D ,2011. Assessing sorghum [Sorghum bicolor (L) Moench] germplasm for new traits: food, fuels & unique uses.Maydica 56 (1750): 85-92.

[11] Dziwulska-Hunek A, Sujak A, KornarzyNski K,2013. Short-Term Exposure to Pre-Sowing Electromagnetic Radiation of Amaranth Seeds Affects Germination Energy but not Photosynthetic Pigment Content Pol. J. Environ. Stud. 22(1): 93-98.

[12] Elfadil A. G. , Abdallah R.A,2013. Effect of light, ultra violet and magnetized water on the growth and development of Dura (*Sorghum sp*.). Agric. Biol. J. N. Am. 4(2): 91-96

[13] Florez M, Carbonell M V, Martınez E,2007. Exposure of maize seeds to stationary magnetic fields:Effects on germination and early growth. Environmental and Experimental Botany 59 : 68–75

[14] GholamiA ,Sharafi S , Abbasdokht H,2010. Effect of Magnetic Field on Seed Germination of Two Wheat Cultivars. Int. J. of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering .4 (8):675-677.

[15] Hozayn M., EL-Mahdy A.A, Abdel-Rahman H. M. H.,2015. Effect of magnetic field on germination, seedlinggrowth and cytogenetic of onion (Allium cepa L).Afr. J. Agric. Res.10(8):849-857

[16] Kataria S, Baghel L, Guruprasad K.N,2015.Acceleration of Germination and Early Growth Characteristics of Soybean and Maize after pre-treated of seeds with static magnetic field.International Journal of Tropical Agriculture.33(2): 985 -992

[17] IjazB ,Jatoi S.A. , Ahmad D. , M. ShahidMasood M.S., Siddiqui S.U., 2012. Changes in germination behavior of wheat seeds exposed to magnetic field and magnetically structured water.African Journal of Biotechnology. 11(15): 3575-3582

[18] Karimi S, Eshgi S, Saeed Karimi, Hasan-Nezhadian S,2017. Inducing salt tolerance in sweet corn by magnetic priming.ActaagriculturaeSlovenica109 : 89 – 102

[19] Kouchebagh S B, Farahvash F, Mirshekari B, Arbat H K, Khoei F R,2014. Effects of physical treatments on germination and stand establishment of sunflower (Helianthus annuus L. var. Hyson) under laboratory condition. International Journal of Biosciences.5(12):1-6

[20] Kordas L,2002. The Effect of Magnetic Field on Growth, Development and the Yield of Spring Wheat.Polish Journal of Environmental Studies. 11(5): 527-530.

[21] KuzinL.M., Vagabova M.E., Vilenchik M.M., Gogvadze V.G.,1986.Stimulation of plant growth by exposure to low levely-radiation and magnetic field, and their possible mechanism of action.Environmental and Experimental Botany. 26(2) :163-167

[22] Maharaj R., "Effects of Abiotic Stress (UV-C) Induced Activation of Phytochemicals on the Postharvest Quality of Horticultural Crops" in Phytochemicals - Isolation, Characterisation and Role in Human Health, A. VenketRao and Leticia G. Rao, Eds.,Ch.9, pp.221-244.

[23] Martinez E, Florez M, Carbonell M.V,2017. Stimulatory Effect of the Magnetic Treatment on the Germination of Cereal Seeds. International Journal of Environment, Agriculture and Biotechnology.2: 2456-1878

[24] Martínez E, Carbonell M.V, M. Florez M., Amaya J.M, Maqueda R,2009. Germination of tomato seeds (Lycopersiconesculentum L.) under magnetic field. Int. Agrophysics. 23: 45-49

[25] Matwijczuk A, Kornarzynski K, Pietruszewski S,2012. Effect of magnetic field on seed germination and seedling growth of sunflower. Int. Agrophys 26:271-278.

[26] Mousavizadeh S.M, Sedaghathoor S, Rahimi A, Mohammadi H,2013. Germination parameters and peroxidase activity of Lettuce seed under stationary magnetic field. International Journal of Biosciences. 3(4):199-207

[27] Muszynski S, Gagos M, Pietruszewski S, 2009. Short-Term Pre-Germination Exposure to ELF Magnetic Field Does Not Influence Seedling Growth in Durum Wheat (*Triticum durum*). Polish J. of Environ. Stud.18,(6): 1065-1072

[28] Naeem A, Saeed M, Abid M, Shaukat S.S, (2013). Effects of UV-B and microwave radiation on seed germination and plant growth in Corn and Okra.Fuuast J. Biol., 3(1): 55-62

[29] PeykarestanB ,Seify M,2012. Uv irradiation effects on seed germination and growth, protein content, peroxidase and protease activity in red bean. Int.J. of Applied and Basic Sciences .3(1):92-102

[30] Pittman U.J,1977. Effects of magnetic seed treatment on yields of barley, wheat, and oats in southern Alberta. Can. J. Plant Sci. 57:37-45.

[31] Rogozhin V.V., Kuriliuk T.T.,Filippova N.P. , 2000. Change in the reaction of the antioxidant system of wheat sprouts after UV-irradiation of seeds. Biofizika . 45: 730-736

[32] RupiasihN.N , VidyasagarP.B,2014. Effect of UV-C radiation and hypergravity on germination, growth and content of chlorophyll of wheat seedlings .The 4th International Conference on Theoretical and Applied Physics (ICTAP) 2014. AIP Publishing (2016)1719: 030035-1–030035-6

[33] Sagan E, Abd El Baset M. A. M,2015. Impact of magnetic on metal uptake, quality and productivity in onion crop. Journal of Agriculture and Veterinary Science.8:43-50

[34] Samani M.A, Pourakbar L, Azimi N,(2013). Magnetic field effects on seed germination and activities of some enzymes in cumin.Life Science Journal. 10(1):323-328

[35] Saurabh C. SaxenaS.C , Joshi P.K , Grimm B. , Arora S, 2011.Alleviation of ultraviolet-C-induced oxidative damage through overexpression of cytosolic ascorbate peroxidase.Biologia 66(6): 1052—1059

[36] Siddiqui A, Dawar S, Zaki M.J, Hamid N,2011 . Role of Ultra Violet (UV-C) radiation in the control of root infecting fungi on groundnut and mungbean. Pak. J. Bot. 43(4): 2221-2224

[37] TahirN.R ,Karim H.F.H,2010.Impact of Magnetic Application on the Parameters Related toGrowth of Chickpea (Cicerarietinum L).Jordan Journal of Biological Sciences. 3(4):184-175

[38] TorresM. ,FrutosG, Duran J.M, 1991. Sunflower seed deterioration from exposure to u.v.-C radiation.Environmental and Experimental Botany.31:201-207

[39] Vashisth A and Joshi D.K, 2017.Growth Characteristics of Maize Seeds Exposed to Magnetic Field.Bioelectromagnetics 38:151-157

[40] Vashisth A, Nagarajan S, 2008.Exposure of seeds to static magnetic field enhances germination and early growth characteristics in chickpea (Cicerarietinum L.).Bioelectromagnetics 29:571-578

[41] Yinana Yb, Yuanc L, Yongqinga Yb, Chunyanga L,2005. Effect of seed pretreatment by magnetic field on the sensitivity of cucumber (*Cucumissativus*) seedlings to ultraviolet-B radiation.Environmental and Experimental Botany.54 : 286–294

Samir K. Lazim The effect of magnetic field and ultraviolet-C radiation on germination and growth seedling of sorghum (Sorghum bicolor L. Moench).” IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS), vol. 10, no. 10, 2017, pp. 30-36.