EFFECT OF LASER IRRADIATION ON JS-335 SOYBEAN SEEDS OF FOUR DIFFERENT AGED SEEDS

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ABSTRACT

This study was to determine whether the germination and electrical conductivity was related to their aged and exposure of laser light. We have taken four ages of seeds (fresh, 6 months old, 12 months old and 18 months old seeds). He-Ne laser of wavelength λ=632.8nm and intensity of beam is 5 mW/mm^2 were irradiation on seeds of time duration was 2, 4, 6, 8, 10, 12 minutes. The results indicate a positive impact of laser irradiation on seed metabolism. Growth characteristics such as germination, seedling length and speed of germination have been found to be significantly increased by laser irradiation. We recorded maximum percentage of germination of JS-335 Soybean seeds was 97.32%, 92.32%, 88.65% and 81.98 for 10 min. irradiation in fresh, 6 months old, 12 months old and 18 months old seeds respectively.

Keywords: *Laser irradiation, germination percentage, vigour index and electrical conductivity.*

Introduction

The laser discovery in the past century has been of great impact and application in the society from its conception until today. Among the outstanding achievements of science in the 20th century, the laser occupies a pivotal position. The characteristics of the laser radiation, such as monochromatic, coherence, polarization and high density, can be used not only in all sphere of engineering but also in medical and plant biology. Among its applications it is used in agriculture as a biostimulator device [1]. The laser light of low intensity produces biostimulation when used on seeds, seedlings and plants [2]. The basis of the stimulation mechanism in any plants physiological stage is the synergism between the polarized monochromatic laser beam and the photoreceptors that, when triggered, activate numerous biological reactions. There are many facts that indicate the biostimulating action of laser radiation on various organs and tissues in animals and plants [3]. The plants absorb light via their photoreceptors. They control all stages of plant development laser activation of plants results in an increase in their bioenergetics potential, and fermentative systems, as a stimulation of their biochemical and physiological process [3,4].

The last 50 years different chemical additives are used for fertilizing crops and controlling pests helping to develop highly successful farm system ensuring an abundant food production. Their application causes the contamination of raw material for food production with toxins, decrease soil yielding capacity [1]. Light play a major role in growing plant. The effect of light during germination process and plant growth is undeniable

Soybean is the world's most popular oil seed crops, cultivated in more than 100 countries. Soybean seed mainly comprised of protein, fiber, vitamin, minerals and source of organic compound, which are most important factors. Establishing the quality of seed lot is a crucial step, whether for cultivation or research activities. In order to obtain the highest crop production yield and quality, seeds of high quality that produce rapid and uniform seedling emergence are required. Germination of seeds depends on seed quality, environment, seed

born pathogen and quality of soil. To increase percentage of germination by using medicine and chemical fertilizer are harmful for environment and society. The biostimulating agent such as laser light is the best method to increase percentage of germination. Various workers in the field provided possibility of accelerating germination of seeds, plant growth, increase their resistance to disease, enzymatic activities and concentration of chlorophyll in the seeds of several plants using LED light, micro-wave and laser light [5-7].The present study is conducted to study the effect of He-Ne irradiation on germination percentage, speed of germination, growth of seedling and electrical conductivity.

Method & Material

A. Seed Materials

Soybean Seeds (Glycine max., JS-335) used in this work was supplied by college of agricultural engineering and technology, Marathwada Krishi Vidyapeeth, Parbhani, India. The experiment was carried out at the department of Physics, Shri Shivaji College, Parbhani, India.

B. Treatments

Continuous laser irradiation at λ= 632.8nm was obtained from He-Ne and intensity of beam is 5mW/mm^2. JS-335 Soybean seeds of four different aged seeds were irradiated to 2, 4, 6, 8, 10 and 12 minutes by He-Ne laser. The irradiation treatment of seeds was performed in the dark room to avoid the influence of the Sun rays.

C. Germination Test

Seed germination capability is measured by standard germination method. The emerging normal seedlings under favourable conditions were different for different seed lot, which can be manifest in storage or in the field [8]. For germination period favourable conditions are necessary to be provided and controlled. These conditions enhance metabolic activity and which results germination.

Treated seeds were placed in petri dishes with equidistance then incubated in a germinator with (25±2)^{0}C temperature for 7 days. Germinated seeds were counted daily for 7 days. A seed is considered to be germinated when radicle emergence is about 5mm [9-11]. At the end of 7th day seedling length were measured. The procedure was repeated thrice for all ages of the seeds.

D. Seed Vigour Index

Seed vigour index were calculated by determining the germination percentage and seedling length of the same seed lot. We were selected randomly 10 germinated seeds and measured seedling length.

The seed vigour index was calculated by using the formula

Vigour Index= Germination % x Average Seedling length (in mm.)

E. Electrical Conductivity Test

A seed sample of 10gm was sterilized with distilled water for 2-3 minutes. The clean sample was immersed in 100ml of water at 25$\pm$1^{0}C temperature for 12hr. After that the seeds were removed by a clean forcep. The steep water left was decanted and was termed as leachate. The conductivity meter was warmed about 30 minutes before testing by deeping in distilled water. First the conductivity of distilled water was measured then leachate was measured. The formula for calculate the electrical conductivity of seed extract was as follows.

E.C.= [Actual E.C. meter reading-E.C. of distilled water]x Cell constant factor

Result & Discussion

Germination Test on Soybean Seeds

Improvement of seed quality and germination rate by He-Ne Laser treatment on pre-sowing Soybean seeds under laboratory condition has been analyzed in detail. In this study we have analyzed the impact of He-Ne Laser irradiation with different doses on germination rate, vigour index and electrical conductivity of leakage solution of JS-335 Soybean seeds for four different ages of seeds (Fresh, 6 months old, 12 months old and 18 months old seeds).

The results indicate a positive impact of laser irradiation on seed metabolism. Growth characteristics such as germination, seedling length, speed of germination and vigour index

have been found to be significantly increased by laser irradiation. We recorded maximum percentage of germination of JS-335 Soybean seeds was 97.32%, 92.32%, 88.65% and 81.98 for 10 min. irradiation in fresh, 6 months old, 12 months old and 18 months old seeds respectively. For high aged seeds shows lower germination percentage due to detonation. Similar results of enhanced germination percentage, seedling length and speed of germination have also been recorded in Scorzonera hispanica L. seeds by Marcela et al. (2016). St. Dinoev et al. (2004) reported that low power Laser irradiation on wheat and Maize seeds that the photon light was stored in seeds and plants utilized this stored energy during growth process and it can be seen in their development.

Electrical Conductivity of JS-335 Soybean Seeds.

Tables 5 shows the effect of Laser irradiation on Germination percentage and electrical conductivity of seed leachate of JS-335 Soybean seeds of fresh seeds, 6 months old, 12 months old and 18 months old seeds respectively. We observed electrical conductivity of fresh, 6 months old, 12 months old and 18 months old seeds where controlled seeds show 7.66, 9.31, 12.07 and 14.40µS.Cm.$^{-1}$gm.$^{-1}$ml.$^{-1}$ and for 12min. irradiation seeds shows 4.21, 5.62, 9.06, and 11.93µS.Cm.$^{-1}$gm.$^{-1}$ml.$^{-1}$ respectively. The experimental data shows that electrical conductivity was higher in controlled as well as in higher age seeds. However the lowest electrical conductivity value for 12min. irradiation and fresh seeds. We notice that electrical conductivity of seed leachate is correlated to germination percentage, speed of germination and seed vigour index. Simona-Laura Lasar et al.(2014) conducted experiments on germination and electrical conductivity tests on artificially aged seed lots of two wall-rocket species. Electrical conductivity was determined by using 0.1 gm of seeds in 10ml of deionised water at 25^{0}C for 24 hours. He stated that the conductivity test is able to predict the viability of wall-rocket seeds stored in high humidity. If seeds have low electrical conductivity then they have high germination power, high seed vigour index. Electrolyte losses were related to decrease in seed germination capacity.

Table 1 Effect of Pre-Germination Exposure with Different Dose of He-Ne Laser on JS-335 Soybean Seed (Fresh Seeds)

Treatment	Germination %	MGT	SOG	Seedling Length	Vigour Index	E.C. (µS.Cm.$^{-1}$gm.$^{-1}$ml.$^{-1}$)
Controlled	82.31	3.12	28.03	11.50	946.56	7.66
2 min.	84.98	3.15	28.84	11.80	1002.76	6.69
4 min.	92.98	3.01	35.17	12.06	1121.33	5.86
6 min.	94.65	2.84	37.09	12.13	1152.10	5.23
8 min.	96.98	2.82	38.09	12.20	1183.15	4.70
10 min.	97.65	2.50	44.49	12.33	1204.02	4.36
12 min.	97.31	2.49	45.68	12.30	1197.88	4.21

Table 2 Effect of Pre-Germination Exposure with Different Dose of He-Ne Laser on JS-335 Soybean Seed (6 months old seeds).

Treatment	Germination %	MGT	SOG	Seedling Length	Vigour Index	E.C. (µS.Cm.$^{-1}$gm.$^{-1}$ml.$^{-1}$)
Controlled	77.32	3.11	26.28	11.03	852.83	9.31
2 min.	79.32	3.09	27.24	11.16	885.21	8.19
4 min.	81.64	2.92	31.47	11.33	924.98	7.32
6 min.	84.98	2.80	33.43	11.90	1011.26	6.15
8 min.	87.98	2.76	35.09	12.20	1073.35	5.62
10 min.	92.32	2.48	42.31	12.50	1154	4.99
12 min.	90.31	2.42	43.13	12.73	1149.64	4.51

Table 3 Effect of Pre-Germination Exposure with Different Dose of He-Ne Laser on JS-335 Soybean Seed (12 months old seeds).

Treatment	Germination %	MGT	SOG	Seedling Length	Vigour Index	E.C. ($\mu S.Cm.^{-1}gm.^{-1}ml.^{-1}$)
Controlled	74.98	3.12	25.56	10.50	787.29	12.07
2 min.	78.31	3.12	26.84	10.43	816.77	11.20
4 min.	79.31	2.91	30.65	10.63	843.06	10.47
6 min.	81.98	2.79	32.28	10.83	887.84	10.03
8 min.	85.31	2.77	33.95	10.86	926.46	9.11
10 min.	88.65	2.50	40.09	11.03	977.80	9.11
12 min.	84.64	2.40	40.28	11.26	953.04	9.06

Table 4 Effect of Pre-Germination Exposure with Different Dose of He-Ne Laser on JS-335 Soybean Seed (18 months old seeds).

Treatment	Germination %	MGT	SOG	Seedling Length	Vigour Index	E.C. ($\mu S.Cm.^{-1}gm.^{-1}ml.^{-1}$)
Controlled	67.31	3.92	16.59	7.33	493.38	14.40
2 min.	71.65	4.10	18.09	7.46	534.50	14.16
4 min.	72.64	3.91	19.56	8.06	585.47	13.53
6 min.	76.31	3.50	21.09	8.20	625.74	13.14
8 min.	79.98	3.49	22.17	8.43	674.23	12.46
10 min.	74.98	3.48	24.66	8.60	705.02	12.02
12 min.	81.64	3.45	24.97	8.93	729.04	11.93

Table 5 Germination percentage and Electrical Conductivity of Seed Leachate for Different Aged Seeds.

Sample	FreshSeeds		6 Months old Seeds		12 Months old Seeds		18 Months old Seeds	
	Germination %	E.C. ($\mu S.Cm.^{-1}gm.^{-1}ml.^{-1}$)	Germination %	E.C. ($\mu S.Cm.^{-1}gm.^{-1}ml.^{-1}$)	Germination %	E.C. ($\mu S.Cm.^{-1}gm.^{-1}ml.^{-1}$)	Germination %	E.C. ($\mu S.Cm.^{-1}gm.^{-1}ml.^{-1}$)
Controlled	82.31	7.66	77.32	9.31	74.98	12.07	67.31	14.40
2min.	84.98	6.69	79.32	8.19	78.31	11.20	71.65	14.16
4min.	92.98	5.86	81.64	7.32	79.31	10.47	72.64	13.53
6min.	94.65	5.23	84.98	6.15	81.98	10.03	76.31	13.14
8min.	96.98	4.70	87.98	5.62	85.31	9.11	79.98	12.46
10min.	97.65	4.36	92.32	4.99	88.65	9.11	74.98	12.02
12min.	97.31	4.21	90.31	4.51	84.64	9.06	81.64	11.93

Conclusion

The germination of each seed is consider as one of the first and most fundamental life stage of a plant, so that the success in growth and yield production is also dependent on this stage. Based on the results obtained from this study it can be conclude that the Laser irradiation on seeds is more beneficial in order to obtain the maximum crop production and quality, seeds germinates quickly and have uniform seedling. The electrical conductivity method is the best and quick method as compared to other vigour test methods to predict the quality of seeds.

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