International Interdisciplinary Virtual Conference on
'Recent Advancements in Computer Science, Management and Information Technology'
International Journal of Scientific Research in Computer Science,
Engineering and Information Technology | ISSN : 2456-3307 (www.ijsrcseit.com)

Laser and UV Radiations Impact On Seed Germination and Growth of Sunflower and Soybean Seeds – A Review

P.R. Khawane[1], G.T. Bhalerao[1], R.S. Nikam[2], Farhan Ahamad[3], R. K. Shirsat[3], H. J. Kharat[3], S. K.Devade[3]

[1]Department of Physics, Mahatma Phule Arts and Science College Patur, Dist. Akola, Maharashtra, India

[2]Department of Physics, Vidnyan Mahavidyalay Malkapur Dist. Buldhana, Maharashtra, India

[3]Department of Physics, Shankarlal Khandelwal Arts, Commerce and Science College Akola, Dist. Akola, Maharashtra, India

ABSTRACT

LASER stands for Light Amplification by stimulated emission of radiation. It has seen that Laser technology has tremendous applications in the field of agriculture. Also, it has observed the UV radiation's intensity is increasing day by day because of depletion of Ozone layer. The use of UV radiation in the field of agriculture also has shown positive results. Application of UV and Laser radiation in agriculture is the current and important topic of research. Laser and UV radiation are used as bio-stimulator where seeds are treated with low intensity. The pre-sowing physical treatment to seeds are low cost and better option. The promising effects of these radiations leads to new dimensions towards producing high quality agriculture products. Oilseeds are one of the most important determinant of our Indian economy. This review paper represents important oilseeds and Laser as well as UV radiation's impact on germination of Sunflower and Soybean seeds.

Keywords: Laser, UV, bio-stimulator, Sunflower, Soybean.

I. INTRODUCTION

The laser is one of the most important rays used in the past and to this day in leveling the earth for cultivation. The word laser is an acronym made up of the first letters of the phrase (light amplification by stimulated emission of radiation). This technique is now well known and accepted by growers. Meanwhile, this technology has also been shown to be not so costly and within the reach of a farmer for his specific requirements (1). Nowadays, some equipment is complemented by space age technologies that allow farmers to grow their crops in more precise and efficient way to cultivate. These technologies include global positioning systems (GPS), geographic information systems (GIS), yield mapping, variable rate application technology, controllers, lasers, and remote sensors. Precision agriculture (the art of using these technologies to control soil leveling, increase yields and profits while protecting the environment) is becoming more prevalent in agriculture. The results obtained in the application of laser irradiation of plant organisms continue to attract scientific interest - in the past by He-Ne lasers and nowadays by semiconductor lasers (2).

There are several ways to promote seed germination, such as the environmentally friendly irradiation of seeds with ultraviolet light-emitting diodes (LEDs) before sowing (3,4). This photoelectric technology is inexpensive and harmless to humans because it is based on natural mechanisms (5,6). In addition, UV irradiation of seeds accelerates the synthesis of active compounds by stimulating phenol metabolism in plant cells (7). A literature review and previous studies show that irradiation of seeds of agricultural plants with UV radiation has beneficial effects and improves germination rates (8-10).

Studies on improving germination rates of seeds by UV irradiation before planting are aimed at increasing the reproductive capacity. The effects of UV irradiation have not been sufficiently studied for the seeds. Therefore, it is a scientifically relevant problem to analyze the effects of UV LEDs in the preparation of seeds before sowing. The aim of this study is to investigate how ultraviolet radiation affects seed germination rates.

II. LITERATURE REVIEW

- Although the oilseeds are energy-rich crops that require higher inputs and better management practices, more than 85% of the area under oilseeds are energy-rich crops requiring higher inputs with better management practices, but more than 85% of the area under oilseeds is rain-fed and managed under low-energy conditions with low inputs and poor management practices, as all the genetic potential of the crops remains unused, which explains the wide variability and poses a high risk.
- Due to the greater importance given to field cereals, progress is not very great, and these crops are usually grown in marginal areas and underwater, where soil fertility for growing field cereals is low, so farmers use these crops only to leave the land fallow.

In addition, these crops are usually grown by farmers in marginal areas who are not irrigated and use poor management practices. Also, input use is very low and farmers are not adapted to new technologies, and due to declining land ownership, mechanization is not very popular.

- These crops are highly affected by pests and diseases. Pests such as aphids and diseases such as powdery mildew and rust cause production losses of up to 50%.
- Technology transfer from the laboratory to the farm is insufficient. The supply of farmers with the technologies and inputs desired by agricultural institutions is very low.

Soybean:

- Drought stress is a major constraint to soybean production and yield stability. For developing high-yielding cultivars under drought conditions, the most commonly used criterion has traditionally been direct selection for yield stability at multiple locations. However, this approach is time and labour consuming because yield is a highly quantitative trait with low heritability and is influenced by differences resulting from soil and environmental heterogeneity.
- Complete flooding at the early seedling stage is a common environmental problem for soybean production worldwide.
- According to MoFA (2006), soybean is harvested when 90% of the pods are yellow or dry. If harvest is delayed beyond this time, it will result in seed bursting, especially in late-planted soybeans whose seeds are mature when the weather is completely dry.

Canola and mustard:

- Flowering and grain filling are the most vulnerable stages to damage from temperature stress, likely due to vulnerability during pollen and grain development, anthesis, and fertilisation, resulting in lower crop yield. High temperatures in brassicas promoted plant development and caused flower abortion and poor grain filling with noticeable losses in seed yield. A 30°C increase in daily maximum temperature (21-24°C) during flowering and grain filling resulted in a 430 kg/had decrease in canola yield.
- The low yield potential of mustard is due to the fact that 30- 50% of mustard flowers do not develop into mature pods. This meansthat the potential number of fruits or seeds is usually much greater than the actual number produced by the plant community. During the reproductive phase, flowering, fruiting, and vegetative growth to physiological maturity occur simultaneously. Therefore, developing reproductive sinks compete with vegetative sinks for assimilates.

Peanut:

Groundnut, popularly known as peanut, is one of the most popular and universal crops in the world, grown in more than 100 countries on six continents.

- The occurrence of pests and diseases is the main problem in peanut production, causing more than 25 percent of yield losses.

Solute leakage as a result of membrane damage is a common response of peanut tissue to various types of stresses, such as low or high temperatures, low soil moisture, or high soil salinity. There is much evidence to suggest that calcium is required to maintain membrane integrity.

Sunflower:

The main physiological limitations in sunflower production are excessive vegetative growth, lack of photosynthetic activity during the seed filling period, poor translocation of photosynthesis, and poor seed set in cultivated hybrids.

Sesame:

Sesame is able to withstand drought by developing an extensive root system, although it suffers significant yield losses during drought when grown on marginal and low-rainfall land. The effect of drought is more pronounced on seed yield of sesame than on other morphological traits (11).

Effects of He-Ne laser on growth of sunflower:

Seeds of sunflower treated with He-Ne laser showed different effects on seed germination rate at different times: As the duration of laser irradiation increased, the seed germination rate first increased and then decreased. Seed germination rate was higher compared to control at irradiation times of 60, 120 and 180 seconds, and the maximum germination rate was 77% at 180 seconds. This indicates that the He-Ne laser can promote the seed germination rate at irradiation time of 60 to 180 seconds. On the other hand, He-Ne laser inhibits the germination rate of sunflower seeds when the irradiation time exceeds 180 seconds. This study demonstrated the effects of He-Ne laser irradiation on the protein content of sunflower seeds at different irradiation times. As the duration of laser irradiation increases, the protein content first increases and then decreases at an irradiation time of 240 seconds. The germination rate of seeds at 120 and 180 seconds was higher than that of the control. The protein content in the seedlings reached a maximum of 1.3 mg/ml at 180 seconds, which was 1.9 times that of CK (control group). When the irradiation time of the laser exceeds 180 s, the protein content decreases sharply. The results of the t-test were highly significant and therefore proved to be very reliable (12).

Effects of UV radiation on growth of sunflower:

Another study proved that when Sunflower seeds were treated with UV radiations it significantly enhanced the leaf biomass.

Chlorophyll contents were higher at vegetative stage as compared to flowering stage. Total soluble proteins, total soluble sugars and total phenolics were increased after UV treatment. Moreover, flavonoid contents were increased by all pre-sowing, but reverse was displayed by anthocyanin at vegetative stage and no effect was noted at flowering stage. However, oil contents showed decreased in response to UV radiation treatment. In conclusion, physical seed pretreatments proved pragmatic option to improve growth and metabolite accumulation especially at vegetative stage in sunflower. Moreover, lower dose of UV treatment improved the yield in term of achenes per capitalism along with achene oil percentage (13).

Effects of Nd- YAG laser on Soybean:

The effect of pre-sowing laser treatment on soybean seeds was studied using a neodymium-doped yttrium aluminium garnet (Nd-Yag) laser source at a wavelength ʎ = 532 nm. Uniform soybean seeds (Glycine max L.) were irradiated with laser for 5, 10, 30, 60, and 120 min. The growth potential of the 4-week-old seedlings was progressively increased with increasing duration of laser treatment. In this study, the protein binding patterns of the leaf pools of the irradiated and non-irradiated control plants were examined to clarify the role of the laser at the molecular level. The obtained results clearly showed that vegetative growth of soybean seedlings (4 weeks old) was significantly increased after Nd-Yag laser treatment.

Effects of 660 nm laser irradiation of soybean seeds on germination, emergence and seedling growth:

The aim of the experiments was to investigate the influence of irradiating soybean seeds (Glycine max, cultivar BRS 537) with a 660 nm laser diode array. The seeds were treated with laser light delivered by a device assembled for the experiments with an output power of I = 3.5±0.2 mW cm-2. The effects of biostimulation were analyzed by determining the germination percentage and dry mass of normal seedlings in a germination experiment. In addition, seedling emergence percentage, emergence rate, and mean emergence time were determined in a greenhouse experiment. Irradiation of seeds with laser light showed a positive effect on bio stimulation in two of the three treatments with light compared to the control (without irradiation). The light dose of 1.6 J cm-2 (t = 457.14 s) significantly increased the germination percentage (5.5%), dry mass (58%), and emergence rate (29%) of normal seedlings and decreased the mean emergence time by 10%, while a dose of 3.2 J cm-2 (t = 914.28 s) significantly increased the dry mass (84%) and emergence rate (13%).

III. CONCLUSION

laser irradiation at 660 nm is able to increase the germination potential of seeds if the light dose is appropriate. Some of the positive effects of laser biostimulation occur in the initial stages of seedling growth, increasing the rate of development of seedling structures and consequently their dry mass. Irradiation of seeds with laser light of 660 nm may have negative effects on growth if the light dose is not appropriate. The results suggest that laser irradiation of seeds before sowing can increase the rate of seedling emergence and thus shorten the mean time required for them to emerge from the soil.

The application of empirically selected algorithms for laser irradiation of soybean seeds resulted in a significant increase in germination. The best germination rate resulted from photo-stimulation of seeds with a 632.8 nm laser light. Irradiation with 514 nm laser light resulted in the greatest increase in soybean seedling biomass. Sunflower seeds treated with He-Ne laser showed different effects on germination rate at different times . As the irradiation time of the laser radiation on the seed was increased, the seed germination rate first increased and then decreased.

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