

# Effect of Laser and UV Radiations on Germination, Growth and Chlorophyll Content of Brassica juncea

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## ABSTRACT

The present study was conducted to determine the dose of red laser, green laser, UV-A, UV-B and UV-C at which the lethality of the seedling is 50%. For this purpose, the uniform seeds of Brassica juncea (mustard) variety TAM 108 were irradiated with laser and UV radiation at different time intervals. Treated and untreated seeds are kept for germination in two replicates. Accordingly, the LD 50 value of Brassica juncea is determined for the red laser, green laser, UV-A, UV-B and UV-C. The seeds treated with higher LD 50 value were analyzed together with the untreated control seeds for their degree of germination. Afterwards the time for irradiation was chosen and presowing irradiation treatment was given to the seeds and their germination, growth and chlorophyll content was studied for laser and UV radiations. The Red laser shows significant effect on germination growth as well as chlorophyll content followed by UV A radiations. While, the UV C shows negative effect on growth, germination and chlorophyll content of Brassica juncea.

**Keywords:** LD 50 value, Glycine max AMS-100-39, Brassica juncea TAM-108, red laser, green laser, UV-A, UV-B, UV-C.

## I. INTRODUCTION

Oilseeds cover nearly 72% of India's rainfed area. Among the nine oilseeds available in India, the area under Mustard is about 24%. The share of yield is also 29% respectively (1). Members of the family brassicaceae are used as pot -herb and are very important worldwide for their chemical constituent's flavonoids and mineral nutrients. To promote oilseed

production, the Union government launched the program "The National Mission on Edible Oilseeds". The aim of the program is to increase domestic oilseed production and reduce the country's dependence on edible oil imports. The development of various agricultural technologies, such as chemical and biological growth promoters and the use of fertilisers, pesticides and plant protection products, leads to an ecological imbalance. For this reason, it is essential to

develop new technological methods that make it possible to unlock the genetic potential of plants and achieve higher yields without harming the environment (2). The main objective of this study is to analyse the effect of laser, UV-A, UV-B and UV-C irradiation before sowing on the percentage of germination of *Brassica juncea* L. and to determine the LD<sub>50</sub> value, growth and chlorophyll content. The LD<sub>50</sub> value is the amount of radiation treatment that leads to death in 50% of the test seed group. The determination of the LD<sub>50</sub> value is of great importance for any plant breeding experiment (3). In order to produce as many viable mutants as possible with minimal damage to the plant, the LD<sub>50</sub> value should be determined (4). It is therefore advisable to determine the LD<sub>50</sub> value before each irradiation treatment. Laser and UV radiation are considered as one of the physical methods that can be safely used to improve crop quality and yield (5). In general, seed stimulation is performed with low doses of laser radiation. Seed stimulation is most commonly performed with low power lasers and relatively long exposure times, measured in seconds or minutes. Higher doses affect the genetic material of the cell, leading to genetic changes in plant traits (6).

Plants depend on energy from the sunlight for their growth and development. It is seen that small change in the wavelength of light can cause the changes in the physiology as well as biochemistry (7). Throughout the life cycle of plants the light regulates the plant physiology (8). Among the whole living system on the planet, plants show the adaptation to absorption and transmission of light. Hence, the study of effect of different light wavelength on plant is important. In recent years, considerable progress has been made in researching the physiological and biochemical effects of light quality on crops. However, understanding how light quality affects plant growth and development remains a complex challenge (9). The recent study shows that the Phytochrome B which is the primary photoreceptor involved in red light induced germination regulates the germination (10).

Various studies have shown how the light quality regulates the plant growth. Red and blue light are most commonly used to regulate the quality of light for plant growth and development and have similar effects on plants, involving a variety of mechanisms such as the growth of plant roots, stems, leaves, flowers, fruits and the absorption of water and mineral elements, and the regulation of photosynthetic pigments, stomatal formation and the process of sugar metabolism (11 -14)

Laser has many types such as Argon Laser, Cobalt laser and many other. One of those types are Helium – Neon Laser and diode Laser. They are most familiar and least expensive. The amazing characteristics of laser radiation such as monochromatism, polarization, coherence and high density can be used in all spheres of engineering as in biology and plant growing (15). Ultraviolet radiation is form of non ionising radiation found at the lower end of the electromagnetic spectrum between x –rays and visible light. The UV-portion of the spectrum is divided into three categories: UVC (220-290 nm), UVB (290-320 nm), UVA (320-400 nm) The longer wavelengths although with less energy, can penetrate deeper into biological tissue therefore can impact biological system.

The present study aimed to evaluate the effect of Laser and UV radiation pretreatment of *Brassica Juncea* Seeds on germination, growth parameters and some physiological parameters and to provide information for the future investigation about how and why Laser or UV or both treatment can improve the *Brassica juncea* growth and productivity.

## II. MATERIALS AND METHODS

- 1) Uniform seeds of *Brassica juncea* (Mustard) of variety TAM 108 are chosen. 20 seeds are used for each treatment. All the seeds of each selected oil seed were grown in petri plates and in soil in sapling bags.
- A) LASER: The source of laser irradiation was located at Department of Physics SKC Akola. The

laser used are Red Laser with output power of 2mW with wavelength 632.8 nm and Green Laser (diode Laser) with wavelength 532nm with very low output power. The irradiation time of seeds was- 10,20,30,40,50, 60 and 90 min.

- B) UV-A: The UV-A blue light of wavelength 395nm with very low output power is used. The irradiation time of seed was 10,20,30,40,50,60,70,80,90 min.
- C) UV-B: The UV-B source of wavelength 265nm with output power 25mW is used. The irradiation time of seed was- 5,10,20,30,40,50,60,70,80,90 min.
- D) UV-C: The UV-C source of wavelength 280 nm with output power 11mW is used. The irradiation time of seed was- 5,8 and 10 min
- E) LD<sub>50</sub> value determination and seed germination: The Red Laser, Green Laser, UV-A, UV-B and UV-C irradiated seeds were germinated on moist filter paper in sterile petri dishes. Petri plates were kept at room temperature. Observation on germination was recorded daily. Small amount of distilled water was added periodically so that the petri plates remain moist. To determine LD<sub>50</sub> value all the seeds of different time exposure to various radiation were made to germinate. The dose of red laser, green laser, UV-A, UV-B and UV-C at which the lethality of the seed is 50% gives the LD<sub>50</sub> value.

A seed was considered to have germinated when the radicle emerged. Counts of germinated seeds were made daily for seven days. Seed germination was calculated as percentage of total seeds used. The changes in seed germination is observed and compared with the non-treated control seeds.

The seeds were sown in sapling bags having equally weighted soil. They are watered regularly and observed the growth for almost 110 days. After every 15 days the physical parameters like shoot length, average no. of leaves, average no. of branches, leaf size etc were studied and compared. The number of days required for flowering, average no. of flowers, average

no of pods was studied. At the end of the experiment the length of the root was studied.

- F) Estimation of chlorophyll content The plants were grown in natural conditions of light and temperature and were watered regularly. The process was conducted on 55<sup>th</sup> day. The 10<sup>th</sup> leaf from the tip of every treated plant was chosen and detached. The leaf is then transferred to laboratory and following procedure was done to estimate the chlorophyll content. 80% Acetone solvent is used for the process. 0.25gm of leaf sample was grounded in 20 ml of 80% acetone. The sample was then filtered and the final volume was made up to 25ml. The volume was then used in spectrophotometer and recorded the absorbance at 663, 646 and 470 nm. The calculations were done using following formulae:
- $$\text{Chl a} = 12.25 (A_{663}) - 2.79 (A_{646})$$

$$\text{Chl b} = 21.5 (A_{646}) - 5.1 (A_{663})$$

$$\text{Total chlorophyll} = \frac{5.24 (A_{663}) - 22.24 (A_{646})}{FW} \quad (16)$$

### III.RESULT AND DISCUSSION

#### LD<sub>50</sub> Value and Seed germination

In present study it became determined that the seed germination is affected extra in case of higher radiation time. Germination of the seed is viability, that's substantially stricken by radiation as the dose of radiation increases. Fig 1 and 2 of displays Red laser and Green laser treatment to Brassica juncea. The Fig 3, 4 and 5 shows UV- A, UV- B and UV- C treatments to Brassica juncea respectively. The seed germination percentage determined to decrease with higher exposure time for all the radiations. As the dose of irradiation increases there is slow decrease in germination. This is very well in agreement with the end result that excessive irradiation reduces the seed germination. The Brassica juncea of selected variety suggests fantastic consequences for seed germination in case of seeds irradiated with Red and Green laser as nicely with UV radiations as compared to govern.

The higher irradiation treatment effects in damage of cellular constituents (17). In addition, decrease doses of laser spark off vegetation, resulting in growing bioenergetical capacity of the cells and better activation in their biochemical and physiological tactics (18). Higher doses of UV radiations display terrible end result for seed germination (19-20). The results show that irradiation treatment with laser and UV indicates effective impact on boom of mustard seeds reducing losses at germination level (21). The radiation remedy leads to new dimension in the direction of producing high satisfactory agriculture products. bodily methods together with mild irradiation for seed biostimulation are taken into consideration as a promising path with the capacity for the seed treatment discipline, that is due to the fact that it's far based on the activation of photoreceptors with the aid of visible mild avoids chemical waste generation. (22). After determination of LD50 value the radiation dose was constant for every radiation so that to get the maximum seed germination percent. The germination percent of the seeds after radiation treatment was studied. The germination percentage changed into observed maximum for the red laser and is 90%. Thereafter 80% germination was observed for each UV A and UV B accompanied with the aid of Green laser and control both 60%. Lowest germination percent become recorded for UV C and is 50%.

### Shoot and Root length and leaf size

The early growth stages of seeds and seedlings are very sensitive to any environmental effect including UV light (23,24). Fig. 9 Shows the average shoot length observed for every 15 days for each radiation treatment. It was found that the red laser treatment is more effective than all the others followed by UV A treatment. The results show correspondance with the results that Red (He-Ne) laser pretreatment cause the increase in shoot length. (25) The shoot length of the UV B treated one was average but more than the ones treated with Green laser, UV C and Control. The

shoot length for the one treated with Green laser and control was almost same. This shows that Green laser treatment has shown no significant change in shoot length. On the other hand, UV C treatment shows negative effect on shoot length as the observed shoot length was lowest of all.

The average root length was found maximum i.e. 36 cm for Red laser treatment followed by UV A treatment 30cm. The root length for Green laser treatment and control was almost same i.e. 24 and 23 cm which is followed by UV B treatment and lowest was found for UV C treatment. The Red laser and UV A treatment shows significant effect on leaf length and breadth. it is followed by the Green laser treatment and control one shows almost same results. On the other hand, UV B and UV C treatment show no significant effect on leaf size. The results matches with the one recorded by R. Neelmegam et al. (26)

The early increase degrees of seeds and seedlings are very sensitive to any environmental effect which includes UV mild. Fig. 7 suggests the average shoot length observed for each 15 days for each radiation treatment. It was found that the Red laser treatment is more powerful than all of the others followed by using UV A treatment. The results show correspondance with the effects that Red (He-Ne) laser pretreatment propose the growth in shoot period. The shoot length of the UV B handled one was average however more than the ones handled with green laser, UV C and untreated control. The shoot period for the one dealt with with Green laser and control turned into almost equal. This suggests that green laser treatment has proven no tremendous change in shoot length. alternatively, UV C treatment affects the shoot length because the determined shoot length turned into lowest of all.

The average root duration turned into observed most i.e. 36 cm for Red laser treatment accompanied with the aid of UV A treatment 30cm. the root length for Green laser treatment and control changed into nearly identical i.e. 24 and 23 cm which is followed through UV B treatment and lowest became found for UV C.

The Red laser and UV A treatment indicates significant effect on leaf duration and breadth. It is followed with the aid of the Green laser remedy and manipulate one suggests almost identical outcomes. On the other hand, UV B and UV C treatment show no extensive effect on leaf size. The results suit with the only recorded by way of R. Neelmegea et al. 2015.

**Chlorophyll a and b content** Germination of seeds irradiated with UV light and its chlorophyll content is also subjected to the plant growth stage and environmental factors (27,28). In the present study the chlorophyll content was found maximum for Red

laser treatment followed by the control. The Green laser treatment shows moderate effect on chlorophyll content but the UV radiation treatment shows the decrease in the chlorophyll content. The cell division process in plant cell is increased due to laser treatment as recorded by J. Ahmad et al. (29). The chlorophyll a content was found to decrease while that of chlorophyll b content was more than a. This corresponds with the results by Shaukat et al. (30), who recorded that UV radiation decreases the chlorophyll a content and there is no significant effect on chlorophyll b content.

**Table 1.** Effect of Laser and UV Radiations on mustard

| Wavelength                           | 632 nm<br>red laser | 532 nm<br>green Laser | 395 nm<br>UV- A | 295 nm UV-B | 280 nm UV-C | Control |
|--------------------------------------|---------------------|-----------------------|-----------------|-------------|-------------|---------|
| LD 50 Value min                      | 90                  | 90                    | 70              | 50          | 8           | -       |
| Chosen time                          | 30                  | 30                    | 50              | 20          | 5           | -       |
| Germination% after 8 days            | 90                  | 60                    | 80              | 80          | 50          | 60      |
| Average Shoot length in cm           |                     |                       |                 |             |             |         |
| After 15 days                        | 10                  | 8                     | 12              | 9           | 5           | 6       |
| After 30 days                        | 20                  | 11                    | 18              | 17          | 13          | 12      |
| After 45 days                        | 23                  | 17                    | 20              | 19          | 15          | 17      |
| After 60 days                        | 32                  | 25                    | 28              | 28          | 21          | 22      |
| After 75 days                        | 38                  | 28                    | 32              | 30          | 25          | 25      |
| After 90 days                        | 42                  | 30                    | 38              | 30          | 26          | 30      |
| After 105 days                       | 50                  | 30                    | 45              | 30          | 26          | 30      |
| Average No. of branches              |                     |                       |                 |             |             |         |
| After 15 days                        | 3                   | 2                     | 3               | 2           | 2           | 3       |
| After 30 days                        | 5                   | 3                     | 3               | 4           | 3           | 3       |
| After 45 days                        | 5                   | 3                     | 5               | 4           | 4           | 6       |
| After 60 days                        | 7                   | 4                     | 6               | 4           | 5           | 6       |
| Average Leaf size in cm <sup>2</sup> |                     |                       |                 |             |             |         |
| After 15 days                        | 4.5*3               | 4.5*1.8               | 5*2             | 3*1.8       | 2.8*1.6     | 3.4*3   |
| After 30 days                        | 8 *4.5              | 6*4                   | 7.2*4           | 6*3         | 5.5*3       | 6*4     |
| After 45 days                        | 11*6                | 8*4.3                 | 9*5.2           | 6.7*4.8     | 6*3         | 8*5     |
| After 60 days                        | 11.2*7.9            | 8*4.3                 | 10*6.5          | 7.2*5.6     | 6*3         | 8*5.3   |
| Average leaves no to each branch     |                     |                       |                 |             |             |         |
| After 15 days                        | 6                   | 3                     | 5               | 5           | 3           | 4       |
| After 30 days                        | 8                   | 4                     | 8               | 6           | 5           | 6       |
| After 45 days                        | 5                   | 3                     | 5               | 6           | 5           | 4       |

| Wavelength                               | 632 nm<br>red laser | 532 nm<br>green Laser | 395 nm<br>UV- A | 295 nm UV-B | 280 nm UV-C | Control |
|------------------------------------------|---------------------|-----------------------|-----------------|-------------|-------------|---------|
| After 60 days                            | 7                   | 4                     | 6               | 4           | 5           | 6       |
| Average Flowering period in days         |                     |                       |                 |             |             |         |
| days                                     | 60                  | 100                   | 69              | 92          | -           | -       |
| Average No. of Flowers per plant         |                     |                       |                 |             |             |         |
| Average flowers per plant                | 20                  | 5                     | 12              | 8           | -           | -       |
| Average no of matured pods               |                     |                       |                 |             |             |         |
| Average no of matured pods               | 8                   | 1                     | 5               | 1           | -           | -       |
| Average root length after 115 days in cm |                     |                       |                 |             |             |         |
| Average root length                      | 36                  | 24                    | 30              | 22          | 17          | 23      |

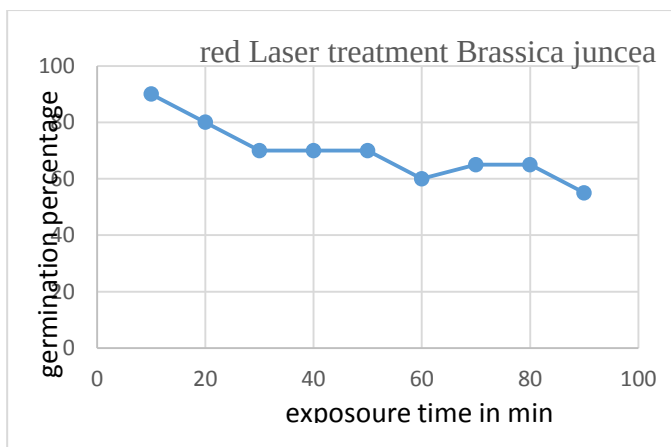


Fig 1: red Laser treatment Brassica juncea

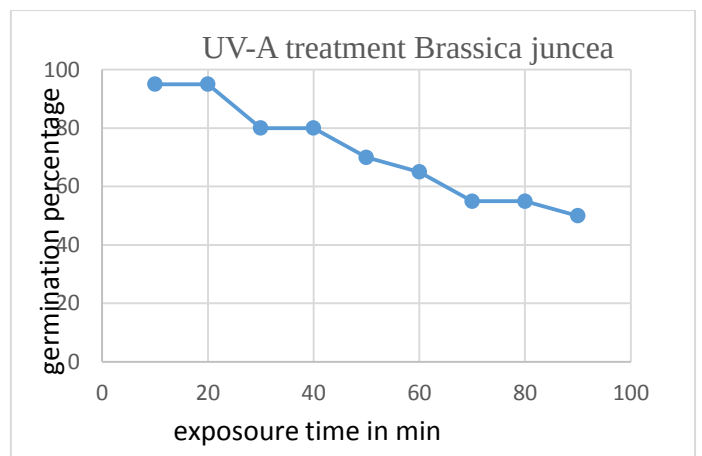


Fig 3: UV- A treatment Brassica juncea

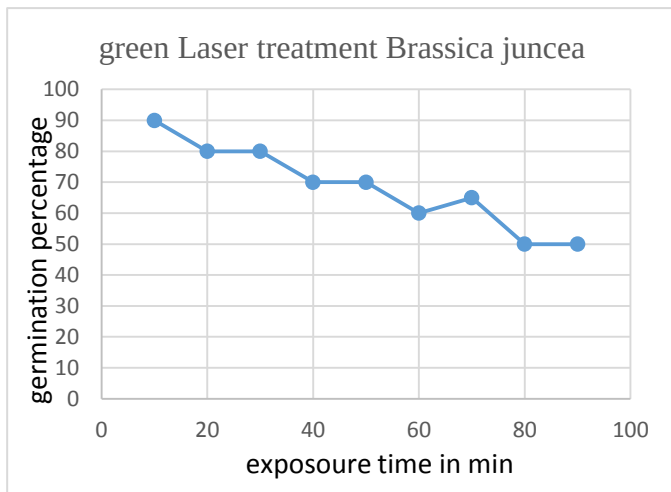


Fig 2: green Laser treatment Brassica juncea

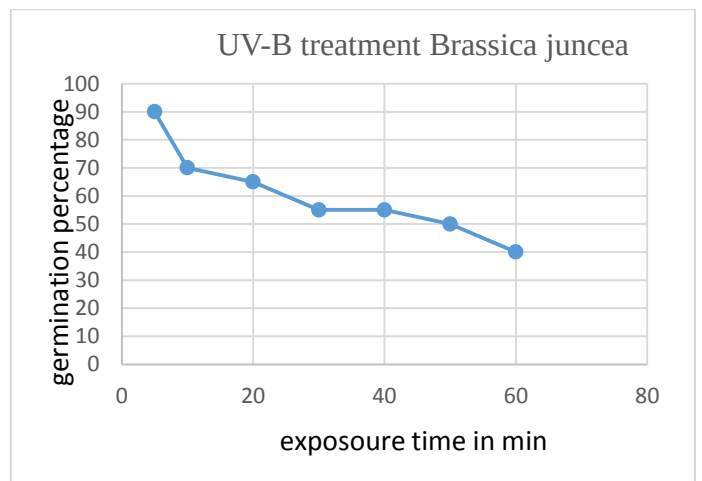


Fig 4: UV- B treatment Brassica juncea

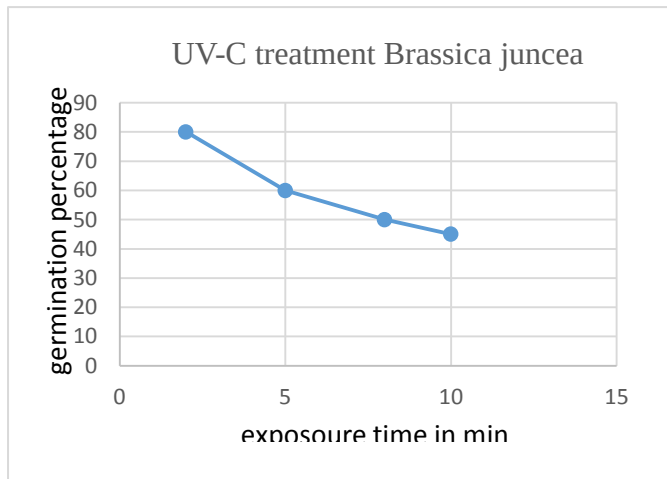


**Fig 5:** UV-C Treatment Brassica juncea

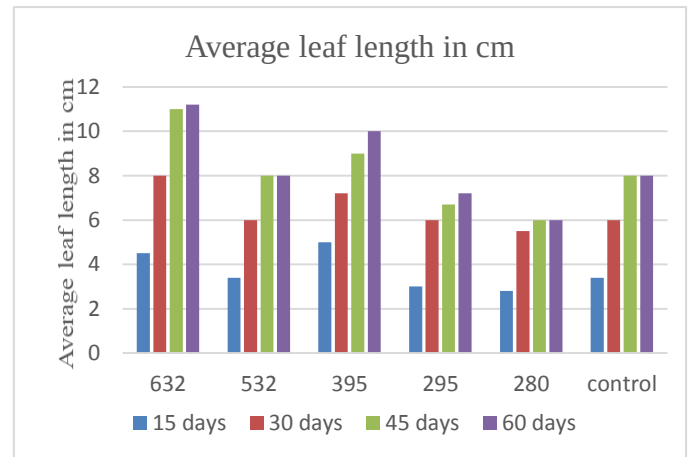


**Fig 9:** Average leaf length

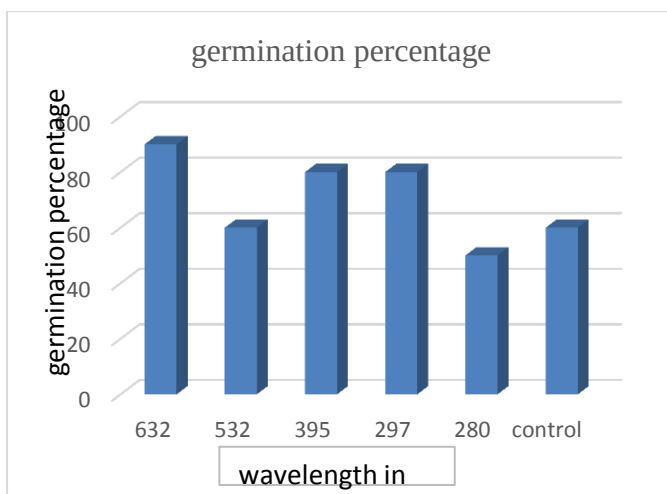


**Fig 6:** after radiation treatment germination percentage

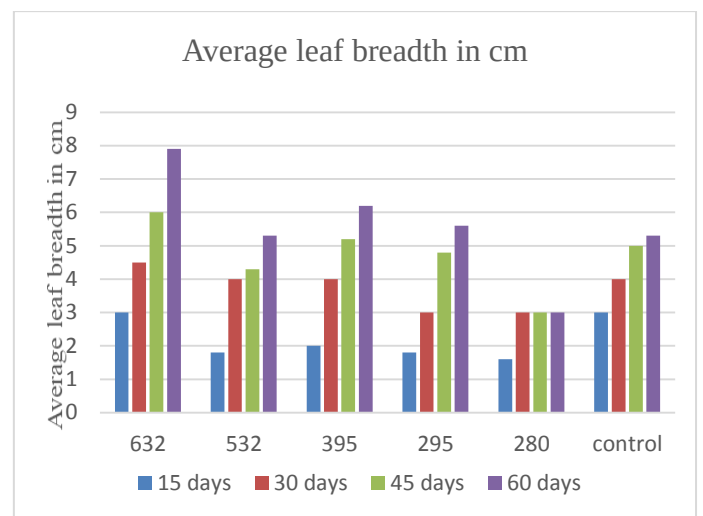


**Fig 10:** Average leaf breadth

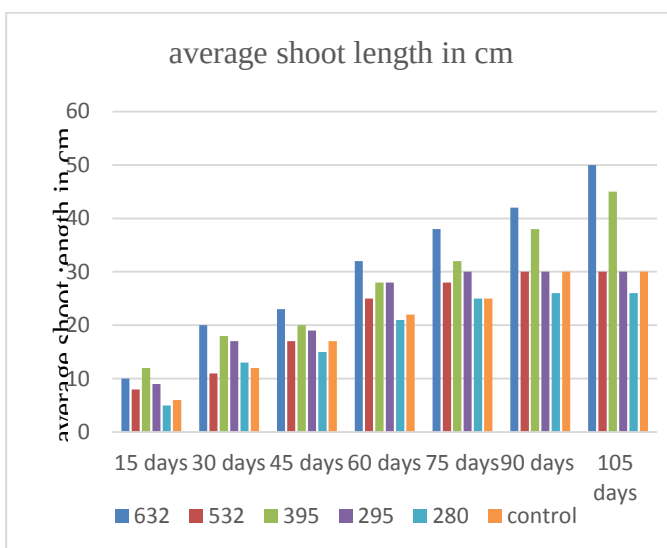


**Fig 7:** Average shoot length

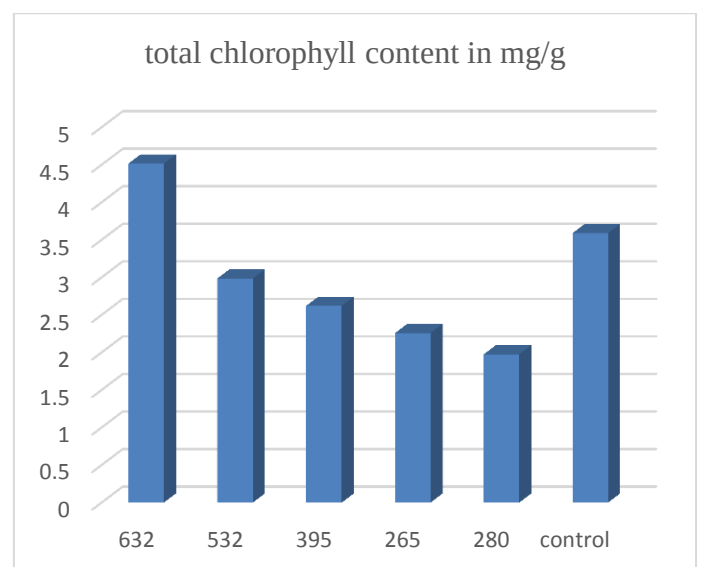


**Fig:** Total chlorophyll content

#### IV. CONCLUSION

Laser and UV radiations play an important role in biostimulation of seeds at lower irradiation time. So determination of LD<sub>50</sub> value i.e. irradiation time at which survivability of seed is 50% is necessary to select proper irradiation time for Brassica juncea. Red laser shows significant effect on the germination, growth, other physical parameters and chlorophyll content of the Brassica juncea than Green laser. The results obtained by Green laser treatment and the non treated control was almost same. So it did not show any significant effect on Brassica juncea. While UV A treatment followed the Red laser treatment and show positive effects on the physical parameters of the Brassica juncea. On the other hand, UV B and UV C shows reduction in germination, growth, other physical parameters and total chlorophyll content. Pretreatment of Laser and UV radiations to Brassica juncea seeds is a low cost technique.

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