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Comparative Study of IR and UV-B Radiation Exposure on Germination, Biomass and Chlorophyll Content of *Pisum sativum* (L.)

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Abstract: ***In this field experiment a comparative study has been carried out on Pisum sativum (L.) under the impact of UV-B (Ultraviolet-B) and IR (Infrared) radiation exposure. The seeds were pre-soaked for 24 hours in distilled water. Plants were grown in the field and exposed to supplemental IR (680-700nm) and UV-B (280-320nm) radiation for 1 hr regularly by the filtered sunlamp (300 watt) from sowing till seedling stage. The result showed significant decrease in germination percentage with UV-B radiation exposure. The length of plumul decreased significantly at UV-B radiation exposure while length of radical decreased higher by IR radiation exposure. The fresh weight, dry weight and chlorophyll content reduced significantly while chlorophyll a/b ratio highly increased at IR radiation exposure in comparison to the control plants.***

Keywords: Pisum sativum, IR and UV-B radiation, seed germination, chlorophyll etc**.**

1. Introduction

Pea (*Pisum sativum* L.) is an important legume grown and consumed extensively worldwide. As a rich source of proteins, carbohydrates and vitamins, peas are important in human nutrition. Consumed mostly as green peas, total production worldwide is around 8.3 million tons (FAO, 2008). Pea is the fourth leading legume in terms of consumption in the world. It is mostly grown in temperate regions, at high elevations, or during cool seasons in warm regions throughout the world (Elzebroek and Wind, 2008). Major pea producers are China, India, Canada, Russia, France and the United States (Food and Agriculture Organization, 2012).

In India, the area under green peas produced rose continuously from 177.7 thousand hectares in 1991-92 to 272.6 thousand hectares in 1999-2000. The percentage of area under peas in India to global area under peas has also risen from 3.2 per cent in 1991-92 to 4.5 per cent in 1999-2000. The production of green peas has increased from 1.30 million tonnes in 1991-92 to 3.20 million tonnes in 2003-04 (www.fao.org). In India, fresh peas are used in various dishes such as *aloo matar* (curried potatoes with peas) or *matar paneer* (paneercheese with peas), though they can be substituted with frozen peas as well. Peas are also eaten raw, as they are sweet when fresh off the bush. Split peas are also used to make *dhal*, particularly in Guyana, and Trinidad, where there is a significant population of Indians. The green raw peas (100g) contains carbohydrate 14.45g, sugar 5.67g, fiber 1.5g, protein 5.42g, vitamin A 5%, vitamin B6 13%, vitamin C 48%, vitamin K 24%, phosphorus 15%, magnesium 9%, iron 11%, zinc 13% and calcium 3%.

It is also grown as a commercial crop. Peas are grown alone or with cereals for silage and green fodder (Elzebroek and Wind, 2008). Peas and other legumes are desirable in crop rotations because they break up disease and pest cycles, provide nitrogen, improve soil microbe diversity and activity, improve soil aggregation, conserve soil water, and provide economic diversity (Biederbeck *et al*., 2005; Chen *et al*., 2006). Peas are grown as green manures and cover crops because they grow quickly and contribute nitrogen to the soil (Clark, 2007). Pea roots have nodules, formed by the bacteria *Rhizobium leguminosarum*, which convert atmospheric nitrogen (N2) to ammonia (NH3). UV-B (280-320 nm) radiations are strongly affected by ozone levels. Physiological and developmental processes of plants are directly affected by UV-B radiations. Indirect changes caused by UV-B may be equally or sometimes more important than damaging effects of UV-B radiations. Infrared light (680-700nm) lies between the visible and microwave region of the electromagnetic spectrum. The sun light has about 60% of infrared light. The plants use red and infrared light to regulate different growth processes. Infrared radiations (IR) and UV-B radiations affects plants differently depending on plant species and plants part. Much research work had been done on UV-B radiations effect on plants but very less information is available in reference to the effect of IR radiation on plants growth. Therefore, present study aimed to compare the effect of IR radiation and UV-B radiation exposure on pea (*Pisum sativum* L.) crop in field conditions.

2. Material and Methodology

2.1 Experimental Site

The experiment was conducted at Department of Botany, Govt. P. G. College, Noida, District Gautam Buddha Nagar, (Uttar Pradesh) India.

2.2 Experimental Design

The experimental design consisted of three block deign measuring (1x1 m) during winter season. The soil used in

the experiment was fairly fertile with C, N, P and K amounting to 1.51, 0.12, 0.0006 and 0.08 percent respectively. Soil was clayey and slightly acidic (pH 6.1) in nature with sufficient water holding capacity and conductivity.

2.3 Material Collection

Seeds of *Pisum sativum* were collected from Etawah district of Uttar Pradesh. Seeds were selected uniformly and surface sterilized with 0.1% $HgCl_2$ for one minute, thoroughly rinsed with distilled water and soaked in distilled water for 24 hour the floating seeds were discarded and viable seeds were sown in the field.

2.4 IR and UV Radiation Treatment:

Supplemental IR (680-700 nm) and UV-B (280-320 nm) radiation for same time periods i.e. T_1 (control), T_2 (1 hour UV-B radiation) and T_3 (1 hour IR radiation) was given daily with the help of filtered sunlamp from starting of germination up-to seedling stage of the crop.

2.5 Seed Germination (%)

The germination percentage was calculated by following formulae:

$$\text{Germination \%} = \frac{\text{Number of seed germinated}}{\text{Total number of seeds plotted}} \times 100$$

2.6 Growth Parameters

For growth study, three seedlings were taken from each treatment after 15 days of seed germination and washed thoroughly with tap water to remove the adhering soil partials. Seedlings were dissected in radicle, plumule and cotyledons for growth measurements. Different growth parameters viz. length, fresh and dry weights were measured.

2.7 Total Biomass

Method of (Odum, 1960) was adopted for biomass studies. The seedlings were dissected in to radicle, plumule and cotyledons and oven dried for about 72 hour at 60 ^{0}C and then dry weight was recorded for each part of the seedlings. The mean values with standard deviation of three seedlings from each plot were calculated, represented in the results with the help of SPSS 15.0 software.

2.8 Chlorophyll Estimation

250 mg fresh leaves were homogenized with 80% acetone, centrifuged at 4000 rpm, for 5 minutes. Filtrate was taken out and final 10 ml volume was made by using 80% acetone. Optical Density was read at 645, 652 and 663 nm with the help of Systronics 105 spectrophotometer. The chlorophyll content was estimated by the formulae given by Arnon, (1949) which are expressed below:

Chl. ‘a’ mg/g =12.7 (D663) – 2.69 (D645) x V/1000 x W
Chl. ‘b’ mg/g = 22.9 (D645) – 4.68 (D663) x V/1000 x W
Total chl. mg/g = D 652 x 1000/34.5 x V/1000 x W

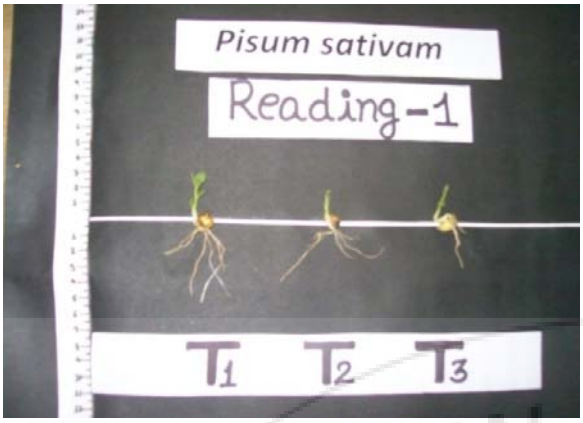
There were three replicates used for the chlorophyll estimation study and mean values with standard deviation of each plot were calculated, represented in the results with the help of SPSS 15.0 software.

3. Results and Discussion

In present investigation, the data given in plat 1 and figure (1, 2, 3 4 and 5) showed that seed germination percentage was decreased up to 23.81% by 1 hour supplemental UV-B exposure while up to 12.70% by 1 hour supplemental IR exposure as compared to control. Siddiqui *et al*., (2007) observed the same results in soybean (*Glycine max* L.) crop whereas Farokh *et al.*, (2010) observed that UV-B radiation promotes the seed germination in safflower (*Carthamus tinctorious*).

Length of radicle was declined up to 30.73% by 1 hour IR while in 1 hour UV-B exposure it decreased 26.14% and plumule length decreased up to 35.92% by 1 hour UV-B exposure however it decreased up to 27.07% with 1 hour IR radiation exposure. The fresh weight of radicle, plumule and cotyledons was declined up to 48.34%, 47.52% & 46.15% respectively by 1 hour supplemental IR radiation and 36.42%, 27.72% and 33.33% by 1 hour UV-B radiation exposure respectively. Dry weight of radicle, plumule and cotyledons was declined up to 24.49%, 38.71% & 42.85% respectively with 1hour IR exposure while it declined up to 16.32%, 35.48% and 14.28% respectively with 1 hour of supplemental UV-B radiation exposure. Similar findings were reported by Wang *et al.*, (2007) in *Cucumis sativus* L., Tevini *et al*., (1981) in *Phaseolus vulgaris* and *Hordeum vulgare* and Pal *et al*., (1995) in *Vigna radiata* observed that UV-B radiation induced reduction in fresh weight, dry weight and length of seedlings.

Chlorophyll ‘a’ chl ‘b’ and total chlorophyll was decreased up to 22.59%, 56.06% and 20.96% respectively with 1 hour supplemental IR exposure while it decreased up to 5.55%, 10.22% and 12.14% respectively by 1 hour UV-B radiation exposure and a/b ratio was increased up to 80.92% with 1 hour supplemental IR exposure and 5.18% with 1 hour UV-B radiation exposure. Significant reduction in different chlorophyll pigments by supplemental UV-B exposures were also investigated by Duysen *et al.*, (1985) in *Glycine max* L.; Sharma *et al.*, (1988) in *Pisum sativum* while Deckymn and Impens, (1995) reported enhancement in chlorophyll content in *Phaseolus vulgaris* (L.). Goyal *et al*., (1987) observed that chl a, chl b and protochlorophyll inhibited by UV-B radiation but reversed by IR radiation in *Cucumis utillissimus* plants.



Plat: Morphological comparison of germinated seedlings of *Pisum sativum* (L.) from different treatment of supplemental IR and UV-B radiation exposure.

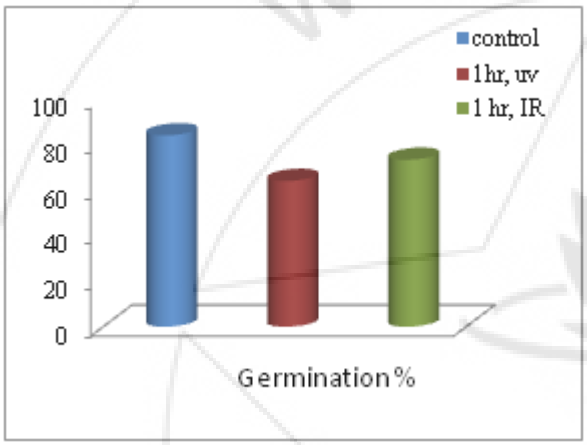


Figure 1: Effect of suplemental IR and UV-B radiation exposure on seed germination % of *Pisum sativum*(L.).

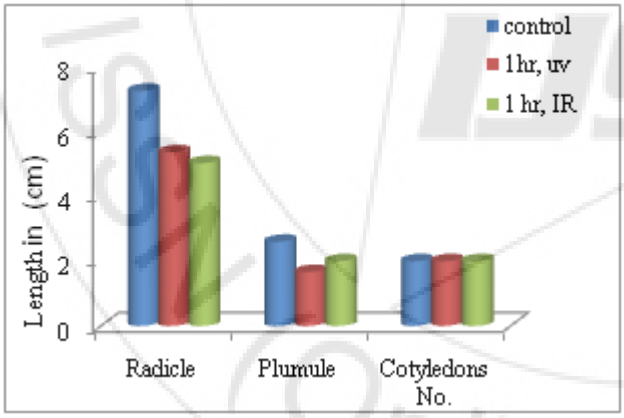


Figure 2: Effect of suplemental IR and UV-B radiation exposure on seedling length of *Pisum sativum*(L.)

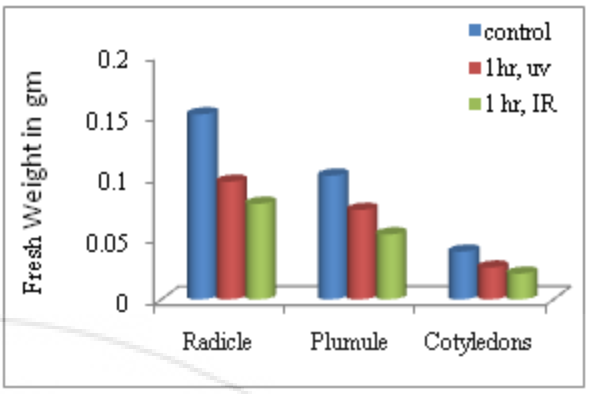


Figure 3: Effect of suplemental IR and UV-B radiation exposure on fresh weight of *Pisum sativum*(L.)

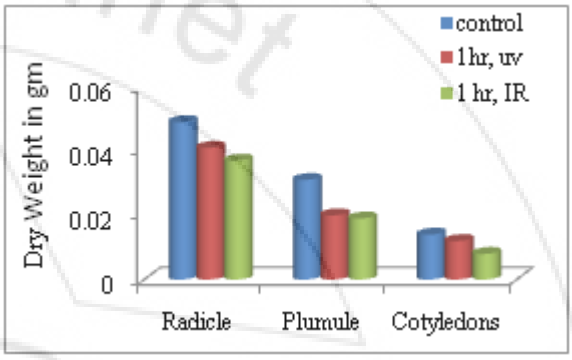


Figure 4: Effect of suplemental IR and UV-B radiation exposure on dry weight of *Pisum sativum*(L.).

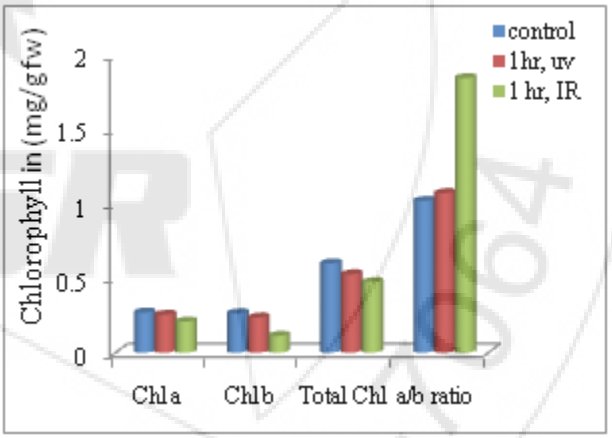


Figure 5: Effect of suplemental IR andUV-B radiation exposure on Chlorophyll content of *Pisum sativum*(L.).

4. Conclusion and Future Scope

In present study, germination percentage and length of seedlings were significantly decreased by supplemental 1 hour UV-B radiation exposure however biomass and chlorophyll content of *Pisum sativum* seedlings was highly declined by 1 hour IR radiation exposure as compare to control. The result showed high adverse effect of supplemental IR radiation exposure than supplemental UV-B radiation exposure on *Pisum sativum* crop. The data observed in present investigation is revealed that exposure of IR radiation and UV-B radiation had inhibitory effect on pea seedlings but further research is required at molecular level to prove the beneficial and harmful effect of IR and UV-B radiation on pea (*Pisum sativum* L.) crop.

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