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UV-B IRRADIANCE INDUCED DELETERIOUS EFFECTS ON THE NET PRIMARY PRODUCTIVITY AND COUNTERACTED BY SOME PLANT GROWTH REGULATORS (PGRs), IN *BRASSICA COMPESTRIS PT-303* (BROWN SARSON)

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ABSTRACT: The aim of present study to be evaluated the appropriate concentrations of plant growth regulators i.e. (10^{-7}) to (10^{-5} M) over UV-B damage on *Brassica compestris PT-303*. Seeds of *Brassica compestris PT- 303* (Brown sarson) were sown in sandy loam soil in field plots (A, B, C, D and E). Plot-A of mustard crop was treated as control and neither sprayed with growth regulators nor exposed to UV-B radiation. Pot-B was treated with UV-B radiation (3-hrs. daily) only. Plot-C was sprayed with IAA solution of (10^{-7} M), Plot D was sprayed with Kn solution of (10^{-5} M) and plot-E was sprayed with solutions of GA_3 (10^{-6} M) concentration daily, along with UV-B radiation in *Brassica compestris PT-303.* It was observed that IAA was found most effective in (10^{-7} M), Kn in (10^{-5} M) and GA_3 in (10^{-6} M) in crop of *Brassica compestris PT-303* respectively. Therefore, for the field studies, only these concentrations were taken to assess for the studies of net primary productivity of *Brassica compestris PT-303* (Brown sarson).
Keywords: *Brassica compestris PT-303*, Total net productivity, IAA, Kn $GA_{3,}$ and UV-B exposure.

INTRODUCTION

During the past decade, reduction in the stratospheric ozone layer due to accumulation of green-house gases viz. anthropogenic chlorophlorocarbons (CFCs), carbon dioxide (CO_2), methane (CH_4) & nitrous oxide (N_2O) has resulted in an increase of UV-radiation, reaching on the earth's surface and may lead to global warming. Ozone (O_3) depletion by anthropogenic gases has increased the atmospheric transmission of solar UV-B (280-315 nm). These undergo sunlight and induced photochemical changes and could alter natural balance of creative and destructive process and in stratosphere, every CFC molecule atom can destroy ozone (O_3) molecules (Molina & Rowland *et al.,* 1974). UV-radiation may cause to adverse effect on biological system & penetrate to a depth of 10% of euphotic zone, but such penetration my reach to a depth of 23 m or greater in clear ocean water. UV-B radiation is considered to be a lethal factor in aquatic system even for submerged organisms. It is known to affect a wide range of functional aspects included genetic variation, cytological, biochemical and physiological, behavioral (motility) and ecological system in photosynthetic organisms.

Photosynthesis is more sensitive to UV-B in phytoplankton than in terrestrial plants, probably owing to less effective screening in phytoplankton. Growth of terrestrial plants reduced has been observed and may be increase in magnitude over successive years. Aquatic productivity is often compromised by short-term exposures to enhanced UV-B radiation and long-term assessments are complicated by dynamic-nature of aquatic systems and by non-linear responses (Thomas A. Day *et al*., 2002).

The changes in plant populations and communities are a product of intra-and inter-specific competition for resources needed for growth and productivity of competing species, as influenced by abiotic and biotic environmental factors (Treshow, 1968). Atmospheric concentrations of chemicals, which cause ozone depletion have peaked in the late 1990s and others are expected to peak in the early years of the 21st century. Ozone depletion is predicted to reach its peak about 15 years later than the peak halogen loadings because of coupling between stratospheric climatic change and ozone chemistry.

The maximum amount of depletion and its timing are uncertain due to complexity of this interaction. However, the future abundance of ozone will be influenced by changes in other atmospheric gases and by interactions with the climate system. Climatic change producing warmer weather and reductions in the capacity of ozone layer to reduce UV-penetration to the earth's surface.

Disturbance in the thermal structure of atmosphere probably causes changes in atmospheric circulation. The life time of this ozone (O_3) destroying substance is very long and they may continue to deplete the ozone layer long. Although the use of most CFCs molecules has been passed out, ozone depletion is currently near or at its minimum (McKenzie *et al*., 2003). The prospects of increased solar UV-B radiation as a result of stratospheric ozone depletion have attracted a great deal of attention. One of the reasons is that clouds have a substantial effect on the amount of UV-B reaching on the earth surface. Summer cloud cover decreases and an increase in UV-B can be expected, with a decrease in cloud cover of 4% likely to be associated with ~2% increase in ambient UV-B levels. Patterns of environmental changes in biosphere include concurrent and sequential combinations of increasing CO_2 levels; long term changes are resulting mainly from stratospheric O_3 depletion, greater troposphere O_3 photochemical synthesis and increasing CO_2 emissions. Effects of selected combinations were evaluated in tomato (*Lycopersicum esculentum*) seedling, using sequential exposures to enhanced UV-B radiation and O_3 in differential CO_2 concentrations. UV-B exposure, increased leaf chlorophyll and UV-absorbing compounds, but decreased leaf area and root/shoot ratio (X. Hao *et al*., 2000).

Enhanced UV-B radiation can deleteriously effect overall growth and biomass accumulation in the plant species (Tevini, 2000). Plants contain a large number of UV-B sensitive targets as nucleic acids, lipids, proteins and quinines (Jordan, 1996), which must be protected to ensure the normal growth and development of plants. Failure to do so may lead to alternations in all over morphology and physiology of many plants exposed to UV-B. Therefore, UV-B exposure is one of the major factors, which responsible for the low productivity of crop plants and natural vegetation, so has become an increasing threat for agricultural crop.

Effects of UV-B radiation on plants observed by Demchik & day (1996) & Smith *et al*., (2000), green-house and growth chamber studies showed that in number of crop plants were exposed to an enhanced UV-B radiation to determine their susceptibility to photosynthetic impairment. As these species were included as sensitive such as pea (*Pisum sativum*), mustard (*Brassica*), soybean (*Glycine max*) and oat (*Avena sativa*) & moderately sensitive such as tomato (*Lycopersicum esculentum*), sorghum (*Sorghum bicolar*), rye (Secale cereale), rice (*Oryza sativa*), *tolerant corn* (*Zea mays*), pearl millet (*Pennisuetum americium*), pea nut (*Arachis hypogaea*) in respect to their sensitivity to UV-B radiation (T.K van *et al*., 1976).

General aspects in study to determine the deleterious effects of UV-B on crop plants that involve the use of UV-source (lamp) coupled with different types of filters to exclude bands of UV-wavelength. Effects of UV-B radiation on crop plants, includes reduction in yield and quality, alteration in species competition, photosynthetic activity, susceptibility to disease and changes in plant structure and pigmentation (Tevini & Teramura *et al*., 1989). Physiological properties of plants such as damage to photosystem-II (Heinrich *et al*., (1999) and reduction in the photosynthetic rate (Feng *et al*., 2003) and increased, activity of antioxidant enzymes such as catalase and ascorbate peroxides (APX) (Mazza *et al*., 1999) and damage to genetic material viz. DNA, RNA (Hidema *et al*., 2000).

UV-B radiation resulted in a decrease of adaxial stomatal conductance by approximately 65% increasing stomatal limitation of CO_2 uptake by 10 to 15%. The growth in UV-B radiation resulted in large reductions of leaf area and plant biomass, which were associated with a decline in leaf cell numbers, cell divisions and also inhibited epidermal cell expansion of exposed surface of leaves. Photo-repair activity of DNA is enhanced and synthesis of UV-absorbing compounds is increased. Most of these responses are thought to play some role in mitigating the hazardous or deleterious impacts of UV-B radiation (Bilger *et al.,* 2001 & Cerovic *et al.,* 2002).

It has been well established that, plant growth regulators (PGRs) such as IAA, Kn and $GA_{3,}$ influence the growth and development of plants.

These chemical substances are able to coordinate growth among different plant parts or different physiological and biochemical processes. Plant growth regulators have been tried to improve growth and ultimately yield (Ram *et al.,* 1973; Patil *et al*., 1987 and Kumar *et al*., 1996), by the foliar application of some plant growth regulators (Chnonkar & Jha, 1963). IAA, Kn and $GA_{3,}$ which are most important growth regulators, has a profound effect on crop production, through increase in the stem length, leaf area, flower induction, shelling percentage, yield and weight of crops.

Therefore, this study was aimed that the counteractive effect of these plant growth regulators (PGRs) viz. IAA, Kn and $GA_{3,}$ over the UV-B damage on net primary productivity of *B. compestris PT-303* (Rai).

MATERIALS AND METHODS

Field experiments were conducted in R.C.U Govt. P.G. College Uttarkashi. Geographically, the District Uttarkashi is located between the central Himalayan region at 30^0 28'to 31^0 28'N latitude and 77^0 49' to 79^0 25'E longitudes at an altitude of 1140 m above mean sea level. Seeds of *B. compestris PT-303* were procured from Seed centre of G.B. Pant University of Agriculture and Technology Pantnagar (Uttarakhand) for the research work.

GENEREL EXPERIMENTAL DESIGN

During field study, seeds of *B. compestris PT-303* were grown in field and the plots were divided by black paper sheets into five blocks. Each field block was given treatments as follows:

(i) In plot-A, mustard plant species (*Brassica compestris PT-303*) was taken as control. No treatment was given to the crop of this plot.

(ii) Plot-B was exposed to 3-hrs. daily UV-B radiation (24.23 Jm^{-2} Z^{-1}) by Sunlamps (300W) filtered with quartz interference filters (320 nm, ORIEL, USA).

(iii) Plot-C was sprayed with IAA (10^{-7} M) solution daily, along with 3-hrs supplemental UV-B radiation using the same source.

(iv) Plot-D was sprayed with Kn (10^{-5} M) concentration daily, along with 3-hrs. supplemental UV-B radiation by using the same source.

(v) Plot-E was sprayed along with GA_3 (10^{-6} M) in *B. compestris PT-303* respectively along with 3-hrs. supplemental UV-B radiation, using the same source as above.

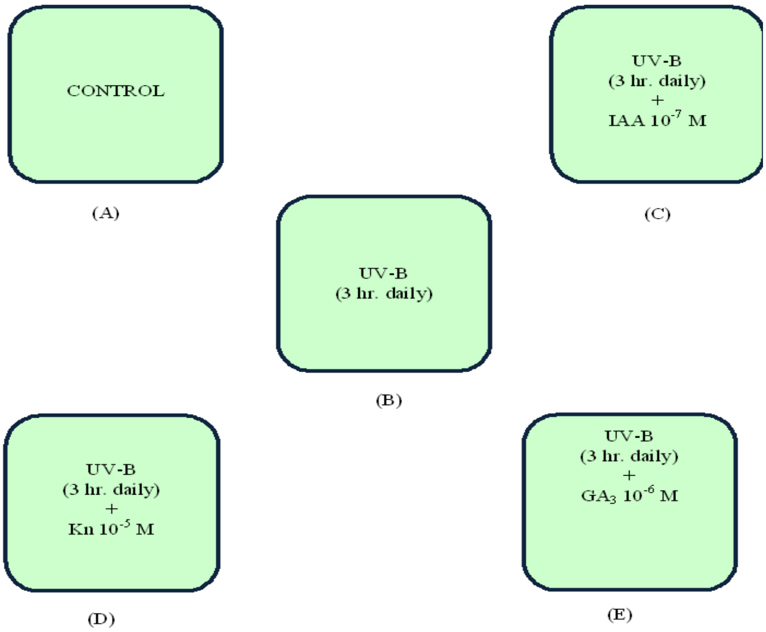

Fig. Experimental design in the field plots.

RESULTS

The study revealed that, deleterious impacts of UV-B exposure alone and along with IAA (10^{-7} M), Kn (10^{-5} M) and GA_3 (10^{-6} M) were studied on the net primary productivity in *Brassica compestris PT-303* (Brown sarson). Net primary productivity was calculated from the standing crop of the biomass at the 15th day interval are summarized in tables 1.1, and fig. 1.1. Whole result followed the trend of the standing crop of biomass indicated that the total net production of mustard crop was affected due to UV-B radiation (3 hrs. daily), alone and along with different plant growth regulators (PGRs). Generally, UV-B exposure was inhibited the total net production of different plant parts viz. Root + stem + Leaf + flower + Fruits. But promotory affect was reported when UV-B exposure was given along with different plant growth regulators (PGRs).

Table 1.1, demonstrated that at the 15th day stage of the growth, the values of net primary productivity and total net productivity of the *Brassica compestris PT-303* (Brown sarson) was recorded to 0.035, 0.034, 0.084 and 0.0153 g/pl in the control plot. Total net productivity was observed to increase continuously up to maturity and recorded as 2.098 respectively. When the crop was exposed to UV-B radiation, the maximum inhibition of total net productivity was recorded at the 105th day stage of growth. When the crop was sprayed along with different plant growth regulators (PGRs), such as IAA (10^{-7} M) concentration with UV-B radiation, the maximum value of total net productivity was recorded at the 105th day stage of growth and increased by ca. 17.9% as compared to the UV-B exposure only. When the crop was exposed by UV-B irradiation along with Kn (10^{-5} M) concentration, the maximum value of total net productivity was found at 135th day stage of growth and increased by ca. 25.2%, as compared to the UV-B exposure only. When the crop was exposed to UV-B radiation along with GA_3 (10^{-7} M) concentration, the promotory affects of T.N.P were also recorded maximum at the 135th day stage of growth and increased by ca. 26.7% as compared to the individual treatment ofUV-Bradiation(3hrs.daily).

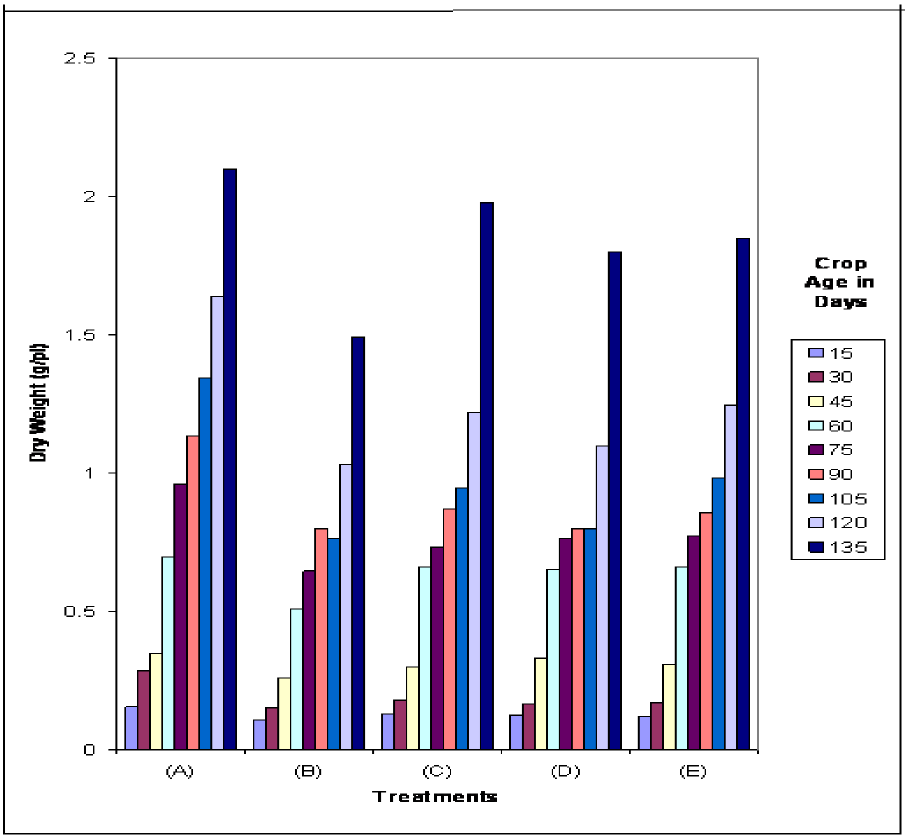

Fig 1.1: Total Net primary productivity on dry weight basis (g/plant/15 days) of *Brassica compestris PT-303* as affected by different treatments

Table 1.1: Net primary productivity on dry weight basis (g/plant/15 days) of root, stem, leaf, flower and fruit of field grown *Brassica compestris PT-303* as affected by UV-B radiation, individually and in combination of IAA, Kn and GA_3.

Treat ments	Paramet ers	CROP		AGE			IN		DAYS	
		15	30	45	60	75	90	105	120	135
	Root	0.035	0.091	0.109	0.234	0.310	0.314	0.413	0.511	0.822
	Stem	0.034	0.102	0.134	0.315	0.414	0.513	0.512	0.514	0.544
A	Leaf	0.084	0.091	0.106	0.112	0.156	0.212	0.214	0.311	0.315
	Flower	-------	-------	-------	0.034	0.048	0.53	0.058	0.062	0.073
	Fruit	-------	-------	-------	-------	0.034	0.043	0.145	0.242	0.342
	Total	**0.153**	**0.284**	**0.349**	**0.695**	**0.962**	**1.135**	**1.342**	**1.641**	**2.098**
	Root	0.030	0.043	0.095	0.098	0.232	0.271	0.214	0.312	0.622
	Stem	0.024	0.055	0.104	0.254	0.244	0.313	0.320	0.332	0.323
B	Leaf	0.052	0.054	0.074	0.142	0.114	0.142	0.142	0.213	0.235
	Flower	-------	-------	-------	0.013	0.036	0.039	0.044	0.053	0.066
	Fruit	-------	-------	-------	-------	0.019	0.035	0.045	0.121	0.245
	Total	**0.106**	**0.152**	**0.273**	**0.507**	**0.645**	**0.800**	**0.765**	**1.031**	**1.491**
	Root	0.032	0.053	0.103	0.223	0.280	0.301	0.321	0.412	0.724
	Stem	0.032	0.057	0.124	0.264	0.276	0.341	0.341	0.354	0.494
C	Leaf	0.64	0.069	0.081	0.152	0.125	0.151	0.164	0.251	0.259
	Flower	-------	-------	-------	0.022	0.029	0.039	0.052	0.059	0.069
	Fruit	-------	-------	-------	-------	0.021	0.040	0.068	0.142	0.293
	Total	**0.128**	**0.179**	**0.308**	**0.661**	**0.731**	**0.872**	**0.946**	**1.218**	**1.836**
	Root	0.030	0.052	0.102	0.213	0.291	0.302	0.322	0.411	0.723
	Stem	0.030	0.55	0.124	0.265	0.274	0.312	0.341	0.352	0.524
D	Leaf	0.064	0.058	0.082	0.152	0.125	0.151	0.174	0.253	0.257
	Flower	-------	-------	-------	0.02	0.044	0.047	0.043	0.054	0.065
	Fruit	-------	-------	-------	-------	0.029	0.038	0.068	0.144	0.283
	Total	**0.124**	**0.165**	**0.308**	**0.652**	**0.763**	**0.850**	**0.948**	**1.216**	**1.852**
	Root	0.032	0.053	0.103	0.223	0.291	0.298	0.331	0.420	0.724
	Stem	0.025	0.056	0.124	0.264	0.281	0.321	0.351	0.362	0.525
E	Leaf	0.064	0.059	0.081	0.153	0.126	0.151	0.174	0.262	0.286
	Flower	-------	-------	-------	0.022	0.044	0.048	0.053	0.055	0.064
	Fruit	-------	-------	-------	-------	0.029	0.039	0.073	0.146	0.254
	Total	**0.121**	**0.168**	**0.308**	**0.662**	**0.771**	**0.857**	**0.982**	**1.245**	**1.853**

DISCUSSION

Hence the present study was revealed that, total net productivity (TNP) of mustard crop was found altered due to individual and combined effects of UV-B radiation and PGRs on the *Brassica compestris PT-303* respectively. Goyal and Jain (1990), observed that similar results as 3 hrs. exposure of UV-B to linseed crop exhibit significant reduction in primary production of different plant parts. Similar result was found that the effects of UV-B radiation on plant have been carried out by some other workers. Most of these studies have been carried out only to evaluate, the deleterious effects of UV-B radiation on net primary productively. Kumar *et al.* (1988) reported that TNP was reduced under supplemental UV-B radiation in the field grown lentil crop. Biggs and Kossuth (1978) studied the impact of solar UV-B radiation on crop productivity. Effects of UV-B radiation on primary production of natural phytoplankton assemblages in Michigan Lake (Gala and Giesy 1991).

When UV-B was applied with daily spray of IAA, Kn & GA_3 an enhancement in net primary productivity of different plant part was noted in all treatment on mustard crop. Increase in dry matter production may be the result of more uptakes of nutrients and synthesis of reserved food material as affected by growth regulators observed by (Irulappan and Muthukrishnan, 1973).

Reports are available that the application of PGRs, ultimately affects the endogenous level of auxins (Andreae and Andreae, 1953 & Wort, 1964), which finally affects the growth, and development of plant. Auxins interact with one or more components of the biochemical system involved in the protein synthesis. However, it has not been identified that the proper step where auxins exert an effect. According to popular concept, auxins do act through influence upon enzyme production. There are definite evidences that nucleic acids are involved in growth. Roychoudhary and Sen (1964) found that application of auxins to peas resulted in an enhanced RNA synthesis.

Similarly, Key and Shanon (1964) found that the incorporation of labelled nucleotides into the nucleic acid is stimulated by auxins. Collectively, these experiments imply that the regulation of growth by auxins may involve the regulation of RNA synthesis and hence, the protein synthesis. Noggle and Fritz (1976) stated that auxins might cause the movement of more sugars into the vacuoles so that more water may enter the cell till the development of sufficient wall pressure. The above findings support that the mitigatory effects of Auxins, GA_3 and Kn towards the deleterious effects caused by UV-B on net primary productivity.

CONCLUSION

As noted, individual treatment of UV-B radiation in *B. compestris PT-303* inhibited the total net primary productivity. When treatment was given with IAA, Kn and GA_3, showed a promotion or enhancement in all plant parts of Brown sarson. Therefore, plant growth hormones (PGRs), would show the maximum mitigation against UV-B induced deleterious or negative impacts on the total net primary productivity of *Brassica compestris PT-303.*

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