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Deleterious effects of uv-b radiation on certain physiological, biological aspects and counteracted by plant growth regulators in wheat crop

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Abstract

The aim of study was to evaluate the appropriate concentrations of plant growth hormones from various concentrations over the UV-B damage on *Triticum aestivum* in case of chlorophyll isolation. Seeds of *Triticum aestivum* was grown in laboratory for the seed germination and seedling growth and then sown in field plots (A, B, C, D) with appropriate concentrations of plant hormones for the isolation of chlorophyll-a, chlorophyll-b,protochlorophyll. Plot-A of rice crop was treated as control and neither sprayed with growth hormones nor exposed to UVB radiation. Pot-B was treated with UV-B radiation (3-hrs. daily) only. Plot-C was sprayed with IAA concentration of (10^{-7} M), plot-D was sprayed with Kn concentration of (10^{-5} M), along with UV-B radiation in *Triticum aestivum*. IAA was found most effective in (10^{-7} M), Kn in (10^{-5}M) sin crop of *Triticum aestivum* and observed enhancement in the chlorophyll at the germinating seedling stage in the laboratory and field study till to maturity of crop.

Key words: *Triticum aestivum* | Plant growth regulators | IAA Kn | Chlorophyll a | Chlorophyll b | Protochlorophyll | UV-B radiation

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Introduction

The decrease in stratospheric ozone has prompted renewed efforts in assessing the potential damage to plant and animal life due to enhanced levels of solar Ultraviolet-B (UV-B, 280-320 nm) radiation (Caldwell, 1971, 1998; Madronich et al., 1998). The effect of UV-B enhancements on plants includes reduction in yield and quality, alteration in species competition, decrease in photosynthetic activity, susceptibility to disease, and change in plant structure and pigmentation (Tevini and Teramura, 1989; Bornman 1989; Teramura and Sullivan, 1991). Some species show sensitivity to present levels

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of UV-B radiation while others are apparently unaffected by rather massive UV enhancements (Becwar *et al*., 1982). This issue is complicated further by reports of equally large response differences among cultivars of a species. About two-thirds of some 300 species and cultivars tested appear to be susceptible to damage from increased UV-B radiation. Crops such as soybean, winter wheat, cotton and corn are susceptible to damage from increased UV-B radiation. All effects of elevated UV-B on plants should be considered in the context of other factors such as water stress, increased atmospheric CO2, tropospheric air pollution, and temperature. The effects of UV-B on plants have been studied mostly under growth chamber, greenhouse while a few experiments conducted under field conditions (Krupa, 1989). There are also few studies that have examined the joint effects of UV-B and other stress factors of plant response. The effect of UV-B on plant growth and productivity varies seasonally and is affected by microclimate and soil fertility. For instance, soybeans are less susceptible to UV-B radiation under water stress or mineral deficiency, but sensitivity increases under low levels of visible radiation (Teramura, 1983). Continued studies over many growing seasons are crucial in any UV-B impact assessment of agricultural productivity.

Materials and Methods

The present study was undertaken at the field of R.C. U. Government Post-Graduate. College, Uttarkashi during. The proper study site was located at Purikhet campus of the college near river Bhagirathi. Four plots measuring 1 x 1 in each were fenced by barbed wire to avoid any biotic interference. Certified seeds of cereals crop *Oryza sativa* were procured from extension branch of Indian Agricultural Research Institute, New Delhi.

General Experimental Design: - During laboratory studies following sets were taken into consideration:

Control: Seeds were soaked for 24-hr. in distilled water and placed on moistened filter paper in Peridishes.

UV-B: UV-B radiation was supplied for 3-hr daily by sunlamps (300 W), filtered with quartz interference filters (320 run, ORIEL, USA).

Growth Regulators: Test solutions of IAA and Kn were prepared in three concentrations viz. 10^{-7}, 10^{-6}, 10^{-5} M (Molarity). Seeds of *Triticum aestivum* were soaked for 24-hr in different concentrations of sd k growth regulators. Soaked seeds were placed in paired Petridishes lined with moistened filter paper. One set of Petridish containing soaked seeds was allowed to grow without any UV-B exposure.

Growth Regulators + UV-B: In second set-one from each concentration of different growth regulators was treated with UV-B radiation, for 3-hr daily.

During field study, both the crops were grown in field and the plot was divided by black paper. sheets into four blocks. Each field block was given treatment as:

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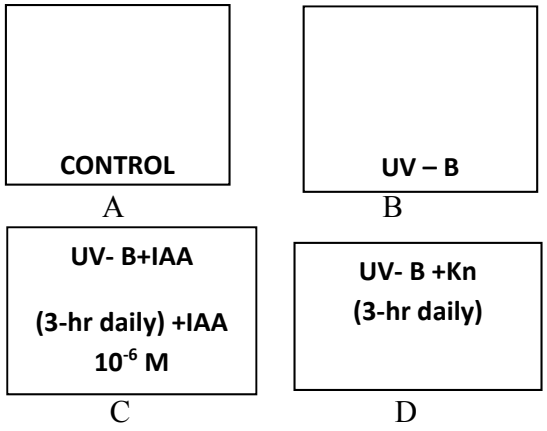
1. Plot A was taken as control. No treatment was given to the crop of this plot.
2. Plot B was irradiated with 3-hr daily UV-B radiation (24.23 Jm211) by Sunlamps (300 W) filtered with quartz interference filters (320 tim, ORIEL, USA).
3. Plot C was sprayed with IAA (10^{-6} M concentration) daily alongwith 3-hr supplemental UV-B radiation using the same source.
4. Plot D was sprayed with Kn (10^{-6} M concentration) daily alongwith 3-hr supplemental UV-13 radiation.

General experimental design may be summarized as:

Treatments Concentration	Control	UV-B	IAA			Kn			UV-B+IAA			UV-B+Kn		
		(3-hr)	10^{-7}	10^{-6}	10^{-5}	10^{-7}	10^{-6}	10^{-5}	10^{-7}	10^{-6}	10^{-5}	10^{-7}	10^{-6}	10^{-5}

Treatment of plots in field conditions:



The field for cultivation was prepared before sowing of seeds as proposed by Dhasmana (1984). Pre-soaked seeds of the crops were sown in the experimental plots. The general experimental plan for different treatments was laid after full germination of both the crops (Kumar, 1981; Dhasmana, 1984; Ambrish, 1992; Dhingra, 1999; Neeta Bhatt, 2002).

Chlorophylls:

Fresh leaves (500 mg) were homogenised with 80% acetone, centrifuged at 4000 rpm for 5 minutes. Filtrate was taken out and final volume was made 100 ml, using 80% acetone. Optical density was read at different wavelengths viz. 626, 645, 663 mm with the help of Systronics Digital Spectrophotometer. The Chlorophyll COl1tefltS were estimated by the formula given by Koski and Smith (1948) which are expressed below:

Chl a,	mg/l =	12.67 A	663 - 2.65 A	645-0.29	626
Chl b,	mg/l =	23.60 A	645 - 4.23 A	663-0.33	626
Protochl,	mg/l =	29.60 A	626 - 3.39 A	663-6.75	645

Anthocyanins

Anthocyanins during germination of seeds or seedlings were extracted by using the modified method of Mancinelli *et al.* (1975). 500 mg, fresh weight of seedlings was grinded in methanolic HCl (80 ml methanol, 20 ml water,

1 ml HCI). Homogenised tissue was transferred into glass stoppered bottle using appropriate amount of methanolic HCl, stored them overnight in refrigerator. It was centrifuged at 4000 rpm and collected in conical flask. Final volume was made 25 ml with methanolic FTC. Absorbance was taken at 530 nm and 660 nm, with the help of Systronics - Digital UV-spectrophotometer. Calculation was determined by using the formulae given by Mancinelli *et al.* (1975).

As = at 530 — 1/3 A at 660

Where As = Anthocynins

A = Absorbance

Enzymes:

1. **Protease:**

Extraction

Ptotease enzyme was extracted in laboratory conditions from germinating seeds of different treatments of both the crops. One gram of germinated seeds were homogenised in chilled Tris-HCI bufferntrifuged at 5000 rpm for 5 minutes and then supernatant was used as enzyme source. The volume of supernatant was made 25 ml by adding Tris-HCI buffer. All the operations were carried out at 4 to 5°C (Sadasivam and Manickam, 1996).

Assay

Protease activity in extracted material was measured by modified method of Green and Neurath (1954). One ml of extracted material in TrisHC1 buffer, extracted earlier and preserved at 4°C, one ml Of protein solution and one ml of Tris-HC1 was incubated at 40°C for 1 hr. One ml of TCA was added to the above and kept in freezer for 3-hr. After that, the whole solution was centrifuged to get clear supernatant. In supernatant solution, 1 ml of 1.5 N NaOH was added in a separate volumetric flask and final volume was made to 10 ml with distilled water.

One ml aliquot of the above solution was mixed with 5-ml. alkaline copper tartrate solutions and then incubated for 10 minutes at 40° C and then 1 ml. of Folinphenol reagent was added. After 30 minuted, the absorbance of the solution was read at 600 rim. A calibration curve was also prepared following above method and utilizing standard amino acids. The released amino acids were measured through comparisons of assayed and standard curves.

Peroxidase

The extraction of crude enzyme was carried out as followed for protease activity (Sadasivam and Manickam, 1996).

Assay

One ml aliquot of enzyme extract prepared earlier and preserved at 4°A was mixed with 7 ml distilled water, 2 ml benzidine solution, 2 ml of 6% H202. The optical density of the solution was measured after 1 minute by spectrophotometer using quartz cuvettes at 610 nrn. The activity measured was expressed in A O.D. (difference) (Mahely and Chance, 1967).

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Result

Treatments	Chlorophyll a	Chlorophyll b	Protochlorophyll	a/b ratio
A	**0.33**±0.03	**0.32**±0.03	**0.34**±0.04	**1.03**
B	**0.24**±0.02	**0.26**±0.03	**0.32**±0.04	**0.92**
C	**0.29**±0.02	**0.30**±0.03	**0.31**±0.04	**0.96**
D	**0.27**±0.03	**0.23**±0.04	**0.30**±0.02	**1.17**

Table 1: Chlorophyll content at seedling stage after 7 days of germination as affected by UV-B radiation (3-hr daily) individually and combination of IAA and Kn in *Triticum aestivum* crop

Treatment	Chlorophyll	15	30	45	60	75	90
	Chlorophyll a	**0.34**±0.02	**0.46**±0.02	**0.57**±0.02	**0.57**±0.02	**0.96**±0.02	**1.04**±0.04
A	Chlorophyll b	**0.38**±0.04	**0.52**±0.03	**0.62**±0.02	**0.71**±0.07	**0.87**±0.04	**0.96**±0.03
	Protochlorophyll	**0.39**±0.02	**0.55**±0.02	**0.67**±0.02	**0.67**±0.07	**0.82**±0.04	**0.83**±0.04
	a/b ratio	**0.87**	**0.83**	**0.85**	**1.11**	**1.17**	**1.25**
	Chlorophyll a	**0.26**±0.04	**0.37**±0.04	**0.48**±0.04	**0.67**±0.03	**0.84**±0.03	**0.98**±0.06
B	Chlorophyll b	**0.23**±0.02	**0.43**±0.03	**0.54**±0.04	**0.69**±0.04	**0.76**±0.02	**0.89**±0.05
	Protochlorophyll	**0.38**±0.02	**0.47**±0.04	**0.59**±0.07	**0.62**±0.04	**0.74**±0.02	**0.79**±0.06
	a/b ratio	**1.13**	**0.86**	**0.85**	**1.08**	**1.13**	**1.24**
	Chlorophyll a	**0.33**±0.02	**0.42**±0.11	**0.52**±0.06	**0.72**±0.02	**0.90**±0.03	**1.02**±0.03
C	Chlorophyll b	**0.45**±0.04	**0.48**±0.05	**0.60**±0.05	**0.68**±0.06	**0.85**±0.07	**0.96**±0.11
	Protochlorophyll	**0.46**±0.02	**0.57**±0.06	**0.65**±0.03	**0.60**±0.09	**0.79**±0.05	**0.83**±0.09
	a/b ratio	**0.73**	**0.87**	**0.86**	**1.05**	**1.13**	**1.22**
	Chlorophyll a	**0.38**±0.02	**0.43**±0.03	**0.53**±0.04	**0.75**±0.04	**0.86**±0.05	**1.00**±0.07
D	Chlorophyll b	**0.26**±0.03	**0.50**±0.04	**0.60**±0.04	**0.72**±0.09	**0.83**±0.04	**0.93**±0.07
	Protochlorophyll	**0.36**±0.04	**0.57**±0.02	**0.66**±0.04	**0.72**±0.04	**0.79**±0.03	**0.82**±0.006
	a/b ratio	**1.46**	**0.75**	**0.88**	**1.04**	**1.03**	**1.07**

Table 2: Chlorophyll contents as affected by UV-Bradiation (5-daily) individually and combition of IAA and Kn in field grown *Triticum aestivum.*

Treatments	*Triticum aestivum*
A	**0.25±0.09**
B	**0.56±0.07**
C	**0.46±0.09**
D	**0.50±0.05**

Table 3: Anthocynin as affected by UV-B radiation(3-hr daily) indiidually and in combination of IAA and Kn in field grown *Triticum aestivum*

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Fig.1.1 : Chlorophyll a (mg/g) of *Triticum aestium* as affected by different treatments

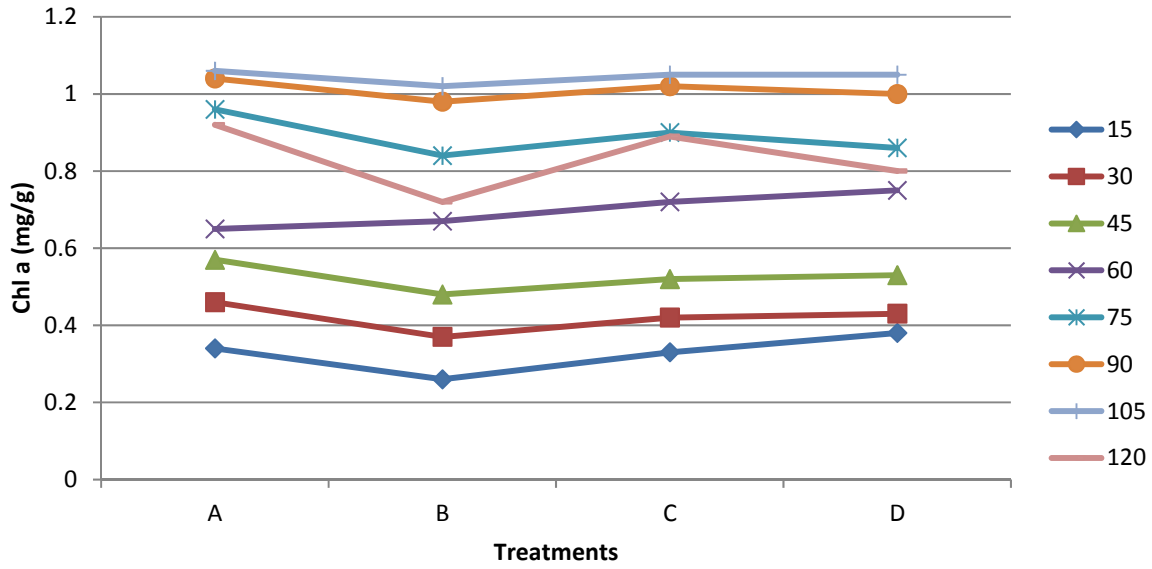
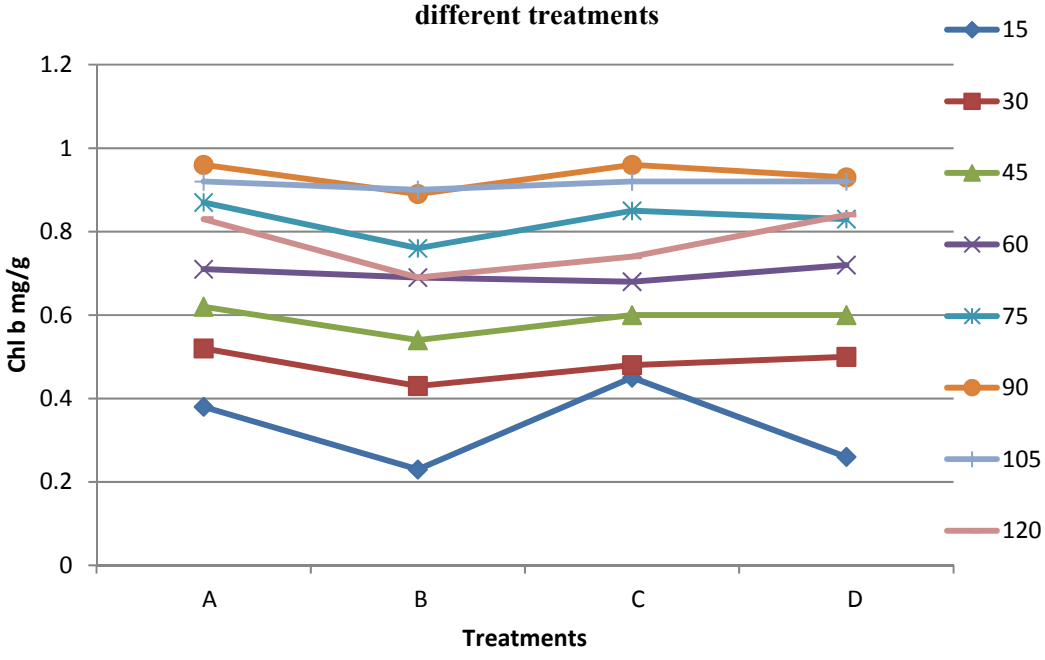


Fig 1.1(a) : Chlorophyll b (mg/g) of *Triticum aestium* as affected by different treatments



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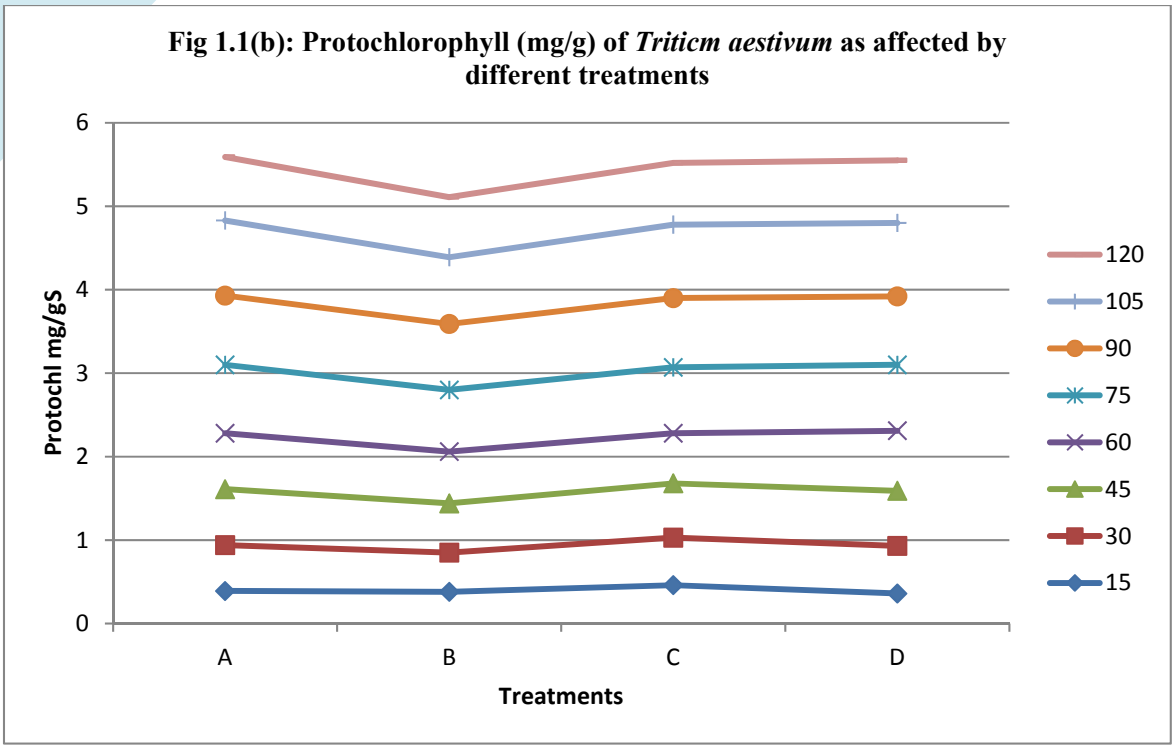

Fig 1.1(b): Protochlorophyll (mg/g) of *Triticm aestivum* as affected by different treatments

Stage	A	B	C	D
Dry	**3.450±0.004**	-	-	-
6-hr	**6.780±0.040**	**9.060 ±0.07**	**10.68±0.70**	**8.070±0.70**
12-hr	**9.650±0.06**	**13.62±0.80**	**15.670±0.130**	**10.470±0.45**
24-hr	**11.780±0.07**	**14.770±0.89**	**18.655 ±0.65**	**13.430±0.83**

Table 4 : Protease activity as affected by UV-B radition (3-hr daily) individually and in combination of IAA and Kn during seed imbibition in *Triticum aestivum*

Stage	A	B	C	D
Dry	**0.302±0.03**	-	-	-
6-hr	**0.325±0.02**	**0.281±0.059**	**0.294±0.02**	**0.290±0.03**
12-hr	**0.327±0.05**	**0.547±0.051**	**0.776±0.069**	**0.626±0.02**
24-hr	**0.346±0.07**	**0.64±0.040**	**0.817±0.062**	**0.517±0.07**

Table 5 : Peroxidase activity as affected by UV-B radition (3-hr daily) individually and in combination of IAA and Kn during seed imbibition in *Triticum aestivum*

Counteracting effects of most of these parameters by different plant growth regulators were also observed during various experiments. These effects are directly or indirectly related to the physiological processes of plants. It can be said that these

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morphological changes caused by UV-B are the result of physiological distortion. So, in the present study, it is desired to investigate Some physiological parameters in relation to individual UV-B exposure and in combination with certain plant growth regulators.

Chlorophyll pigment during seedling growth

Surface sterilized seeds of Wheat was imbibed in water for 6-hr Distilled water washed seeds were transferred to 9 cm petridish (9 diameter cm) for germination and seedling growth studies and treated with UV-B radiation (3-hr daily) alone and alongwith different concentration of plant growth regulators. Chlorophyll a, b and Protochiorophyll were measured after 7 days of growth in both the crops as described in material & methods. The results are presented in table 1.1 for *Triticum aestivum* .

A perusal of result in table 1.1 shows that chlorophyll a (mglpl), chlorophyll b (mg/pl) protochiorophyll (mg/pl) and ratio of a/b in control set were valued as 0.33±0.03, 0.32±0.03, 0.34±0.04 and 1.03 respectively. When the seedlings were studied with UV-B radiation alone, it showed a marked decline in contents of different chlorophyll pigments. The inhibition was recorded as Ca. 27%, 19%, 6% & 11% respectively as compared to control. When sets C & D were observed (PGRs + UV-B), a general promotion of these pigments was observed as compared to set B (UV-B only). IAA was found to be the most effective to counteract the UV-B induced inhibition for all the studied chlorophyll pigments. Data recorded as Ca. 21%, 15%, 19%, & 4% increase over the UV-13 alone treatment (set B) in chlorophyll a, proto chlorophyll & a/b ratio respectively.

Chlorophyll development during crop growth

Effects of UV-B radiation alone and in combination with plant growth regulators on chlorophyll development were also carried out in the same two cereals, which were grown earlier for growth pattern studies. Plants for chlorophyll estimation were sampled regularly at 15 days interval from seedling emergence up to maturity.

Table 1.2. & Fig. 1.1, showed that in plot A (control), values of chlorophyll a, chlorophyll b, protochlorophyll and chlorophyll a/b ratio, observed at 15 days stage of crop growth were amounted 0.34±0.02, 0.38±0.04, 0.39±0.02 mg/pl. and 0.87 mg/pl and recorded a consistent increase up to 105 days stage and amounted 1.06±0.04, 0.92+0.033, 92 0.90±0.02 mg/pl and 1.15 for chlorophyll a, chlorophyll b, protochlorophyll and chlorophyll a/b ratio respectively.

A decline in all the chlorophyll pigments was observed at maturity. Plants of plots B were experienced marked reduction in chlorophyll pigment as compared to control. Maximum inhibition of chlorophyll a, chlorophyll b, protochlorophyll and ratio of a/b were noted at 30-day stage and 120-day stage and reduced by Ca. 17%, 22%, 15% and 18% respectively as compared to control (Plot A). When the plot C and D were studied, the promotion of content of chlorophyll a, chlorophyll b,

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protochlorophyll and ratio a/b were noted. Plot C was shown the maximum value of content of chlorophyll a, chlorophyll b and protochlorophyll at 15 days of growth and ratio a/b at maturity and noted as Ca. 27% 95%, 21% and 20% as compared to UV-B treatments alone (Plot B). The plot D was shown the maximum value of contents of chlorophyll a, chlorophyll b, protochlorophyll and ratio a/b at 15 days old, 30 days and 120 day stage of growth and promoted by ca. 96%, ca. 21% & Ca. 22% as compared to UV-B treatment alone (Plot B).

Anthocyanins

The effect of UV-B radiation individually and in combination of IAA and Kn on anthocyanin development was studied in both wheat and rice. Seeds of both the crops were presoaked in distilled water in dark for 24 hours and transferred in different petridish for germination and further growth. One petridish carrying seeds of each crop was exposed to ordinary white light and treated as control. One petridish of each crop was exposedto daily 3-hr UV-B only. Three petridishes of both the crops were exposed to UV-B alongwith different plant growth regulators and were carried out in growth chamber. Three days old seedlings were taken for extraction of the anthocyanin as described in material and method.

Ultraviolet—B radiation has positive effect on the accumulation of anthocyanin in *Triticum aestivum* seedling. Plant growth regulators viz. IAA (10^{-6}M) and Kn (10^{-6}M) were observed counteracting and lowered down the anthocyanin accumulation induced by UV-B treatment. A perusal of data given in table (1.3) shows that anthocyanin accumulation is directly related to UV-B irradiation. A 3-hr daily UV-B exposure in wheat caused by a marked accumulation of anthocyanin (ca. 124%) as compared to control. IAA and Kn given alongwith UV-B irradiation were inhibitory to anthocyanin pigment accumulation as compared to UV-B individual exposure. IAA was found to be effective to inhibit anthocyanin accumulation and this was inhibited by Ca. 18% as compared to UV-B exposed alone. In case of Kn it was reduced by ca. 11% as compared to UV-B treatment individually.

Enzymes

Protease

Effect of UV-B irradiation alone and in combination of plant growth regulators on the protease activity was studied in the seeds of Wheat. Uniformly selected seeds were soaked in distilled water for 6 hrs, 12 hrs & 24 brs respectively. Now these presoaked seeds were spread in different petridishes (A, B, C, D). One petridish was kept as control (Neither UV-B nor PGRs), another was exposed to only 3-hr daily UV-B radiation and two petridishes were added with IAA & Kn respectively and exposed to 3- hrs daily UV-B radiation. After providing different treatments, development of protease activity was measured as described in materials & method.

Table 1.4 showed the effect of UV-B radiation alone & in combination of PGRs on protease activity in wheat seeds. After imbibition in

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water, there was a considerable rise in activity of protease. Data obtained form petridish B (UV-B exposed) showed a marked promotion, and showed Ca. 34%, 41% & 25% increase at 6 hrs, 12 hrs & 24 hrs respectively as compared to control. Protease analysis of seeds of petridish C showed slight inhibition of protease activity as compared to UV-B exposed alone. Maximum inhibition was recorded in seeds soaked in Kn and a reduction of Ca. 11%, 23%, 8% was reported at 6, 12 & 24 hrs respectively as compared to UV-B alone treatment.

Peroxidase

In order to test the effect of UV-B irradiation individually and in combination of IAA & Kn on peroxides activity, investigations were made on *Triticum aestivum* during the course of seed imbibition.

Table 1.5 showed that there was a considerable rise in peroxidase activity in control and reported as 7.7±0.06, 8.73±0.07, 10.28±0.37 at 6 hrs, 12 hrs, 24 brs respectively. Pestridish B showed a notable rise in peroxidase activity and was recorded ca. 118.2%, 125%, 163% at 6hrs, 12 hrs, 24 hrs respectively as compared to control. Petridish C & D showed a rise of ca. 3%, 96% and 96%; 92, 97% and 93% at 6 hrs, 12 hrs, 24 hrs respectively as compared to UV-B treatment.

Discussion

In The present study, carried out in the laboratory, destruction of chlorophyll, a, b, protochlorophyll and chi a/b ratio was noticed when the crops were treated with UV-B radiation. In this crop, chlorophyll a and chlorophyll b were found almost equally reduced due to 3-hr daily treatment of UV-B. When the crops were supplemented with PGRs in addition to the UV-13 radiation, a promotory effect was noted in the present study. Kn (10^{-7}M) was found most promising growth regulator when compared with IAA. Significant reductions in different chlorophyll pigment by UV-B exposure were also investigated by Jain and Goyal (1990), Duysen *et al.* (1985), Sharma *et al.* (1988), Goyal *et al.* (1991), Ambrish (1992) and Dhingra (1999).

The chlorophyll content were also analysed in the field grown crops under the influence of various treatments. In general, it was observed that UV-B inhibits the chlorophyll development throughout the crop age. However, more reduction was recorded in early stages of growth and at maturity. Kn, when applied with UV-B radiation, was found to enhance the different chlorophyll pigments level in the crops, however, the other PGRs also mitigate the adverse effects of UV-B, marginally.

These findings showed the lethal effects of UV-B towards chlorophyll development and repaired by Kn 10^{-6}M. This effect was found variable with the crop skecies. Vu *et al.* (1981, 1983) reported that chlorophyll a/b ratio decreased due to UV-B radiation in soybean but increased in pea.

Tevini *et al.* (1981) concluded that UV-B radiation inhibited the biosynthesis of chlorophyll b than chlorophyll a. Jain and Goyal (1990), while working with lentil crop under field conditions, reported the similar

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results. They also emphasized that interconversion of protochiorophyll to chlorophyll was retarded. As Kn was found to improve the synthesis of chlorophyll even under increased radiation energy (Purohit, 1988), an improvement in different chlorophyll contents was reported in the present study under similar conditions. One of the measures, which plants develop for the defence towards higher UV-B radiation, is the development of anthocyanin. Present study showed that the crops *Triticum aestivum* adevelop over 124 % anthocyanin production as compared to control when treated with 3-hr daily UV-B radiation. A slight decrease in anthocyanin content was noted when the crops were exposed to combined effects of UV-B and different growth regulators. This shows that growth regulators caused insignificant change in the anthocyanin accumulation in plants towards UV-B radiation. Ambler et al. (1975) and Bennett (1981) found the accumulation of anthocyanin as a defence of cotton plants against enhanced UV-B radiation. Hashimoto et al. (1991) also reported the similar observation, while working with chlorophyll due to enhanced UV-B radiation can be correlated with each other. Enhancement of anthocyanin synthesis can be explained as chloroplast may provide a large reserve pool for the biosynthesis of anthocyanin (Mancinelli et al., 1975). UV-B induced anthocyanins production has also been reported in mustard hypocotyles, corn, wheat and rye coleoptiles (Wellmann, 1982). Arakawa et al. (1985) found synergistic increase in anthocyanin production caused by UV-B (312 nm) with white light in apple fruits. Yatsuhashi and Hashimoto (1985) found multi facet action of UV-B photoreepto and phytochrome in the synthesis of anthocyanin using 290 nm (UV-B radiation).

Similar to anthocyanin, flavonoid concentration was also increased, in UV-B treated seedlings after four days of treatment. In contrast, high UV-B fluence increased the flavonoid accumulation (Prem Kumar et al., 2001). According to (Tevini et al., 1990) flavonoid accumulation is regarded as protective mechanism in higher plants to provide against UV-B radiation.

Hence, it is concluded that the UV-B treated seedlings may activate a defense mechanism against UV-B damage by increasing flavonoid. Pal *et al*, (1999) concluded that flavonoid concentration can reduce the UV-B penetration and protect the photosynthetic apparatus upto some extent, but it depends upon threshold level which may vary in different species. However, there is also evidence that flavonoids may function in plants to screen harmful radiation, bind phytotoxins and help to regulate the stress response by controlling auxin transport (Shirley, 2002).

This study showed considerable rise in protease and peroxidase activities in the germinating seeds as compared with the pre-existing enzymes in the seeds. Experimental data showed enhancement of protease activity up to Ca. 8% in UV-B exposed germinating seeds as compared to control. When the crop was subjected to combine treatment of PGRs with UV-B, Kn (10^{-6}M)was found most mitigatory which lowered the activity of

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peroxidase up to 125% while protease activity was lowered slightly when compared to UV-B individual treatment. No significant effects were observed in peroxidase activity with IAA.

Conclusion

1. Experimental studies showed pronounced effect of UV-B exposure and PGRs individually and in, combination on chlorophyll development, of seedlings of the crops. Results of the present study show decrease of Ca. 27%, 19%, 6% of chlorophyll a, chlorophyll b and protochlorophyll respectively in case of *Triticum aestivum* after 15 days of seedling growth. When the seedlings were treated with UV-B alongwith IAA it showed as 15%, 19%, 4% for chlorophyll a, chlorophyll b and protochiorophyll in case of *Triticum aestivum*, when individual treatment of UV-B was given to field grown crops a decline of 22%, 17% and 15% in case of *Triticum aestivum*. When these crops were suppleniented with combination of UV-B and PGRs, an increase in different chlorophyll contents was recorded. Out of the two PGRs, was found to an improved the chlorophyll contents by 27%, 95% and 21% for chlorophyll a, chlorophyll b and protochiorophyll respectively for (IAA + UV-B), 96%, 22% and 21% of chlorophyll a, chlorophyll b and protochiorophyll (Kn + UV-B) in case of *Triticum aestivum*. Plants develop anthocynin as a protection pigment against UV-B radiation as evidenced by present as well as other experimental studies. When the seedlings were treated with UV-B, a marked promotion of Ca. 124% of anthocynin pigment was recorded due to UV-B treatment in *Triticum aestivum* . IAA was found to mitigate the effect of UV-B radiation and consequently lowers down the accumulation of pigment as compared to UV-B treatment in *Triticum aestivum*.
2. The protease activity was also enhanced in germinating seeds of the crops due to UV-B radiation. A rise of Ca. 34%, 41% and 25%, was recorded after 6 hr; 12 hr. 24 hr of soaking in *Triticum aestivum* in treated seeds as compared to control.
3. 17. A marked increase in peroxidase was noted in inhibited seeds of both the crops due to UV-B radiation. An increase of Ca. 118%, 125%, 163% was recorded in *Triticiim aestivum* after 6 hr, 12 hr and 24 hr of imbibition respectively due to UV-B (3-hr daily) radiation as compared to control. When the seeds were supplied with PGRs alongwith the above treatment, this effect was altered significantly and a decrease of Ca. 11%, 23% and 8% at 6 hr, 12 hr and 24 hr respectively was reported in *Triticurn aestivum*.

All the parameters considered during the present study such as Photosynthetic pigments viz, chlorophyll a, chlorophyll b and protochiorophyll and enzymes Protase as well as Proxidase were also reduced when subjected to UV-B radiation. Effect of UV-B on Wheat, as far as anthocyanin is concerned was reported an enhancement. It can be assumed after overall studies that accumulation of anthocyanin because of UV-B could act as a

screen by absorbing UV-B radiation and in turn protect the chioroplast from UV-B induced damage.

When these most important cereals viz. Wheat was treated with UV-B alongwith PGRs (IAA & Kn), a counteracting effect was reported in all the parameters studied. So, it has been concluded in our study that these plant growth regulators (IAA & Kn) can mitigate the hazardous or deleterious effects caused by UV-B in this cereal crops significantly.

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