DELETERIOUS EFFECTS OF UV-B RADIATION ON CERTAIN GROWTH PATTERN AND COUNTERACTED BY PLANT GROWTH REGULATORS IN RICE CROP

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Abstract - The aim of study was to evaluate the appropriate concentrations of plant growth hormones from (10^{-7}) to (10^{-5} M) concentrations over the UV-B damage on *Oryza sativa* in case of growth pattern. Seeds of *Oryza sativa* sown in field plots (A, B, C, D) with appropriate concentrations of plant hormones for growth pattern. 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) daily, along with UV-B radiation in *Oryza sativa*. IAA was found most effective in (10^{-7} M), Kn in (10^{-5} M) in crop of *Oryza sativa* and observed enhancement in the growth pattern stage in the field study till to maturity of crop.

INTEX TERM- *Oryza sativa,*Plant growth regulators, IAA Kn,UV-B radiation

INTRODUCTION-Agricultural scientists have responded with as series of investigations of the effect of artificial and solar UV-B radiation upon plnt growth and development. A great variety of physiological and morphological plant responses to UV-B radiation have been subsequently demonstrated over years. Most of these experiments, however, have employed UV-B lamp, wich usually emit radiation quite unlike the radiation present in normal terrestrial solar spectrum. 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 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 CO_2, troposphere 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 season . . 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* was 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 Petridises.

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

Growth Regulators: Test solutions of IAA and Kn were prepared in three concentrations viz. 10^{-7}, 10^{-6}, 10^{-5} M (Molarity).Seeds of *oryza sativa* was 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, 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:

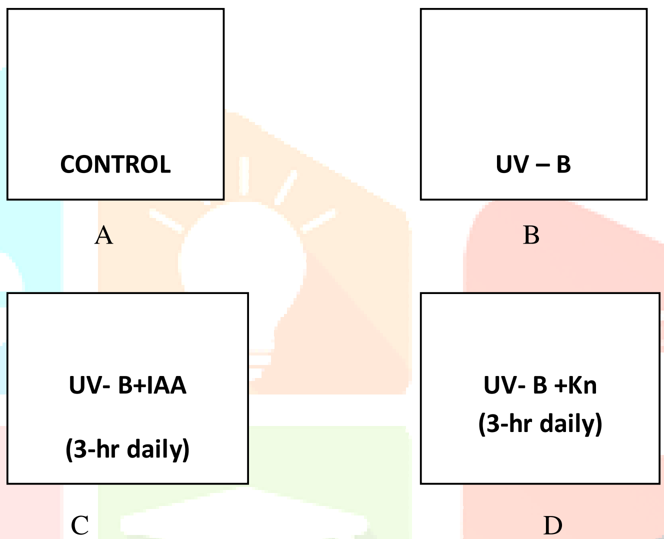
1. Plot A was taken as control. No treatment was given to the crop of this plot.
2. Plot B was irradiated with 3-hr daily UV-B radiation (24.23 Jm211) by Sunlamps (300 W) filtered with quartz interference filters (320 tim, ORIEL, USA).
3. Plot C was sprayed with IAA (10^{-6} M concentration) daily alongwith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

In laboratory conditions:

Treatments	Control	UV-B	IAA			Kn			UV-B+IAA			UV-B+Kn		
Concentration		(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).

Growth Pattern:

Seeds of *Oryza sativa* (Rice) were sown in fields in sandy loam soil in rows placed 0.1 m apart in 4 plots (A, B, C and D) of 1×1 in each. Plot A of both the crops was treated as control and neither sprayed with growth regulators nor exposed to UV-B radiation. Plot B, C and D of both the crops, were treated with UV-B radiation (3-hr daily), supplied by Sunlamps (300 W) filtered with quartz interference filters (ORIEL, USA). Plot C of both the crops was sprayed with IAA solution of 10^{-6} M concentration daily through hand spray machine. Plot D of both the crops was sprayed with Kn 10^{-6} M concentration. Above treatments were carried out daily as described in both the crops till maturity (harvesting period).

The samples for growth analysis were taken regularly at 15-day intervals from each plots separately after the seedling emergence two leaf stage) till maturity. For each study, fifteen phenotypically identical plants from each plot were taken carefully to laboratory where these were washed in running water to remove the soil particles using a mesh of 0.32 mm pore size and tap water current. The growth measurements were taken on parts per plant basis for leaf, stem, root, fruits etc. for each treatment separately.

The mean values of 15 plants of each sample plot were calculated, results represented with ± S.D.

RESULTS

The growth pattern of *Oryza sativa* was also studied under influence of UV-B individually and in combination of growth regulators in terms of stem, leaf, root and fruit development (table 1.1 and fig. 1.1). In control, the value of stent length fresh weight and dry weight were found maximum at 15 days stage of growth i.e. 10 cm, 5.45 and 1.55 g/pl respectively and increased continuously till maturity and maximum values were observed as 62.8 cm, 11.25, 2.65 g/pl respectively. In Plot-B (UV-B only), a reduction in all parameters was observed as compared to control. Maximum inhibition in length was recorded at 30 days stage and reduced by Ca. 26.2% as compared to control. Fresh weight was found inhibited maximum at 60 day stage and it reduced by ca. 31.7% and dry weight was found inhibited maximum at the maturity stage and reduced by ca. 60.4% as compared to control. When UV-B was given in combination with PGRs, a trend of promotion was noted in all parameters as compared to individual treatment of UV-B and IAA. The concentration of 10^{-6}M was found to be the most effective in all the parameters considered. Maximum promotion in length was recorded at 45 days stage and promoted by ca. 22.7% over the plant treated with UV-B. Maximum fresh weight was noted at maturity and promoted by ca. 29.4%, maximum dry weight was noticed at maturity and promoted by ca. 95% as compared to UV-B treated plants. When the UV-B was given alongwith Kn, the maximum promotion of length, fresh weight & dry weight were reported at 45 day increased by ca. 21% and ca. 22% and ca. 37% as compared to UV-B alone.

The data of leaf growth pattern as affected by various treatments are shown in table 1.2 and fig.1.2. The value of leaf area (cm^2/pl) fresh weight (g/pl) and dry weight (g/pl) of leaf was recorded maximum at 15 day stage of growth i.e 7.29 cm^2/pl, 4.24 g/pl, 0.90 g/pl respectively and were found to be increased consistently up to maturity and recorded 24.5 cm^2/pl, 14.0 g/pl and 3.24 g/pl respectively. When the plants were exposed to UV-B only, a marked reduction in leaf area, fresh weight and dry weight of leaf was reported as compared to control. The maximum reduction of leaf area was reported at 60-day stage of growth and amounted ca. 51.8%. A significant reduction of fresh & dry weight were observed at 30 and 45-day stage and reduced by ca. 28% & ca. 50% as compared to control. When UV-B was given alongwith PGRs, a mitigatory response was noted in consideration of all parameters. When UV-B irradiation was given alongwith IAA, a maximum value of leaf area, fresh weight & dry weight were observed at the 15 day, 45 day & 60 day stage of growth and increased by ca. 137%, ca. 37% & ca. 67% as compared to UV-B only. When the UV-B irradiation (3-hr daily) alongwith Kn was provided, the maximum value of the leaf area, fresh weight and dry weight were noticed at the 45 day, 75 day & maturity and increased by Ca. 92%, ca. 118% & ca. 137% as compared to UV-B treatment individually.

The data of root growth patterns as affected by different treatments under investigation are presented in (table 1.3 and fig. 1.3). Perusals of results indicate that 3-hr UV-B exposure given daily, individually and in combination with different growth regulators affect significantly the root growth pattern of *O*. sativa. The maximum inhibition of fresh weight & dry weight were observed at 45 day stage & 60 day stage of growth and decreased by ca. 40% and ca. 48.2% respectively as compared to control. When UV-B exposure was given alongwith PGRs, an enhancement in trend of concerned parameters was recorded. When UV-13 exposure alongwith IAA was given, a promotion of fresh weight & dry weight was noted at 15 day & 60 day stage of growth and enhanced by ca. 87% & ca. 92% as compared to UV-B exposed only. When UV-B alongwith Kn was studied, a mitigatory response was reported in trend of fresh weight & dry weight at 15 day & 60 day stage of growth and mitigated by ca. 62% & ca. 90% as compared to UV-B treatment only.

Fruiting determine the yield of crop in agriculture system, therefore, the excellence of fruiting was also studied. A promotion of fresh weight and dry weight of fruits was reported when treated with combination of PGRs as compared to individual UV-B exposure. A maximum inhibition of fresh & dry weight have been noted at 45 day & 75-day stage of growth and amounted as ca. 36% & ca. 35% respectively as compared to control. When UV-B treated alongwith IAA, it showed maximum value of fresh & dry weight at 60 day & 90-day stage of growth and increased by ca. 17% and ca. 10%. When UV-13 alongwith Kn was given, it showed maximum value of fresh weight & dry weight at 15 day & 75 day stage of growth and increased by ca. 95% & ca. 40% respectively as compared to UV-B treatment only

Table 1.1 : Stem growth pattern of field grown *Oryza sativa* as affected by UV-B radiation (3-hr daily) individually and in combination of IAA and Kn

Treatments	Parameters	CROP	AGE	IN			DAYS
		15	30	45	60	75	90
A	Length(Cm.)	1010±3.00	27.50±4.00	41.30±2.75	50.20±2.00	60.20±3.50	62.80±4.00
	F.W. (g)	5.45±1.75	8.25±1.00	13.25±2.00	15.00±1.87	16.75±1.75	11.25±1.80
	D.W. (g)	1.55±0.75	1.75±0.50	1.75±0.85	1.75±0.75	2.05±0.50	2.65±0.65
B	Length(Cm.)	8.70±1.50	20.30±2.00	33.00±4.00	46.50±4.00	50.10±3.00	50.10±4.00
	F.W. (g)	4.01±2.00	7.75±1.00	11.26±2.00	10.25±2.00	15.04±2.75	11.01±2.00
	D.W. (g)	1.08±0.50	1.75±0.50	2.20±0.75	2.06±0.60	1.07±0.65	1.05±0.65
C	Length(Cm.)	10.00±2.00	23.20±4.00	40.50±3.00	49.00±4.00	53.10±4.00	61.50±4.00
	F.W. (g)	5.08±1.00	8.05±1.65	13.00±2.00	12.00±2.00	16.06±3.00	9.70±3.00
	D.W. (g)	1.58±0.60	1.06±0.62	2.67±0.65	2.06±0.55	2.05±0.65	2.05±0.67
D	Length(Cm.)	8.90±2.75	18.10±3.00	40.00±4.00	47.00±3.00	50.70±4.00	54.50±4.50
	F.W. (g)	5.05±1.75	8.00±2.00	13.00±2.00	14.00±2.20	16.20±3.00	7.06±3.00
	D.W. (g)	1.89±0.55	1.25±0.65	2.60±0.50	1.75±00.50	2.05±0.70	1.20±0.50

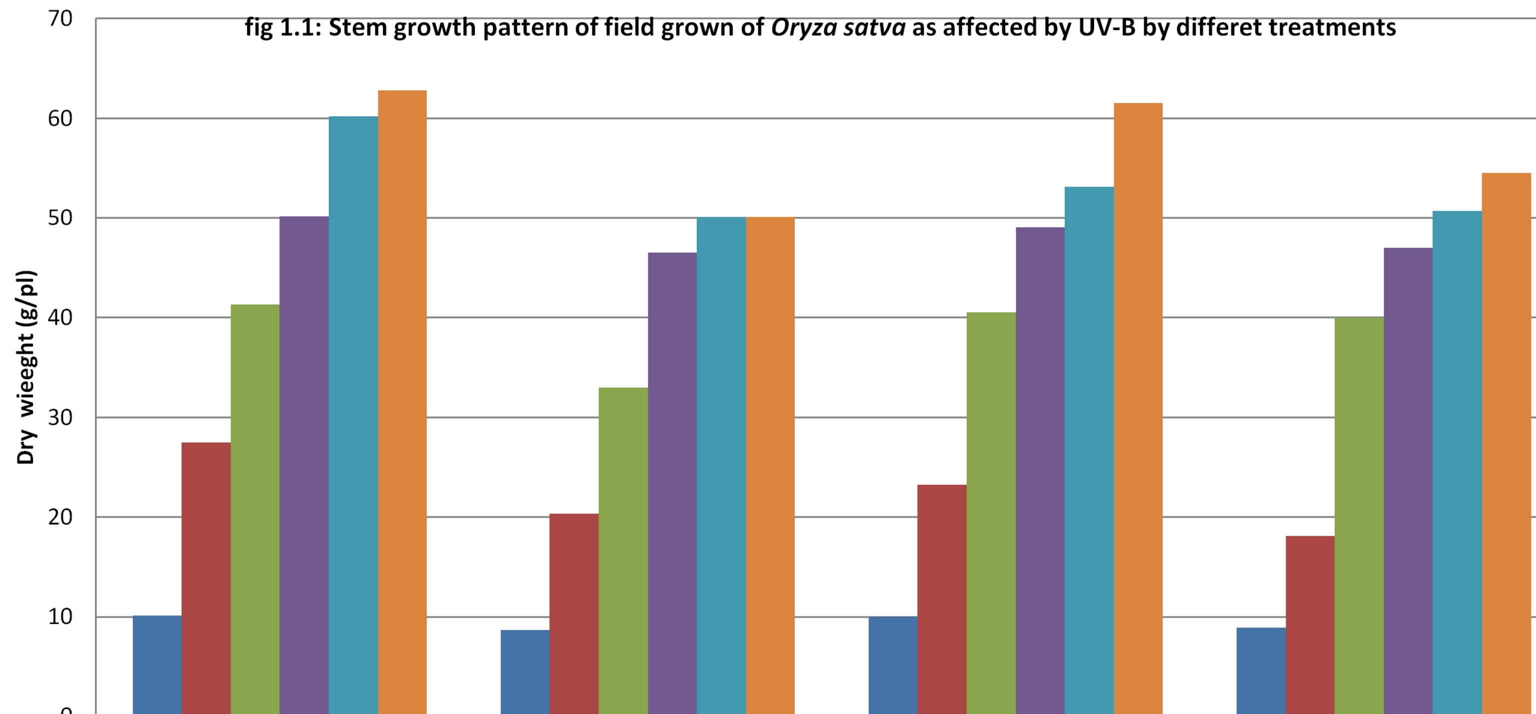


fig 1.1: Stem growth pattern of field grown of *Oryza satva* as affected by UV-B by differet treatments

	A	B	C	D
15	10.1	8.7	10	8.9
30	27.5	20.3	23.2	18.1
45	41.3	33	40.5	40
60	50.2	46.5	49	47
75	60.2	50.1	53.1	50.7
90	62.8	50.1	61.5	54.5

Table 1.6: **Leaf growth pattern of field grown *Oryza sativa* as affected by UV-B radiation (3-hr daily) individually and in combination of IAA and Kn**

Treatments	Parameters	CROP AGE IN DAYS

		15	30	45	60	75	
A	**Leaf area(Cm^2.)**	7.39±3.00	15.30±2.00	26.08±3.00	23.20±3.00	15.50±3.25	24
	F.W. (g)	0.24±0.02	5.45±2.00	7.25±2.00	7.00±2.00	8.00±3.00	14
	D.W. (g)	0.09±0.02	1.50±0.50	1.45±0.55	1.25±0.75	1.05±0.70	3.2
B	**Leaf area(Cm^2.)**	7.20±2.50	14.60±3.00	17.90±3.00	12.00±2.75	15.00±2.65	15
	F.W. (g)	3.36±0.50	4.21±1.00	3.65±1.65	6.15±1.00	6.03±2.50	11
	D.W. (g)	0.66±0.02	1.09±0.02	1.19±0.05	1.75±0.75	1.60±0.50	1.0
C	**Leaf area(Cm^2.)**	8.90±2.00	15.00±3.00	26.00±3.00	20.00±3.00	18.60±2.75	22
	F.W. (g)	5.08±0.50	5.05±2.00	5.00±0.75	7.70±1.00	7.00±2.00	13
	D.W. (g)	1.58±0.50	1.78±0.75	1.75±0.55	1.78±0.75	1.78±0.75	1.0
D	**Leaf area(Cm^2.)**	8.60±3.00	14.50±2.50	17.50±2.00	21.00±2.00	32.80±4.00	18
	F.W. (g)	4.05±0.55	5.07±2.00	7.00±1.00	7.75±2.00	6.25±1.00	13
	D.W. (g)	1.09±0.05	1.75±0.75	2.90±0.56	1.75±0.75	1.75±0.75	2.9

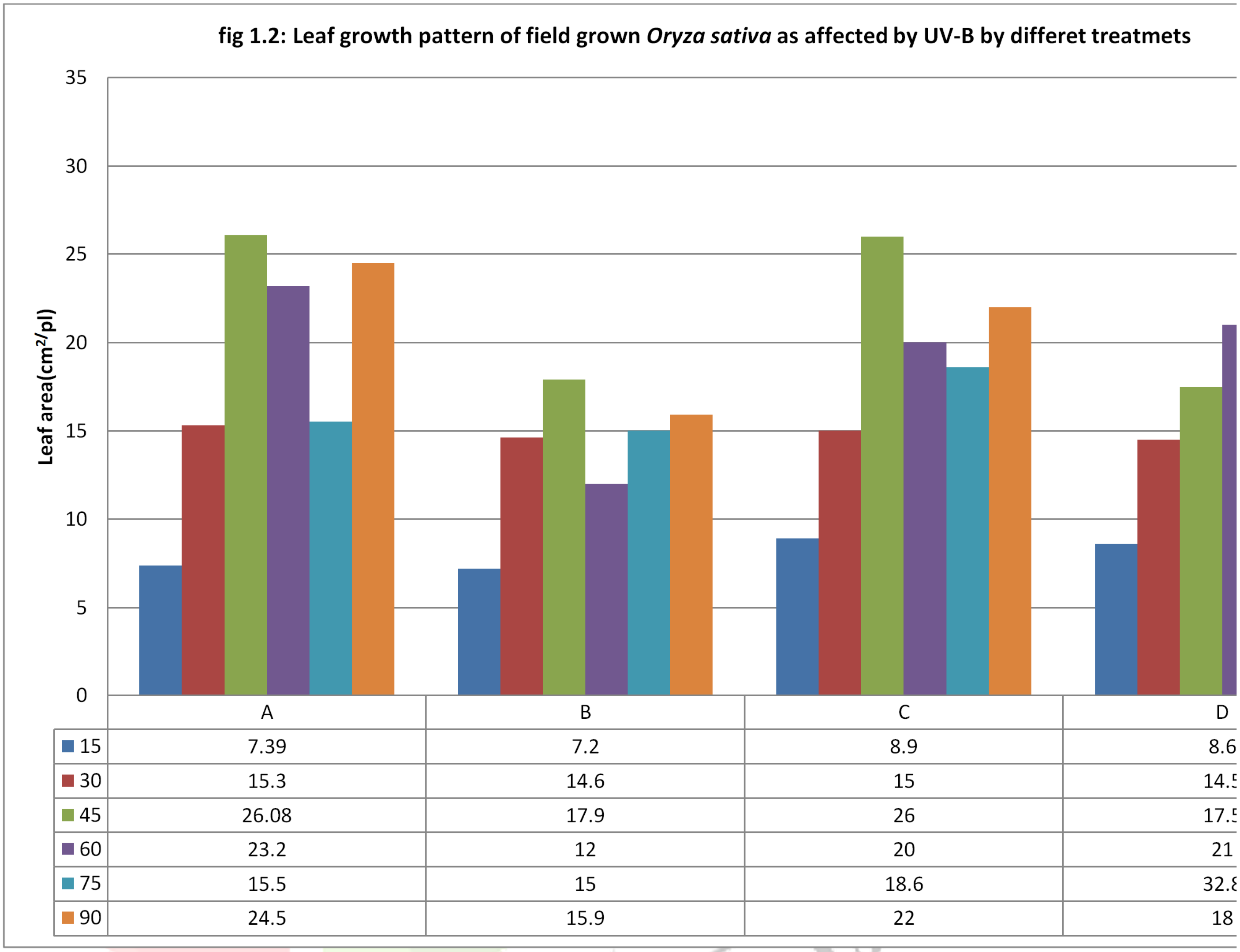
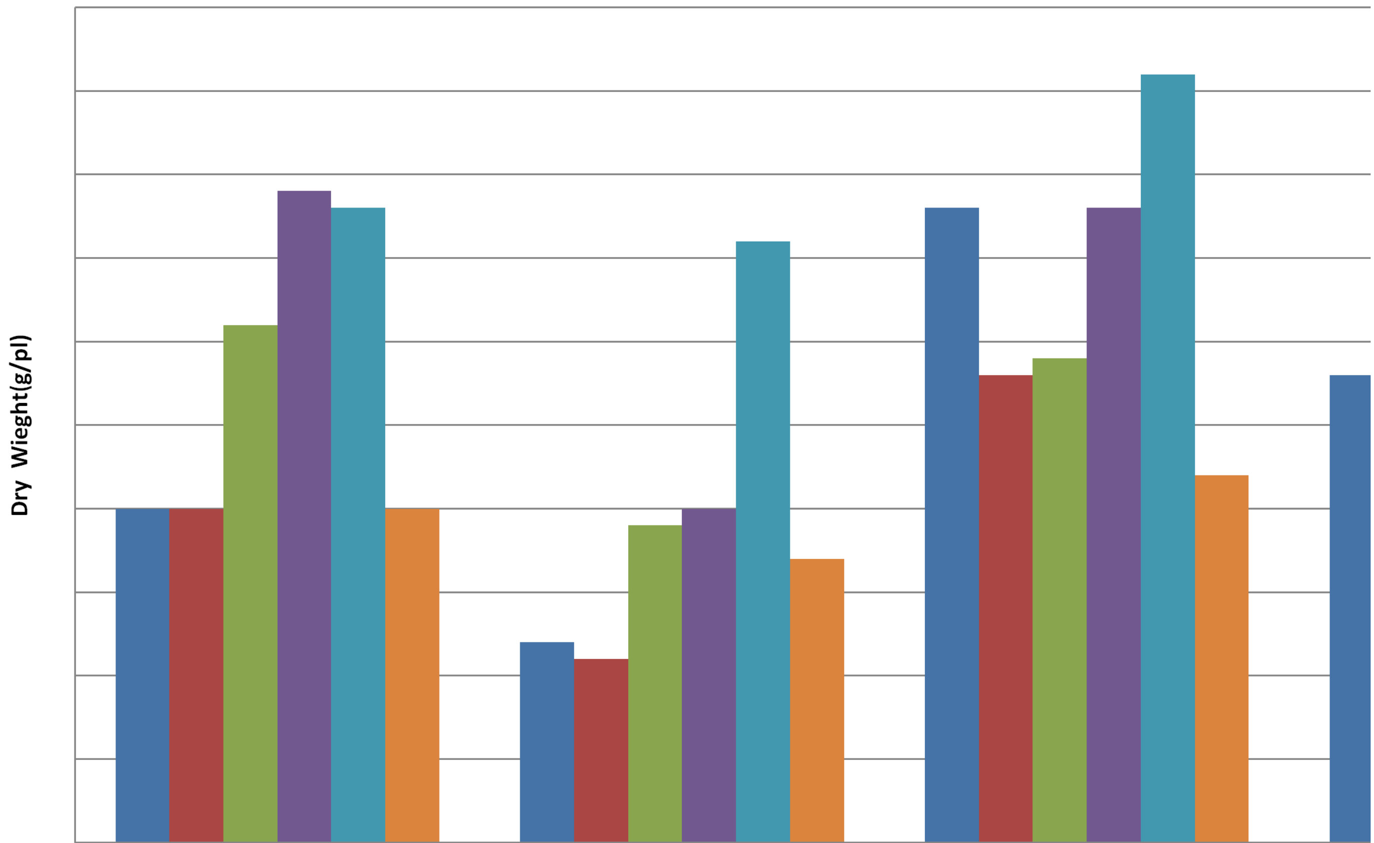


Table 1.3 : Root growth pattern of field grown *Oryza sativa* as affected by UV-B radiation (3-hr daily) individually and in combination of IAA and Kn

Treatments	Parameters	CROP AGE IN DAYS					
		15	30	45	60	75	90
A	F.W . (g)	**0.50**±0.02	**0.60**±0.02	**0.75**±0.05	**0.81**±0.02	**0.78**±0.05	**0.90**±0.08
	D.W .(g)	**0.20**±0.01	**0.20**±0.01	**0.31**±0.01	**0.39**±0.01	**0.38**±0.04	**0.20**±0.03
B	F.W . (g)	**0.40**±0.02	**0.53**±0.01	**0.45**±0.02	**0.70**±0.02	**0.78**±0.03	**0.78**±0.06
	D.W .(g)	**0.12**±0.01	**0.11**±0.01	**0.19**±0.01	**0.20**±0.03	**0.36**±0.05	**0.17**±0.05
C	F.W . (g)	**0.75**±0.04	**0.60**±0.03	**0.60**±0.03	**0.79**±0.06	**0.90**±0.03	**0.80**±0.03
	D.W .(g)	**0.38**±0.03	**0.28**±0.03	**0.29**±0.03	**0.38**±0.03	**0.46**±0.04	**0.22**±0.04
D	F.W . (g)	**0.65**±0.03	**0.55**±0.04	**0.67**±0.03	**0.78**±0.04	**0.88**±0.05	**0.81**±0.06
	D.W .(g)	**0.28**±0.04	**0.26**±0.03	**0.28**±0.04	**0.38**±0.03	**0.38**±0.03	**0.29**±0.05

fig 1.3: Root growth pattern of field grow *Oryza sativa* as affected ny UV-B by different treatme



	A	B	C
15	0.2	0.12	0.38
30	0.2	0.11	0.28
45	0.31	0.19	0.29
60	0.39	0.2	0.38
75	0.38	0.36	0.46
90	0.2	0.17	0.22

Table 1.4 :**Fruit growth pattern of field grown Oryza sativa as affected by UV-B radiation (3-hr daily) individually and in combination of IAA and Kn**

Treatments	Parameters	CROP		AGE	IN		DAYS
		15	30	45	60	75	90
A	F.W. (g)	-	-	4.35±0.50	7.30±1.75	9.68±0.45	4.25±0.50
	D.W. (g)	-	-	1.95±0.40	2.00±0.85	2.05±0.75	1.97±0.75

B	F.W. (g)	-	-	3.95±0.75	6.95±2.00	6.25±1.90	3.65±1.75
	D.W. (g)	-	-	1.05±0.65	2.05±1.05	1.90±0.05	1.90±0.50
C	F.W. (g)	-	-	4.05±2.00	6.99±3.00	7.37±0.75	4.05±2.00
	D.W. (g)	-	-	1.09±0.50	1.95±0.75	1.92±0.75	1.09±0.75
D	F.W. (g)	-	-	4.25±2.10	6.15±0.75	8.27±1.25	4.18±1.00
	D.W. (g)	-	-	1.15±0.75	1.50±0.02	2.00±0.04	2.00±0.05

DISCUSSION

Generally, combined effect, of UV-B and different growth regulators were found promotory when compared with the UV-B treated seedlings of both crops. Epicoty1, hypocoty1 and radicle length, fresh and dry weight has been found increased over UV-B individual treatment. IAA (10^{-6}M) and Kn (10^{-6}M) were found most effective in case of radicle, hypocoty1 and epicoty1 respectively. While the growth regulators have their pronounced promotory effects on different parts of the seedling as reported here and elsewhere and UV-B suppress the development of different parts of the seedlings, the combined treatment of UV-B and PGRs showed their promotory effect over individual treatment of UV-B. Similar results have also been observed by Kumar (1981), Jain et al, (1996); Russell et al. (1998) and Dhingra (1999).

In general individual treatment of UV-B radiation showed pronounced inhibitory effects on growth in terms of leaf area, fresh weight and dry weight of leaves, root and stem and their fresh and dry weight in both the crops. When crops under investigation were treated with UV-B in combination of PGRs, an increase in all the above parameters were observed as compared to individual treatment of UV-B radiation.

A Number of studies have been carried out in India and abroad on the effects of UV-B radiation on growth and development of various crops and natural vegetation (Murali and Teramura, 1985, 86; Steinmetz and Wellman, 1986; Kumar et al,. 1988, Ambrish, 1992; Tezuka et al., 1993; Grobe and Murphy, 1994; Teramura and Sullivan, 1994; Fiscus and Booker, 1995; Ballare et al., (1996); Dhingra (1999). Daily treatment of UV-B radiation (3hrs) showed overall inhibition in number and weight of all parts of plant in the present study. Biggs et al. (1981) reported reduction in plant height and dry weight of soybean when subjected to UV-B radiation. They reported that plant height and total dry weight of soybean was decreased by 56% and 42% respectively caused by UV-B radiation.

Fruiting determine the yield of a crop. Hart et al, (1975) observed a significant reduction in fruit in pepper as influenced by UV-B radiation. Biggs and Kossuth (1978), Ohtani et al. (1982) and Ambrist, (1992) were reported similar results for flower and fruit development. Ohtani et al. (1982) reported inhibition of flowering due to blue light near UV-B radiation in *Lemma paucicostata*. Flowering was also found inhibited in rice during its kernel development due to UV-B radiation by Morie et al. (1989).

When the crop was treated with UV-B in combination of different concentrations of IAA and Kn, a promotion in all the growth parameters was observed over individual treatment of UV-B in both the crops. The IAA was found most effective in case of leaf, which enhanced ca. 174% of fresh weight, 118% of dry weight, 173% of area over individual treatment of UV-B in *oryza sativa;* while the dry weight was increased by 41% and 43% in both the crops respectively over individual treatment of UV-B. The above studies found support from the work of Jauhari et al. (1960), Castro and Bergmann (1973), Grunwald and Lockard (1973), Biggs and Kossuth (1978), Dickson and Caldwell (1978), Kumar (1981), Ohtani et al. (1982), Ambrist (1992), Agrawal et al. (1994), Kaur et al (1998), Ressell et al. (1998) and Dhingra (1999).

SUMMARY

1. Stem growth pattern were also found affected due to the treatments: UV-B (3-hr daily) reduced the stem growth considerably in terms of length, fresh weight, and dry weight. The length, fresh weight and dry weight were found to be reduced Ca. 29%, 28% and 33% due to UV-B radiation as compared to control. When the crops was treated alongwith plant growth regulators in combination of UV-B radiation, the permotory effect was reported and maximum mitigation of length, fresh weight and dry weight were notified as Ca. 29%, 91%, 88% respectively.

2. Leaf growth pattern was found significantly reduced with individual treatment of UV-B in terms of fresh weight, dry weight, leaf area in *Oryza sativa*, the inhibition due to UV-B radiation was recorded Ca. 52%, 49%, 2% respectively in leaf growth pattern. A promotory trend was recorded in combined treatment with IAA and Kn and enhanced upto 118%, 92%, 137% in fresh weight, dry weight and leaf area respectively.

3. Similarly the root growth pattern was also found affected the treatments.. In case of *Oryza sativa* the UV-B induced inhibition was recorded ca. 40% and 48% in fresh weight and dry weight respectively. IAA improved the inhibition in combined treatment and promoted ca. 87% and ca. 92% over UV-B individual treatment for fresh weight and dry weight. Kn improved the inhibition in combined treatment and promoted Ca. 62% and 90% as compared to UV-B individual treatment for the fresh weight and dry weight of root.

4. Fruiting is the index of the yield of crops. It was also found affected significantly due to individual and combined treatments of UV-B with different PGRS.. In *Oryza sativa*, the inhibition was recorded as ca. 35% and 36% respectively in fresh and dry weight of fruit as compared to control. IAA improved the deleterious effects when given in combination and improved by ca, 17% and 104% in fresh and dry weight of fruits respectively. Kn when given

alongwith UV-B as compared to individual UV-B exposure brought about an improvement of ca. 34% and 95% in fresh and dry weight of fruit of Rice.

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