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SHORT COMMUNICATION

EFFECT OF UV-C RAYS ON GROUNDNUT SEEDLINGS (*ARACHIS HYPOGEAE* L.)

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Seven days old seedlings of groundnut (*Arachis hypogeae)* were exposed to UV-C rays for 5 days. After 30 days seedlings exposed to UV-C rays showed increased root length, root nodules and decreased shoot length as compared to control plants. A significant reduction in carbohydrate, total protein, amino acids and secondary metabolites in UV-C exposed seedlings was observed. Chlorophyll a and b, and carotenoids contents were found to be decreased in UV-C treated plants. The nitrogen-fixing ability of the *Rhizobium* bacteria was negligible.

***Key words*: *A. hypogeae*, chlorophyll, secondary metabolites, UV-C radiation**

Studies have shown that UV-B radiation oxidise the cellular components, such as proteins, lipids and nucleic acids which ultimately lead to cell death. Ultraviolet radiation penetrates the outer structure of the cell and alters the cellular DNA. This alteration prevents the cell from reproducing and eventually kills the cell (Campos *et al*. 1991). The elevated UV-C radiation does not reach the Earth's surface due to its absorption in the atmosphere, with the exception on high mountain locations (Hader *et al*. 2007). Tok *et al.* (1997) showed a marked decrease in nodule mass in plants grown under elevated UV-B radiation. Since UV-B radiation does not penetrate into the soil UV-B effects on nodulation must be indirect. Although very dangerous UV-C has no physiological relevance as it is being blocked by the ozone layer in the stratosphere. Such rays have been used to study DNA damage, as their photoproducts are the same as those induced by UV-B radiation (Cleaver 2006). The studies on effect of UV-C rays on plants are very limited therefore, this study was planned.

Seeds of groundnut (*Archis hypogeae*) procured from Tamil Nadu Agricultural University, Coimbatore, India, were used for the experimental purpose. The surface sterilized seeds were sown in pots containing 300 g of the soil (soil : manure, 20:1) and allowed to germinate in normal sunlight for a week Each pot contains six seedlings. The seedlings were divided into two groups of 10 pots each. Group 1 served as control and group 2 was exposed to UV-C light for 2 minutes per day for 5 days. The seedlings allowed to grow for 30 days. After 30 days seedlings uprooted and morphological changes such as shoot, root length and number of root nodules were measured. The leaves were used for biochemical studies.

The known quantity of leaves was homogenized in distilled water and centrifuged. The supernatant was used for the estimation of protein by the method of Lowry *et al*. (1951). A known quantity of the shade dried leaves of *Arachis hypogeae* was extracted with 80% methanol using Soxhlet apparatus for 3 hours. The flavonoid content of the extract was determined by the method of Siddhuraju and Becker (2003).

Standard methods to estimate amino acids (Moore

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Table 1. Effect of UV-C on some morphological and biochemical parameters in groundnut seedlings

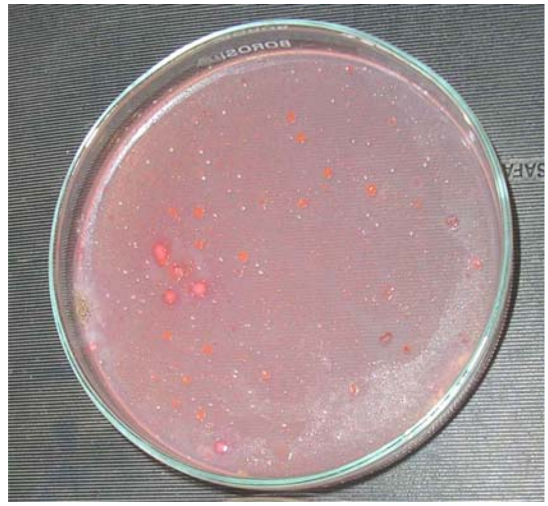
Quantitative analysis	Control plant	UV-C treated plant
Shoot length (cm plant^{-1})	15±1.3	11±0.9
Root length (cm plant^{-1})	12±1.1	17±1.3
Number of root nodules	31±2.0	48±3.0
Soil nitrogen (ppm)	102±9.0	70±6.0
Carbohydrate (mg g^{-1} fw)	25±2.3	13.2±1.12
Protein	13±0.95	9.2±0.72
Amino acid	07±0.33	5.3±0.23
Phenols	04.2±0.22	2.8±0.13
Flavonoids	1.88±0.093	0.56±0.031
Total chlorophyll (mg g^{-1} fw)	163.28±3.10	155.7±2.90
Chlorophyll a (mg g^{-1} fw)	41.37±0.0413	38.97±0.037
Chlorophyll b (mg g^{-1} fw)	48.35±0.047	46.28±0.043
Carotenoids (mg g^{-1} fw)	0.5±0.02	0.003±0.00015

Values are expressed as Mean ±SD of six observations from each group.

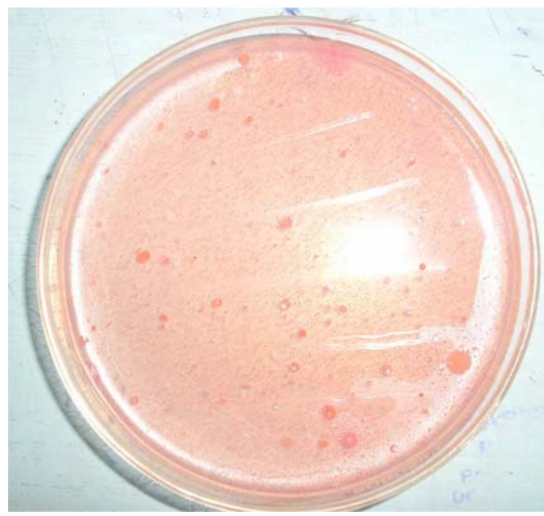
and Stein 1948), carbohydrates (Hedge and Hofreiter 1962), phenol (Malick and Singh 1980), protein (Lowry *et al.* 19951), flavonoid (Siddhuraju and Becker 2003) and carotenoid and chlorophyll (Arnon 1949) were used.

The UV-C treated and control plants were carefully uprooted, washed in running water and the number of root nodules was counted. Root nodules were removed and surface sterilized in 98% ethanol for 8 seconds. *Rhizobium* bacteria were isolated and cultured following the method of Somasegaram and Hoben (1994). Soil nitrogen was estimated by the method of Schmitt and Randall (1994).

The number of root nodules and root length increased due to exposure to UV-C rays while shoot length was reduced (Plate 1). Carbohydrate, protein, aminoacid and phenol and flavonoids in UV-C treated plants showed a marked decrease as compared with control plants. Decreased levels of chlorophyll a and b, total chlorophyll and carotenoids in UV-C treated plants were recorded in comparison to control plants. The number of colonies was found to be increased in UV-C treated plants than in control plants and the nitrogen content was decreased from the soil used for growing UV-C treated plants (Plate 2). These results are in accordance with Dai *et al.* (1995) but on contrary, the root length and the number of root nodules were found to be increased in UV-C exposed plant as compared with control plants.



(a) *Rhizobium* colonies from root nodules of control plants



(b) *Rhizobium* colonies from root nodules of UV-C exposed plants

Plate 1. *Rhizobium* isolated from the root nodules of control and UV-C exposed *Arachis hypogeae* seedlings

In leguminous plants, flavonoids are associated with nodulation on the roots (Kapulnik *et al.* 1987). Our interest was to understand whether UV-C rays elevate the level of these UV-absorbing pigments enhance nodulation and/or activates symbiotic N_2-fixation in leguminous plants and we found increased number of root nodules and *Rhizobium* colonies in UV-C exposed

(a) Control

(b) UV-C exposed

Plate 2. Control and UV-C exposed *Arachis hypogeae* seedlings

seedling. On contrary, the level of soil nitrogen was found to be decreased from the soil where UV-C treated plants were grown. The amount of nitrogen fixed, depends on the amount of carbon products provided by the host plant. Reduced photosynthesis may imply a reduction in carbon available for the *Rhizobium* bacteria. Though there was an increase in number of *Rhizobium* colonies, not able to fix the nitrogen effectively. This could be due to the less availability of carbon sources to fix the atmospheric nitrogen.

Decrease in flavonoid content, total chlorophyll, chlorophyll a and b, and carotenoids contents as recorded in UV-C treated plants could be due to the injury of thylakoid lumen, where the centre of light harvesting system chlorophyll 'a' could be damaged and disintegrated (Smith *et al*. 2000). In addition, carotenoids and xanthophylls are the main protective agents dissipating excess energy and protecting photoreaction centre from auto-oxidation (Yamamoto and Bassi 1996). Decreased amount of photosynthetic pigments in groundnut leaves might indicate plant sensitivity to UV-C radiation. The increased roots length could be attributed to an increase in indole acetic acid (IAA) level in roots than in shoots where IAA may be destructed by UV-C in shoots and not in roots. Hence, the increase in IAA might have elongated the roots and/or may be a protective, adaptive mechanism developed by the plant against the harmful UV-C rays.

REFERENCES

Arnon, D.S. (1949). Copper enzymes in isolated chloroplast: Polypenloxidase in *Beta Vulgaris*. *Plant Physiol*. **14:** 1-15.

Campos, J.L., Figueras, X., Pinol, M.T., Boronat, A. and Tiburcio, A.F. (1991). Carotenoids and conjugated polyamine levels as indicators of ultraviolet-C induced stress in *Arabidopsis thaliana*. *Photochem. Photobiol.* **53:** 689-693.

Cleaver, J.E. (2006). Cells have long experience of dealing with UV-C light. *Nature.* **442:** 244-247.

Dai, Q., Pens, S., Chavez, A.Q. and Vergara, B.S. (1995). Effect of UV-B radiation on stomatal dencity and opening in rice (*Oryza sativa* L.).*Ann. Bot.* **76:** 65-70.

Hader, D.P., Kumar, H.D., Smith, R.C. and Worrest, R.C. (2007). Effects of solar UV radiation on aquatic ecosystems and interactions with climate changes. *Photochem. Photobio Sci.* **6:** 267-285.

Hedge, J.E. and Hofreiter, B.T. (1962). In: *Carbohydrate Chemistry* 17 (Eds. Whistler R.L. and B. Miller, J.N). Academic Press, New York.

Kapulnik, Y., Joseph, C.M. and Phillips, D.A. (1987). Flavone limitations to root nodulation and symbiotic nitrogen fixation in alfalfa. *Plant Physiol.* **84:** 1193-1196.

Lowry, O.H., Rosebrough, N.J., Farr, A.L. and Randall, R.J. (1951). Protein measurement with the Folin phenol reagent. *J. Biol. Chem*. **193:** 265-275.

Malick, C.P. and Singh, M.B. (1980). In: Plant Enzymology and Histo enzymology. Kalyani Publications, New Delhi, pp. 286.

Moore, S. and Stein, W.H. (1948). Photometric method for use in the chromatography of amino acids. *J. Biol. Chem*. **176:** 367-388.

Schmitt, M.A. and Randall, G.W. (1994). Developing a soil nitrogen test for improved recommendations for corn. *J. Prod. Agric*. **7:** 328-334.

Siddhuraju, H.P.S.P. and Becker, K. (2003). Plant Secondary Metabolites. *Theor. Appl. Genet.* **106:** 1234-1243.

Smith, J.L., Burritt, D. and Bannister, P. (2000). Shoot dry weight, chlorophyll and UV-B absorbing compounds as indicators of plants sensitivity to UV-B radiation. *Anals. Bot.* **86:**1057-1063.

Somasegaram, P. and Hoben, H.J. (1994). In "Hand book for Rhizobia, Methods in Legumes-Rhizobium Technology". Pup. Springer Verlag. New York. pp. 402-408.

Tok, J.B.H., Tzeng, Y.L., lee, K., Zeng, Z. and Lynn, D.G. (1997). Mechanisms for initiation of pathogenesis. *Canadian J. Soil Sci.* **658:** 108-116.

Yamamoto, H.Y. and Bassi, R. (1996). Carotenoids; localization and function. In: Ort D.R.and Yocum, C.F. (eds). Oxygenic Photosynthesis: the light reaction. Kluwer Dordrecht, pp. 539-563.