International Journal of Innovative Research and Review ISSN: 2347 – 4424 (Online)
An Online International Journal Available at http://www.cibtech.org/jirr.htm
2014 Vol. 2 (4) October-December, pp.77-82/Kokilavani and Rajendiran
Research Article

ULTRAVIOLET-B INDUCED REDUCTION IN NODULATION IN TEN VARIETIES OF COWPEA

Kokilavani V. and *Rajendiran K.
Department of Botany, K.M. Centre for Post Graduate Studies, Pondicherry – 605 008
**Author for Correspondence*

ABSTRACT

Nitrogen calls the tune in the performance of the plant. For this reason investigating the nodulation becomes critical, especially when the test plants are legumes. The present study is to evaluate the differences in nodulation in ten varieties *viz.* CW-122, COVU-1, COFC-8, CO-1, COVU-2, KM-1, CO-6, VAMBAN, CO-3 and PUDUVAI of cowpea, *Vigna unguiculata* (L.) Walp. after ultraviolet-B (UV-B) exposure. The fully developed root systems were harvested on 30 and 45 DAS (days after seed germination) from ten varieties of cowpea, *Vigna unguiculata* (L.) after exposure to supplementary UV-B radiation (2 hours daily @ 12.2 kJ m^{-2} d^{-1}; ambient = 10 kJ m^{-2} d^{-1}). The number, fresh and dry weight of nodules, assessed on 30 and 40 DAS when the nodule development was reportedly peaking, revealed a distinct impact of the UV-B irradiation upon the nodulation process. The number of nodules in all the UV-B stressed plants was always less than the control. A reduction above 50 % was recorded on 30 DAS while all plants showed a sign of recovery as the reduction was only 33.33 to 46.42 % in almost five varieties on 45 DAS. However the suppressive tendency of UV-B irradiation continued in the remaining five varieties *viz.*, CW-122, COVU-1, COFC-8, CO-1 and CO-3 as they produced less than 50 % of nodules even on 45 DAS. The inhibitory tendency of UV-B continued in fresh weight of nodules also. The nodules weighed less by 27.21 to 86.10 % below control on 30 DAS and 30.77 to 84.70 % on 45 DAS.

Keywords: *Ultraviolet-B, Cowpea, Ten Varieties, Nodulation*

INTRODUCTION

Biological nitrogen fixation represents the major source of nitrogen input in crop fields. The major Symbiotic systems play a significant role in improving the fertility and productivity of nitrogen deficient soils. The *Rhizobium*-legume symbioses have received most attention and have been examined extensively. Severe environmental conditions such as salt stress, drought stress, acidity, alkalinity, nutrient deficiency, fertilizers, heavy metals, and pesticides suppress the growth and symbiotic characteristics of most *Rhizobia*; however, several strains, distributed among various species of rhizobia, are tolerant to stress effects (Zahran, 1999). The present work deals with the screening of ten varieties of cowpea against ultraviolet-B stress.

MATERIALS AND METHODS

Cowpea (*Vigna unguiculata* (L) Walp.), the nitrogen fixing grain legume was chosen for the study. Viable seeds of the ten varieties of cowpea *viz.* CW-122, COVU-1, COFC-8, CO-1, COVU-2, KM-1, CO-6, VAMBAN, CO-3 were procured from Saravan Farms, Villupuram, Tamil Nadu and PUDUVAI from local farmers in Pondicherry. The seeds were selected for uniform colour, size and weight and used in the experiments. The crops were grown in pot culture in the naturally lit greenhouse (day temperature maximum 38 ± 2 ºC, night temperature minimum 18 ± 2 ºC, relative humidity 60 ± 5 %, maximum irradiance (PAR) 1400 µmol m^{-2} s^{-1}, photoperiod 12 to 14 h). Supplementary UV-B radiation was provided in UV garden by three UV-B lamps (*Philips TL20W/12 Sunlamps*, The Netherlands), which were suspended horizontally and wrapped with cellulose diacetate filters (0.076 mm) to filter UV-C radiation (< 280 nm). UV-B exposure was given for 2 h daily from 10:00 to 11:00 and 15:00 to 16:00 starting from the 5th day after sowing. Plants received a biologically effective UV-B dose (UV-B_{BE}) of 12.2 kJ m^{-2} d^{-1} equivalent to a simulated 20 % ozone depletion at Pondicherry (12º2'N, India).

The control plants, grown under natural solar radiation, received UV-B_{BE} 10 kJ m^{-2} d^{-1}. Ten plants from each treatment were carefully uprooted from the soil at 30 and 45 DAS when the nodulation was at its peak and the number and fresh weight of nodules were recorded after removing the soil particles by washing them repeatedly and blotting to dryness.

Whole plants and plant parts were photographed in daylight using a Sony digital camera fitted with appropriate close-up accessories. At least ten replicates were maintained for all treatments and control.

The experiments were repeated to confirm the trends. The result of single linkage clustering (Maskay, 1998) was displayed graphically in the form of a diagram called dendrogram (Everstt, 1985).

The term dendrogram is used in numerical taxonomy for any graphical drawing giving a tree-like description of a taxonomic system. The similarity indices between the ten varieties of cowpea under study were calculated using the formula given by Bhat and Kudesia (2011).

$$\text{Similarity index} = \frac{\text{Total number of similar characters}}{\text{Total number of characters studied}} \times 100$$

Based on the similarity indices between the ten varieties of cowpea, dendrogram was draw to derive the interrelationship between them and presented in tables and plates.

RESULTS AND DISCUSSION

Assessed at a time when the nodulation is reportedly peaking (30 and 45 DAS), nodule number in all the UV-B irradiated varieties of cowpea were always less than the control (Table 1).

A reduction above 50 % was recorded on 30 DAS (Table 1, Plate 1), while all plants showed a sign of recovery as the reduction was only 33.33 to 46.42 % in almost five varieties on 45 DAS.

However the suppressive tendency of UV-B irradiation continued in CW-122, COVU-1, COFC-8, CO-1 and CO-3 as they produced less than 50 % of nodules even on 45 DAS compared to control (Table 1). The inhibitory tendency of UV-B continued in size and fresh weight of nodules also.

The nodules weighed less by 27.21 to 86.10 % below control on 30 DAS and 30.77 to 84.70 % on 45 DAS (Table 1).

Similar inhibition of nodulation, fresh biomass of nodules after UV-B exposure was also reported by Rajendiran and Ramanujam (2006) in green gram, Sudaroli and Rajendiran (2013) in *Sesbania grandiflora* (L.) Pers.,

Arulmozhi and Rajendiran (2014a) in *Lablab purpureus* L. var. CO-5, Arulmozhi and Rajendiran (2014b) in *Lablab purpureus* L. var. Goldy, Vijayalakshmi and Rajendiran (2014a) in *Cyamopsis tetragonoloba* (L.) Taub. var. PNB and Vijayalakshmi and Rajendiran (2014b) in *Phaseolus vulgaris* L. cv. Prevail.

Rajendiran (2001) and Rajendiran and Ramanujam (2006) opined that UV-B stressed shoot system decreased allocation of food to root system which reacted quickly with reduced root system, thereby providing lesser surface area for *Rhizobium* inoculation and root nodules formation.

Figure 1: CW-122

Figure 2: COVU-1

Figure 3: COFC-8

Figure 4: CO-1

Figure 5: COVU-2

Figure 6: KM-1

Figure 7: CO-6

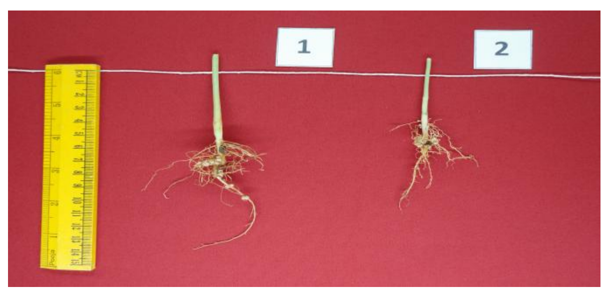

Figure 8: VAMBAN

Figure 9: CO-3

Figure 10: PUDUVAI

Plate 1: Comparative gross morphology of root systems showing nodulation in ten varieties of *Vigna unguiculata* (L) Walp. on 30 DAS. (1: Control, 2: UV-B)

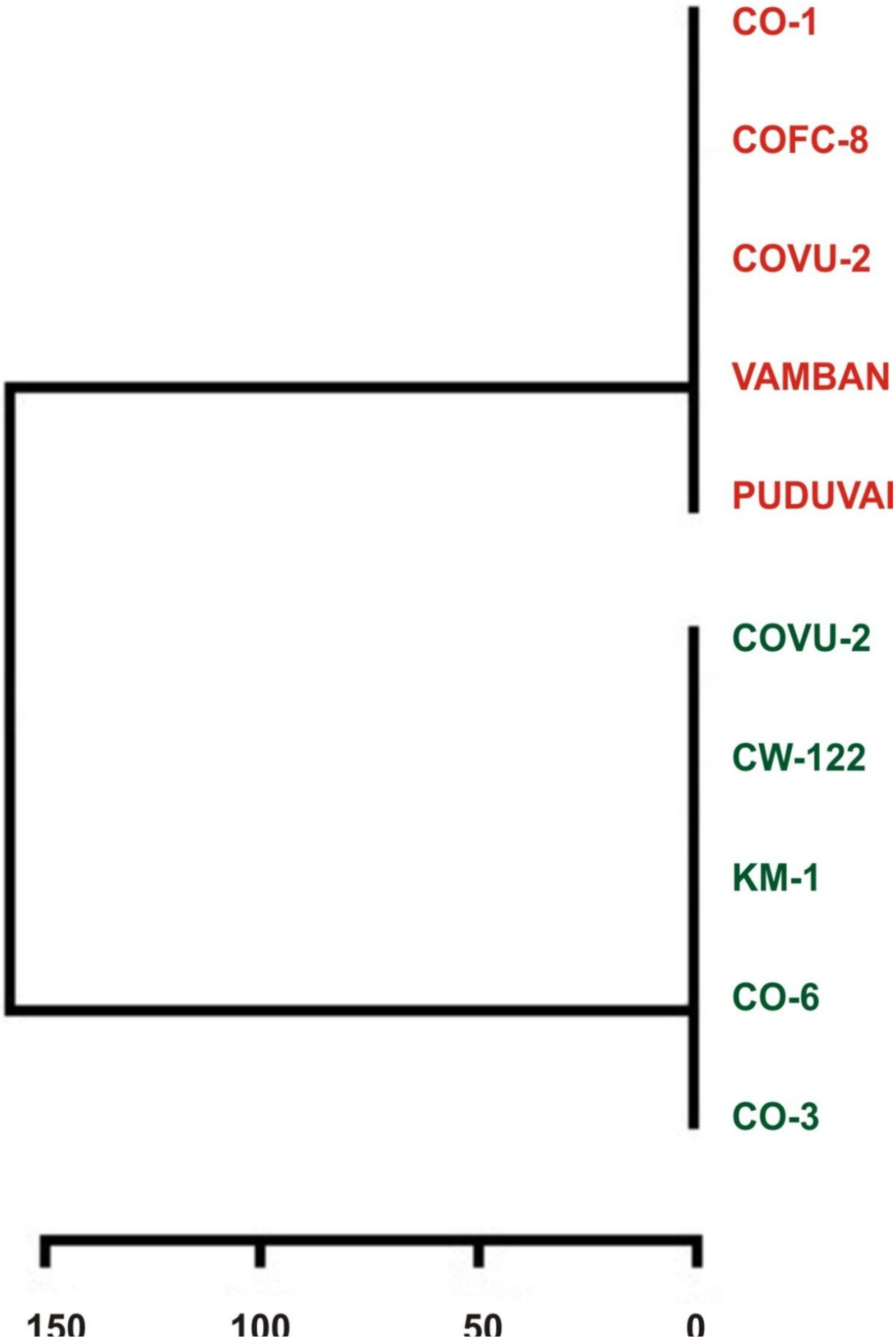

Plate 2: Dendrogram showing the interrelationship between the ten varieties of *Vigna unguiculata* (L.) Walp. in nodulation under supplementary UV-B

Table 1: Changes in nodulation of ten varieties of 30 DAS *Vigna unguiculata* (L.) Walp. under control and supplementary UV-B exposed conditions

Varieties	Treatment	Nodule number plant $^{-1}$		Fresh weight of nodule plant $^{-1}$ (g)	
		30 DAS	45 DAS	30 DAS	45 DAS
CW-122	Control	21	32	0.181	0.822
	UV-B	8	11	0.080	0.125
COVU-1	Control	12	21	0.101	0.766
	UV-B	6	9	0.073	0.129
COFC-8	Control	6	28	0.089	0.743
	UV-B	4	12	0.052	0.160
CO-1	Control	18	32	0.105	0.808
	UV-B	2	15	0.053	0.215
COVU-2	Control	10	19	0.116	0.437
	UV-B	3	11	0.041	0.086
KM-1	Control	25	24	0.197	0.336
	UV-B	5	16	0.061	0.136
CO-6	Control	12	23	0.075	0.251
	UV-B	4	13	0.049	0.095
VAMBAN	Control	12	28	0.100	0.387
	UV-B	4	15	0.019	0.168
CO-3	Control	10	35	0.053	0.538
	UV-B	2	16	0.010	0.202
PUDUVAI	Control	4	15	0.076	0.092
	UV-B	2	8	0.010	0.064

Table 2: The similarity indices in nodulation of ten varieties of *Vigna unguiculata* (L.) Walp. under supplementary UV-B exposed conditions

Varieties	CW-122	COVU-1	COFC-8	CO-1	COVU-2	KM-1	CO-6	VAMBAN	CO-3	PUDUVAI
CW-122	100%	100%	50%	50%	50%	100%	100%	50%	100%	50%
COVU-1	100%	100%	50%	50%	50%	100%	100%	50%	100%	50%
COFC-8	50%	50%	100%	100%	100%	50%	50%	100%	50%	100%
CO-1	50%	50%	100%	100%	100%	50%	50%	100%	50%	100%
COVU-2	50%	50%	100%	100%	100%	50%	50%	100%	50%	100%
KM-1	100%	100%	50%	50%	50%	100%	100%	50%	100%	50%
CO-6	100%	100%	50%	50%	50%	100%	100%	50%	100%	50%
VAMBAN	50%	50%	100%	100%	100%	50%	50%	100%	50%	100%
CO-3	100%	100%	50%	50%	50%	100%	100%	50%	100%	50%
PUDUVAI	50%	50%	100%	100%	100%	50%	50%	100%	50%	100%

Nodule number and fresh biomass in all the ten varieties of cowpea were always less than the control under UV-B exposure. KM-1, CO-6, CO-3, CW-122 and COVU-2 as one group recorded only minimum reduction in nodule formation after UV-B irradiation and remained away from COVU-1, COFC-8, CO-1, VAMBAN and PUDUVAI varieties of cowpea which showed severe reduction (Table 2, Plate 2). To conclude, UV-B radiation which was proved to be detrimental to aerial parts of the plants causing reduction in photosynthesis, also disturbed the vital functions of the root system in general and the legume-*Rhizobium* symbiotic nitrogen fixation in particular.

ACKNOWLEDGEMENT
The authors thank Prof. Dr. Thamizharasi Thamilmani, Director, KMCPGS, Puducherry for providing research facilities.

REFERENCES

Arulmozhi D and Rajendiran K (2014a). Effect of supplementary ultraviolet-B radiation on nodulation and nitrogen metabolism in *Lablab purpureus* L. var. Goldy. *International Journal of Advanced Biological Research* **4**(3) 343-346.

Arulmozhi D and Rajendiran K (2014b). Supplementary ultraviolet-B induced reduction in nodulation and nitrogen metabolism in hyacinth bean. *International Journal of Geology, Earth and Environmental Sciences* **4(2)** 73-77.

Bhat TM and Kudesia R (2011). Evaluation of Genetic Diversity in Five Different Species of Family Solanaceae using Cytological Characters and Protein Profiling. *Genetic Engineering and Biotechnology Journal* 1- 8.

Everstt B (1985). *Clustering Analysis* (John Wiley and Sons) New York.

Maskay N (1998). Single linkage clustering. In: *Encyclopedia of Biostatistics*, edited by Armintage P and Cotton T (Wiley) New York **5** 4121- 4122.

Rajendiran K (2001). Amelioration of Ultraviolet-B radiation impacts in green gram by Triadimefon. PhD. Thesis, Pondicherry University.

Rajendiran K and Ramanujam MP (2006). Interactive effects of UV-B irradiation and triadimefon on nodulation and nitrogen metabolism in *Vigna radiata* plants. *Biologia Plantarum* **50**(4) 709-712.

Sudaroli Sudha J and Rajendiran K (2013). Effect of elevated UV-B irradiation on the nodulation and nitrogen metabolism in *Sesbania grandiflora* (L.) Pers. *International Journal of Science and Nature* **4**(4) 664 - 667.

Vijayalakshmi R and Rajendiran K (2014a). Impact of ultraviolet-B radiation on nodulation and nitrogen metabolism in *Phaseolus vulgaris* L. cv. Prevail. *International Journal of Advanced Biological Research* **4**(3) 339 - 342.

Vijayalakshmi R and Rajendiran K (2014b). Impact of ultraviolet-B radiation on nodulation and nitrogen metabolism in *Cyamopsis tetragonoloba* (L.) Taub. var. PNB. *International Journal of Geology, Earth and Environmental Sciences* **4**(2) 78 - 82.

Zahran HH (1999). *Rhizobium*-legume symbiosis and nitrogen fixation under severe conditions and in an arid climate. *Microbiology and Molecular Biology Reviews* **63**(4) 968 - 989.