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Research Article

COMPARISON OF YIELD ATTRIBUTES OF THREE VARIETIES OF COWPEA UNDER ELEVATED ULTRAVIOLET-B RADIATION

***Rajendiran K., Gowsalya L. and Sudaroli Sudha J.**
Department of Botany, K.M. Centre for Post Graduate Studies, Pondicherry - 605 008, India
**Author for Correspondence*

ABSTRACT
Cowpeas are known for their excellent drought resistance, good tolerance of heat and adaptation to a range of soil conditions. In this study three varieties of cowpea (*Vigna unguiculata* (L.) Walp.) *viz.* GOWMATHI, FOLA and NS-634 were exposed to *in situ* supplementary UV-B radiation (2 hours daily @ 12.2 kJ m^{-2} d^{-1}; ambient = 10 kJ m^{-2} d^{-1}) to evaluate their harvest in UV-B elevated environment. On 60 DAS (days after sowing) mature fruits were harvested from each plant and the data on the length and weight of pod, number of seeds per pod and number of seeds per plant and weight of seeds per plant was collected. UV-B radiation reduced the entire yield components per plant basis *viz.*, pod number (33.33 to 60 %), pod weight (31.31 to 58.49 %), length of the pod (27.57 to 34.56 %), number of seeds (27.27 to 40.90 %) and mass of seeds (39.19 to 75.66 %). Many fruits of UV-B irradiated cowpea varieties had very few seeds. FOLA variety of cowpea recorded the least harvest index (62.58 %) under UV-B treatment followed by GOWMATHI (50.79 %) reduction compared with the respective control crops. *In situ* supplementary UV-B failed to create an impact on the harvest index of NS-634 variety as the value was only 0.28% below the control crop. Shelling percentage followed the same pattern.

***Keywords:** Ultraviolet-B, Cowpea, Three Varieties, Yield Attributes*

INTRODUCTION
Cowpeas (*Vigna unguiculata* (L.) Walp.) are the most productive heat adapted legume used agronomically. They thrive in hot, moist zones where corn flourishes, but require more heat for optimum growth (Miller, 1989). Cowpea varieties have diverse growth habits. Some are short, upright bush types. Taller, viny types are more vigorous and better suited for use as cover crops. Cowpeas protect soil from erosion, smother weeds and produce high yield. Dense residue helps to improve soil texture but breaks down quickly in hot weather. Excellent drought resistance combined with good tolerance of heat, low fertility and a range of soils make cowpeas viable throughout the habitat where summers are warm or hot but frequently dry (Singh *et al.*, 2003). In recent years increases in UV-B flux severely affects the leaves (Kokilavani and Rajendiran, 2013; Kokilavani and Rajendiran, 2014a; Kokilavani and Rajendiran, 2014b; Kokilavani and Rajendiran, 2014c; Kokilavani and Rajendiran, 2014d; Kokilavani and Rajendiran, 2014f; Kokilavani and Rajendiran, 2014g; Kokilavani and Rajendiran, 2014h; Kokilavani and Rajendiran, 2014j; Kokilavani and Rajendiran, 2014k; Kokilavani and Rajendiran, 2014l; Kokilavani and Rajendiran, 2014m; Kokilavani and Rajendiran, 2014n; Kokilavani and Rajendiran, 2015a; Kokilavani and Rajendiran, 2015b) inhibits growth (Rajendiran and Ramanujam, 2003; Rajendiran and Ramanujam, 2004; Kokilavani and Rajendiran, 2014o), suppresses yield (Kokilavani and Rajendiran, 2014e) and reduces nodulation and nitrogen metabolism (Rajendiran and Ramanujam, 2003; Sudaroli and Rajendiran, 2013a; Sudaroli and Rajendiran, 2013b; Kokilavani and Rajendiran, 2014i; Sudaroli and Rajendiran, 2014a; Sudaroli and Rajendiran, 2014b; Sudaroli and Rajendiran, 2014c; Arulmozhi and Rajendiran, 2014a; Arulmozhi and Rajendiran, 2014b; Arulmozhi and Rajendiran, 2014c; Vijayalakshmi and Rajendiran, 2014a; Vijayalakshmi and Rajendiran, 2014b; Vijayalakshmi and Rajendiran, 2014c) in sensitive crops. The goal of this work was to assess whether cowpea can tolerate *in situ* supplementary UV-B irradiation.

MATERIALS AND METHODS
Cowpea (*Vigna unguiculata* (L.) Walp.) belonging to the family Fabaceae which is a nitrogen fixing grain legume was chosen for the study. Viable seeds of the three varieties of cowpea *viz.* GOWMATHI, FOLA

and NS-634 (Namdhari Seeds) were procured from Saravana Farms, Villupuram, Tamil Nadu and 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}. Mature fruits were harvested periodically from each plant and the length and weight of the pod, number of seeds per pod and number of seeds per plant and weight of seeds per plant were recorded. Harvest index (Mohan *et al.,* 1992) and shelling percentage (Francis *et al.,* 1978) were calculated using the following formulae.

$$\text{Harvest index} = \frac{\text{Yield of the plant (g)}}{\text{Biomass of the plant (g)}} \times 100$$

$$\text{Shelling percentage} = \frac{\text{Seed wt. plant}^{-1}}{\text{Fruit wt. plant}^{-1}} \times 100$$

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 three varieties of cowpea, dendrograms were draw to derive the interrelationship between them and presented in tables and plates.

RESULTS AND DISCUSSION

Supplementary UV-B exposure consistently decreased the entire yield components per plant basis, the decreases being 33.33 to 60 % in the pod number, 31.31 to 58.49 % in pod weight, 27.57 to 34.56 % in pod length, 27.27 to 40.90 % in seed number and 39.19 to 75.66 % in seed mass (Table 1; Plate 1 to 2). Analysed on the basis of number of seeds per pod, only the UV-B treated plants had more fruits with fewer number of seeds. Harvest index was the least in FOLA variety of cowpea after UV-B treatment which showed severe reduction of 62.58 % followed by GOWMATHI which showed 50.79 % reduction compared with the controls. Despite UV-B stress NS-634 recorded only little reduction of harvest index by 0.28% when compared with the performance of the respective control crop. A similar pattern was obtained for data on shelling percentage also (Table 1). Kokilavani and Rajendiran (2014e) in ten varieties of cowpea, Rajendiran *et al.,* (2015a) in *Amaranthus dubius* Mart. Ex. Thell., Rajendiran *et al.,* (2015b) in *Macrotyloma uniflorum* (Lam.) Verdc., Rajendiran *et al.,* (2015c) in *Momordica charantia* L., Rajendiran *et al.,* (2015d) in *Spinacia oleracea* L., Rajendiran *et al.,* (2015e) in *Trigonella foenum-graecum* (L.) Ser., Rajendiran *et al.,* (2015f) in *Benincasa hispida* (Thunb.) Cogn. and and Rajendiran *et al.,* (2015g) in *Vigna mungo* (L.) Hepper var. ADT-3 have reported similar yield reductions under supplementary UV-B exposure.

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Figure 1: GOWMATHI

Figure 2: FOLA

Figure 3: NS-634

Plate 1: Harvested pods of three varieties of *Vigna unguiculata* (L) Walp. on 60 DAS. (1: Control, 2: UV-B)

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Figure 1: GOWMATHI

Figure 2: FOLA

Figure 3: NS-634

Plate 2: Harvested seeds of three varieties of *Vigna unguiculata* (L) Walp. (1: Control, 2: UV-B)

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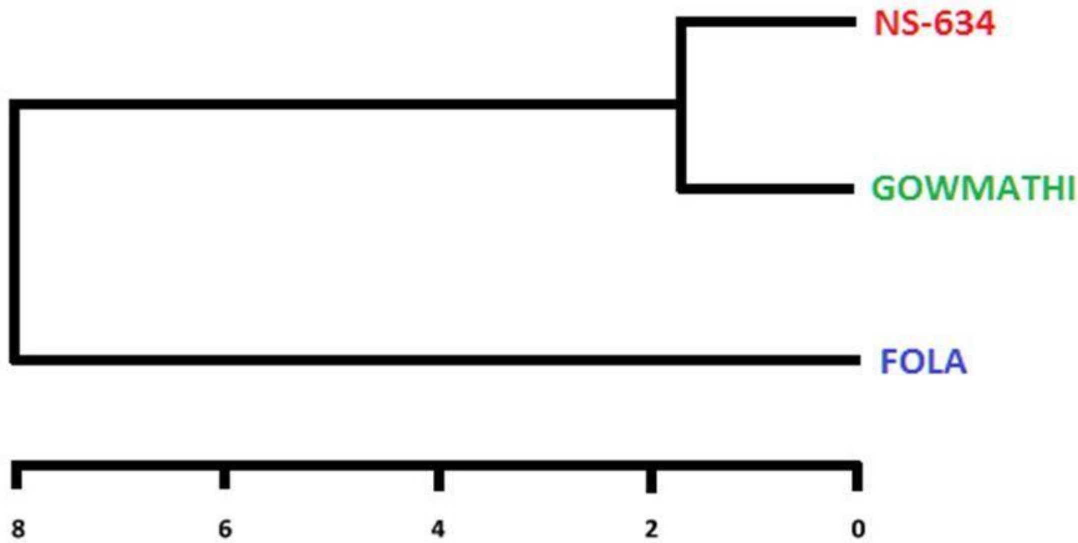

Plate 3: Dendrogram showing the interrelationship between the three varieties of *Vigna unguiculata* (L.) Walp. in yield attributes under control and supplementary UV-B - *In situ.*

Table 1: Changes in yield components of three varieties of *Vigna unguiculata* (L.) Walp. under control and supplementary UV-B exposed conditions – *In situ.*

Varieties	Treatment	Pod number plant^{-1}	Single pod wt. (g)	Pod wt. plant^{-1} (g)	Length of the pod (cm)	Seed number pod^{-1}	Seed number plant^{-1}	Seed mass pod^{-1} (g)	Seed mass plant^{-1} (g)	Shelling percentage plant^{-1}	Harvest index
GOWMATHI	Control	5	0.996	5.579	16.3	11	49	1.021	5.522	83.162	54.592
	UV-B	2	0.680	1.621	16.3	8	15	0.941	2.011	75.715	26.863
FOLA	Control	2	2.767	5.533	21.7	17	32	2.831	5.934	119.878	48.181
	UV-B	1	1.406	1.406	14.2	10	10	1.777	1.777	102.849	18.027
NS-634	Control	3	4.421	14.429	30.1	22	62	2.922	8.201	33.211	112.744
	UV-B	2	1.835	3.935	21.8	13	24	1.723	4.987	32.282	112.421

Table 2: The similarity indices in yield parameters of three varieties of *Vigna unguiculata* (L.) Walp. under supplementary UV-B exposed conditions – *In situ.*

Varieties	GOWMATHI	FOLA	NS-634
GOWMATHI	100%	35%	10%
FOLA	35%	100%	30%
NS-634	10%	30%	100%

Elevated UV-B altered the DNA and protein, which in turn altered the vital metabolisms including photosynthesis reflecting them in the form of reduced yield and nutrition content in the grains (Rajendiran and Ramanujam, 2003; Rajendiran and Ramanujam, 2004).
The similarity index values for the yield attributes *viz.*, pod number, pod length, pod weight, seed number, seed mass, shelling percentage per plant and harvest index were calculated in three varieties of cowpea

after irradiation with supplementary UV-B in comparison with their controls on 60 DAS. The similarity index value between GOWMATHI and NS-634 was only 10 % (Table 2; Plate 3). These two varieties as one group showed close relationship with FOLA which had 35 and 30 % similarity index with GOWMATHI and NS-634 respectively.

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