ROLE OF SUPPLEMENTAL UV-B RADIATION ON FLOWER AND POD FORMATION IN PEA (*PISUM SATIVUM* L.).

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Abstract : Sun is the basic source of energy on the planet earth. It emits UV rays along with solar radiation. These UV rays (UV-B) increase the average temperature of the earth and harmful for living beings. A field experiment was conducted to observe the impact of supplemental UV-B radiation on flower and pod formation in pea (*Pisum sativum* L.). Supplemental UV-B radiation was given to the plant for different time periods (0, 1 hour, 2 hour and 3 hour) by halogen lamps. First time treatment was given when germination started and it was continued upto the maturity of crop. The study revealed that exposure of supplemental UV-B showed promotary effect over control in terms of number, fresh and dry weight of flower and pod in *Pisum sativum* L.

Keywords : *Pisum sativum* L., Supplemental UV-B radiation, flower, pod

INTRODUCTION

Depletion of stratospheric ozone has increased solar ultraviolet-B (UV-B) radiation at high and mid latitudes in both northern and southern hemispheres (Madronich and de Gruijl 1994; Seckmeyer *et al.,* 1994; Mckenzie *et al.,* 1999). Recent projections suggest that ozone depletion will reach its maximum in the coming years and forecasted to recover slowly over the next several decades (Koti *et al.,* 2004).

Surface level ultraviolet radiation (280-320nm) and ozone are components of the global climate and any increase in their levels can lead to adverse effects on crop growth and productivity on a broad geographic scale. There have been numerous studies examining physiological and growth responses by plants to enhanced UV-B radiation. Enhanced UV-B radiation was generally characterized as harmful for plants and its effects were species specific (Teramura and Sullivan, 1993). Field investigations have focused on seed yields of economically important cultivated species with characteristically variable results. Thus, seed yield in soybean was suppressed, stimulated or remained unchanged depending on variety, year of study or additional watering (Murali and Teramura, 1986; Sinclair *et al.,* 1990; Teramura *et al.,* 1990; Miller *et al.,* 1994). Enhanced UV-B radiation can have many direct and indirect effects on plants including inhibition of photosynthesis, DNA damage, changes in morphology, phenology and biomass accumulation (Caldwell *et al.,* 1995). Pea yield was reduced by UV-B radiation (Mepsted *et al.,* 1996). In the few wild plants studied so far under field conditions and with realistic ozone depletion scenarios, a consistent trend towards an increase in flower number was observed in the Mediterranean *Mentha spicata* (Grammatikopoulos *et al.,*1998) and in *Colobanthus quitensis* and *Deschampsia antarctica* in the Antarctic Peninsula (Day *et al.,* 1999). In addition, Gwynn-Jones *et al.,* (1997) found an increase in berry production in the subarctic *Vaccinium myrtilus*. However, the seed yield was not measured in these investigations. In another study with the Mediterranean shrub *Cistus creticus*, the number of flowers was not affected, yet pollination success was improved and seed yield increased (Stephanou and Manetas, 1998). Surplus UV-B radiation, acting as a premature environmental signal, could alter the timing (Ziska *et al.,* 1992) or the number of flowers (Musil, 1995; Grammatikopoulos *et al.,* 1998; Day *et al.,* 1999).

Ying Wang *et al.,* (2008) observed that fruit biomass was not affected by enhanced UV-B radiation in *Cerastium glomeratum* Thuill. Enhanced UV-B radiation delayed onset of flowering by 1 day and shortened duration of flowering by 5 days in *Cerastium glomeratum* Thuill. But because of the long period of flowering time (83-88 days), this did not make any significant effect on flower number, seed number, pollination success (number of seeds per fruit) or reproductive success (fruit to flower ratio) in *Cerastium glomeratum* Thuill.

Based on the above persual of literature and findings, a field experiments was conducted to investigate the effects of supplemental UV-B radiation on flowering, fruiting and their fresh and dry weight in a leguminous pea crop (*Pisum sativum* L). The purpose of this study was to find out whether supplemental UV-B radiation was harmful, neutral or beneficial in this crop.

MATERIAL AND METHOD

The experiment was conducted in the Department of Botany, Govt. P.G. College Noida. Seeds of pea (*Pisum sativum* L.) were sown in soil, in rows spaced 0.1 meter a part in 4 plots of 1 x 1 meter square each. After seedling emergence, plants were irradiated daily with supplemental UV-B radiation supplied by sun lamps (300 watt) held in frames suspended 1 meter above the plants in the fields. The total supplemental UV-B irradiance received at the top of the plants beneath the lamps was 24.23 $Jm^{-2}s^{-1}$.

Control plants (T_1) were not exposed to supplemental UV-B radiation. Plants of plots T_2, T_3 and T_4 were exposed to supplemental UV-B radiation for 1 hr, 2 hr and 3 hr daily till maturity of the crop. The samples for growth analysis were taken regularly at 15 days interval after the seedling emergence till maturity. The five identical plants were transported to laboratory for the observation of flower and pod in terms of number, fresh weight and dry weight (Kumar, 1981). The mean values of five plants were calculated, represented in results with standard deviation and test of significance at 5% level.

RESULT AND DISCUSSION

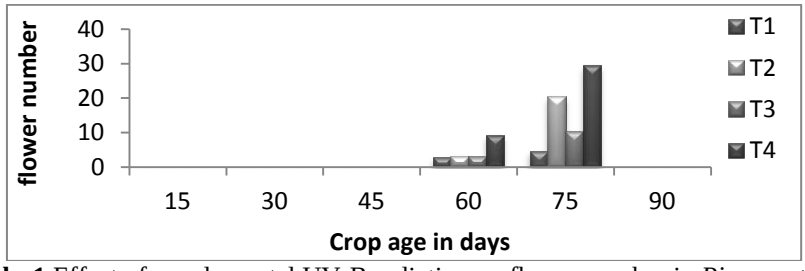
The effect of supplemental UV-B radiation on the growth and development of flower and pod has been shown in table -1(graph 1-3) and in table 2 (graph 4-6) in pea (*Pisum sativum* L.) respectively.

Table -1: Flowers growth pattern of field grown *Pisum sativum* under control and supplemental UV-B radiation.

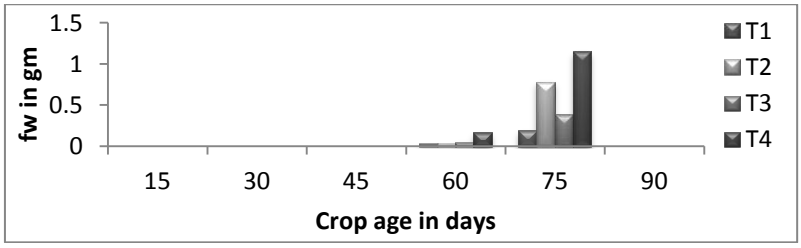
Daily UV-B irradiance		CROP AGE IN DAYS					
Parameters		**15**	**30**	**45**	**60**	**75**	**90 (Maturity)**
Control	Flower no.	----	----	----	2.80±1.643	4.60±0.181	---
	fw, gm	----	----	----	0.034±0.013	0.195±0.028	----
	dw, gm	----	----	----	0.006±0.002	0.031±0.002	----
1- hour	Flower no.	----	----	----	3.00±0.707	*****10.40±10.30	----
	fw, gm	----	----	----	0.035±0.013	*****0.387±0.437	----
	dw, gm	----	----	----	0.006±0.002	*****0.068±0.014	----
2- hour	Flower no.	----	----	----	3.20±0.836	*****20.40±0.547	----
	fw, gm	----	----	----	0.052±0.010	*****0.782±0.052	----
	dw, gm	----	----	----	*****0.010±0.004	*****0.118±0.014	----
3- hour	Flower no.	----	----	----	*****9.20±2.302	*****29.40±4.037	----
	fw, gm	----	----	----	0.169±0.066	*****1.151±0.154	----
	dw, gm	----	----	----	*****0.026±0.009	*****0.186±0.021	----

no. = number**, fw** =fresh weight**, dw** = dry weight**, ±** Standard Deviation**., *** =significant at 5% level.

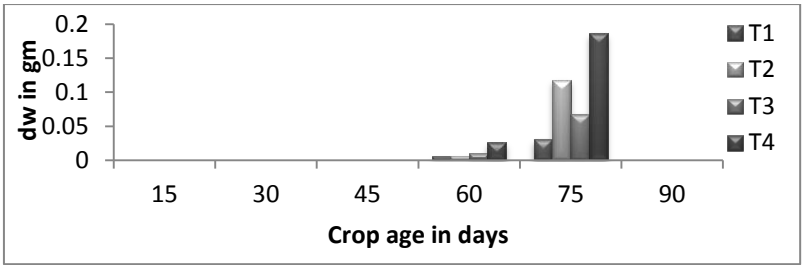
First time flower was observed at 60 day stage. Flower number was promoted 7%, 14%, and 228% at 60 day stage and 126%, 343% and 539% of control at 75 day stage at 1 hr, 2 hr and 3 hr supplemental UV-B radiation respectively. Fresh weight of flower was promoted 2%, 53% and 397% at 60 day stage and 98%, 301% and 490% of control at 75 day stage of crop growth at 1 hr, 2 hr and 3 hr supplemental UV-B radiation respectively. Dry weight of flower was promoted 0%, 66% and 333% at 60 day stage and 119%, 280% and 500% of control at 75 day stage of crop growth at 1 hr, 2 hr and 3 hr supplemental UV-B radiation respectively.



Graph: 1 Effect of supplemental UV-B radiation on flower number in *Pisum sativum.*



Graph: 2 Effect of supplemental UV-B radiation on fresh weight of flower in *Pisum sativum.*



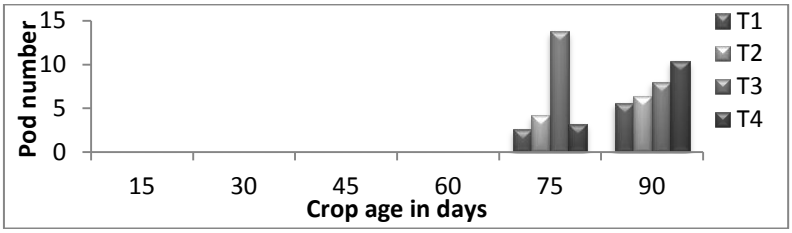
Graph: 3 Effect of supplemental UV-B radiation on dry weight of flower in *Pisum sativum*.

Pod number was promoted 23%, 61% and 430% at 75 day stage and 14%, 43% and 85% of control at 90 day stage of crop growth at 1 hr, 2 hr and 3 hr supplemental UV-B radiation respectively. Fresh weight of pod was promoted 42%, 140% and 619% at 75 day stage and 18%, 52% and 80% of control at 90 day stage of crop growth at 1 hr, 2 hr and 3 hr supplemental UV-B radiation respectively. Dry weight of pod was promoted 10%, 42% and 606% at 75 day stage and 5%, 62% and 6% of control at 1 hr, 2 hr and 3 hr supplemental UV-B radiation respectively.

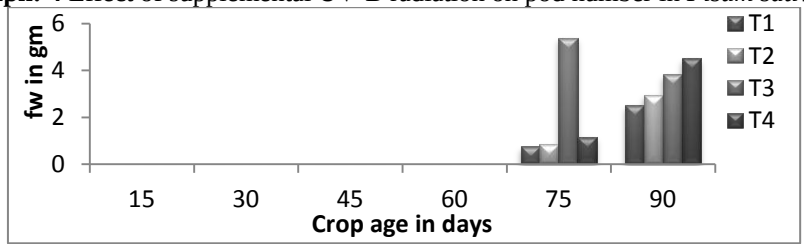
Table -2: Pod growth pattern of field grown *Pisum sativum* under control and supplemental UV-B radiation.

Daily UV-B irradiance		**CROP AGE IN DAYS**					
Parameters		**15**	**30**	**45**	**60**	**75**	**90(Maturity)**
Control	Pod no.	----	----	----	----	2.6±0.894	5.6±1.140
	fw, gm	----	----	----	----	0.747±0.020	2.503±0.212
	dw, gm	----	----	----	----	0.103±0.012	1.706±0.185
1- hour	Pod no.	----	----	----	----	3.2±0.447	4.4±1.341
	fw, gm	----	----	----	----	1.166±1.838	2.947±0.423
	dw, gm	----	----	----	----	0.114±0.016	*0.700±0.080
2- hour	Pod no.	----	----	----	----	4.2±1.303	*8.0±0.707
	fw, gm	----	----	----	----	*0.851±0.040	*3.818±0.025
	dw, gm	----	----	----	----	*0.146±0.013	*2.759±0.214
3- hour	Pod no.	----	----	----	----	*13.8±2.588	*10.4±0.547
	fw, gm	----	----	----	----	*5.376±0.409	*4.504±0.012
	dw, gm	----	----	----	----	*0.728±0.067	1.810±0.033

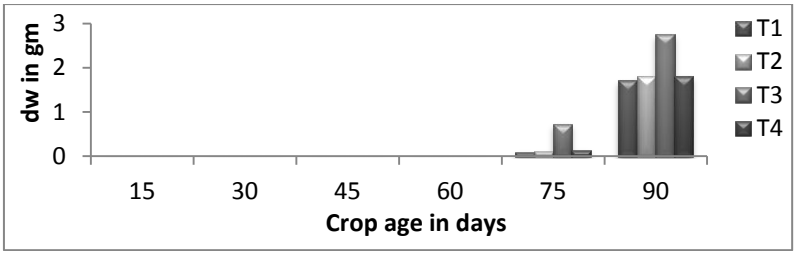
no. = number, **fw** =fresh weight, **dw** = dry weight, ± = Standard Deviation, *= Significant at 5% level.



Graph: 4 Effect of supplemental UV-B radiation on pod number in *Pisum sativum.*



Graph: 5 Effect of supplemental UV-B radiation on fresh weight of pod in *Pisum sativum.*



Graph: 6 Effect of supplemental UV-B radiation on dry weight of pod in *Pisum sativum.*

The results of present study revealed that exposure of supplemental UV-B showed promotary effect over control in terms of number, fresh and dry weight of flower and pod in *Pisum sativum* L.

Stephanou and Manetas (1998) in *Cistus creticus* and Petropoulou *et al.,* (2001) in *Malcolmia maritima* observed that UV-B radiation had no effect on fruit biomass and flower number however flower diameter per flower was significantly increased by supplemental UV-B radiation. Saile *et al.,* (1996) observed the flowering delay up to a maximum of 5 days under higher UV-B radiation. Kakani *et al.,* (2003) in *Gossipium hirsutum* observed the reduction in all floral parts due to UV-B radiation. Rajendiran K. and Ramanujam M.P. (2004) in *Vigna radiata* (L.) and Ying Wang *et al.,* (2008) in *Cerastium glomeratum* observed the delay in flowering due to UV-B radiation.

Gwynn-Jones *et al.,* (1997) found an increase in berry production in the subarctic *Vaccinium myrtilus*. Stephanou and Manetas, (1998) observed the increase in seed yield in *Cistus creticus* due to UV-B radiation. Murali and Teramura (1986); Teramura *et al.,* (1990) in *Glycine max* L. and Petropoulou *et al.,* (2001) in *Malcolmia maritima* and Ying Wang *et al.,* (2008) in *Cerastium glomeratum* observed that UV-B radiation had no effect on fruit biomass however Mepsted *et al.,* (1996) in *Pisum sativum* L. observed the significant decreases in the number of pods and dry weight of pods per plant but UV-B treatment had no effect on the number of peas per pod or average pea weight. Saile *et al.,* (1996) observed the flowering delay in several cultivars of mays (*Zea mays* L.) up to a maximum of 5 days under higher UV-B radiation. Probably due to this delay in the cob development the yield decreased under higher UV-B radiation at the first harvest after 12 and 14 weeks, whereas at the second harvest after 14 and 16 weeks no reduction in yield was observed. Rajendiran and Ramanujam (2004) observed that UV-B stresses delayed achievement of flowering in *Vigna radiata* (L.) by which yield and seed number were reduced significantly by enhanced UV-B radiation.

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