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UTILIZATION OF UV RADIATION FOR THE IMPROVEMENT OF ECONOMIC TRAITS IN THE SILKWORM, *BOMBYX MORI* L.

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Abstract: To detect the effect of ultraviolet (UV) radiation on some economic traits of the silkworm, *Bombyx mori* L. variety Urboshi-1, 5-day old pupae were irradiated with 366nm wavelength of UV-rays at a distance of 10.6 cm for 1, 5 and 10 min. UV-radiation had significant effects on majority of the 16 characters considered for the study. Three different lines *viz.* U1-DW, U1-LW and U10-LD were isolated on the basis of their cocoon shape and size from the rearing of the 1st radiated generation (R_1). The rearing of the R_2 generation produced cocoons which conformed to the shape and size of the cocoons as selected in the R_1 generation. The selected lines showed better rearing performance than the control for majority of the characters, especially the cocoon characters which had direct relationships with the commercial cocoon production. Cocoons produced in the R_2 generation were utilized in the R_3 generation. The evaluation of the cocoon characters of the R_3 generation revealed that U1-LW and U10-LD lines hold promise for commercial exploitation. Moreover, U10-LD also showed the lowest larval mortality.

Key words: UV-rays, economic traits, *Bombyx mori*.

mvivsk: †ikgKxU, *Bombyx mori* Gi Urboshi-1 Rv‡Zi gKKx‡Ui Dci AwZ‡eMwb (UV)-iwk¥i cfve wbavi‡Yi Rb¨ GB M‡elYwU MnY Kiv nq| cvP w`b eq‡mi gKKxU‡K 10.6 †m.wg. `i‡Z 366nm Zi½‰`‡N¨i 1, 5, Ges 10 wgwbU a‡i iwk¥cvZ Kiv n‡qwQj| Aa¨q‡bi Rb¨ 16wU ˆewkó¨‡K Avg‡j †bqv nq| ‡ekxi fvM ˆewk‡ó¨i Dc‡i UV-iwk¥i Zvrch¨cY cfve wQj| ‡KvK‡bi AvKvi Ges AvKwZi Dci wfwË K‡i 1g iwk¥KZ Rb‡bi cwZcvjb n‡Z 3wU wfb jvBb, U1-DW, U1-LW Ges U10-LD c_K Kiv nq| 2q Rb‡bi cwZcvjb n‡Z Abi¦c AvKvi AvKwZi †KvKb Drcv`b Kiv nq hv 1g Rbb n‡Z evQvB Kiv n‡qwQj| ‡ekxi fvM ˆewk‡ó¨i ‡¶‡G, we‡kl K‡i †KvKb ˆewkó¨, hv evwYwR¨K †KvKb Drcv`‡bi mv‡_ mivmwi m¤úKh³, evQvBKZ jvBb¸wj K‡›Uv‡ji Zjbvq AwaK Drcv`bdj †`wL‡q‡Q| Drcb 2q Rb‡bi †KvKb 3q Rb‡bi Rb¨ e¨envi Kiv nq| 3q Rb‡b Drcb †KvKb ˆewk‡ó¨i ch‡e¶Y cgvY K‡i ‡h evwYwR¨K Pv‡li Rb¨ jvBb U1-LW Ges U10-LD fvj ˆewkó¨ enb K‡i| GKBmv‡_ U10-LD mewbg gKKxU gU¨wjwUI c`kb K‡i|

Introduction

Research on the mutagenic action of ultraviolet (UV) rays started soon after the discovery of X-ray mutagenesis. Altenburg (1934) was first to discover the mutagenic effect of UV rays on the polar cap cells in *Drosophila melanogaster*. Experiments with UV rays show that they do not possess sufficient energy to induce ionization (Levine 1980). Subsequently, it has been demonstrated that like X-rays, UV radiations produce point mutations, small deficiencies, chromosome breaks and chromosome rearrangements at different relative frequencies in many organisms. However, investigations reveal that radio-sensitivity varies according to the species, strains, individuals and even in different developmental stages of the same species (Gardner and Snustad 1981; Singh *et al.* 1990; Hasan *et al.* 1998; Faruki 2004; Faruki and Kundu 2005). Tazima (1983, 1984) also reported the significant effect of chemical mutagen and ionizing radiation on *B. mori*.

Though majority of radiation-induced mutations are more or less harmful to the organisms, beneficial mutations can be induced by radiation and extensive breeding work with plants on radiation breeding has yielding many useful mutants (Aurbach, 1976). Tazima (1964), Mallik *et al.* (1968), Coulon (1969), Kotani *et al.* (2002) and Hosagoudar and Manjunatha (2006) worked with ultraviolet-, infrared-, X- and γ-rays on different developmental stages in *B. mori* and on different aspects of its biology. In addition, a number of researchers namely Sengupta *et al.* (1973), Datta and Roy (1976) and Sengupta *et al.* (1977) carried out experiments on X-ray and γ-ray induced mutagenesis to improve their local silkworm races and they also recorded positive results at low doses of irradiation. Recently, Hosagoudar and Manjunatha (2011) investigated the effect of picosecond UV laser radiation on morphological, biochemical and biological changes of silkworm, *Bombyx mori*.

Urboshi-1 is an evolved variety of mulberry silkworm in our country. As the quantitative traits of silkworm variety are mostly controlled by polygenes, it is presumed that new genetic variability to the gene pool of *B. mori* can be added by applying radiation treatment at different developmental stages (Sengupta *et al.* 1973). The present investigation was therefore undertaken to find out the effects of UV-radiation on some quantitative traits of this multivoltine silkworm variety.

Materials and methods

Experimental animal and irradiation: The experimental materials of 5-day old male and female pupae of Urboshi-1 *B. mori* L. (Lepidoptera: Bombycidae) were procured from the Germplasm Bank of the Bangladesh Sericulture Research and Training Institute (BSRTI), Rajshahi. The pupae were exposed to 366nm wavelength of UV-ray at three different durations *viz.* 1, 5 and 10 min from a distance of 10.6cm in each case. A 15W germicidal lamp, GE15T8 measuring 20×4cm was the source of UV radiation, emitting at a wavelength of 366nm. The irradiation was carried out at the Genetic Engineering Laboratory, Department of Zoology, Rajshahi University. The male and female moths that emerged from the treated pupae were mated. Eggs were collected on egg cards for next rearing. Silkworm larvae were reared following the techniques described Krishnaswami (1978) and Rahman (1983). A single batch of non-irradiated worms was simultaneously reared on fresh mulberry leaves as the control. The experiment was replicated thrice.

Isolation: On the basis of weight, shape and size of cocoons recovered from UV-radiated R_1 generation three different lines were isolated as follows: (1) U1-DW, selected from 1 min treatment and had dumbbell shaped cocoon provide with wrinkles; (2) U1-LW, also selected from 1 min dose of UV-radiation but the cocoons had long with round tips; and (3) U10-LD, selected from 10 min UV treatment that had long cocoons with depression in the middle.

Table 1. Effect of UV-radiation on the economic traits of a multivoltine variety (Urboshi-1) of the silkworm *B. mori*.

Traits	Doses of UV-radiation (min)				F-values
	1	5	10	0(Control)	
LW-3	117.8±1.789	129.70±0.321	132.97±1.675	98.73±0.578	214.04**
LW-4	398.37±3.578	383.93±2.764	376.97±1.920	369.03±2.699	17.56**
LW-5	508.66±0.821	465.50±5.953	512.90±3.477	466.80±4.833	31.48**
LW-M	1522.57±15.740	1407.00±54.87	1300.93±19.01	1376.60±20.917	8.29*
LL-4	31.13±0.145	31.46±0.133	31.06±0.384	28.90±0.251	17.25**
LL-5	50.67±0.240	48.70±1.147	47.67±0.240	43.93±0.982	10.85**
LL-M	50.67±0.240	47.70±1.171	47.67±0.240	43.93±0.982	10.90**
LM	38.33±1.666	43.66±0.881	35.66±2.333	41.33±0.666	4.12ns
CW	1027.56±4.909	927.37±26.274	925.80±18.885	851.07±23.613	16.15**
SW	135.63±2.744	125.80±3.017	125.13±1.162	112.47±0.057	14.52**
SR%	0.127±0.0004	0.119±0.0003	0.126±0.0008	0.129±0.0005	5.00*
CL	30.53±0.352	28.90±0.458	27.73±0.508	28.30±0.200	7.06*
CB	14.07±0.284	14.10±0.115	15.03±0.066	14.40±0	0.86ns
PL	24.13±0.384	23.17±0.450	23.50±0.100	23.23±0.145	1.66ns
PB	8.67±0.120	8.77±0.218	8.77±0.218	9.00±0.264	0.35ns
PW	981.17±0.896	900.97±0.433	871.07±6.970	858.63±10.446	64.76**

* = 5% level of significance, ** = 1% level of significance, ns= not significant; weight of 3rd instar larvae = LW-3, weight of 4th instar larvae = LW-4, weight of 5th instar larvae = LW-5, weight of mature larvae = LW-M, length of 4th instar larvae = LL-4, length of 5th instar larvae = LL-5, length of mature larvae = LL-M, larval mortality =LM, weight of cocoon = CW, weight of shell = SW, shell ratio = SR%, length of cocoon = CL, breadth of cocoon = CB, length of pupa = PL, breadth of pupa =PB, weight of pupa = PW.

Parameters: The selected lines were reared for two successive generations and were designated as R_2 and R_3. The characters considered for the study were weight of 3rd instar(LW-3), 4th instar (LW-4), 5th instar(LW-5) and mature larvae(LW-M); length of 4th instar(LL-4), 5th instar(LL-5) and mature larvae(LL-M); larval mortality(LM), weight of cocoon(CW) and shell(SW); shell ratio(SR%), length(CL) and breadth(CB) of cocoon; and weight(PW), length(PL) and breadth(PB) of pupa.

Statistical procedures: Data of all the characters were subjected to analyses of variance. Here, the variance ratio F was calculated from the ratio between treatment mean square and residual mean square and the value was compared with the tabulated value for significance.

Table 2. Mean performance of different lines isolated from UV-irradiated pupae of *B. mori* for different traits.

Traits	Lines				F-values
	U1-DW	U1-LW	U10-LD	0(Control)	
CW	926.00±1.072	955.00±5.507	1018.67±0.88	982.11±6.914	59.31**
SW	117.11±4.655	130.55±3.890	130.56±3.447	120.29±4.063	13.65**
SR%	0.130±0.001	0.136±0.003	0.134±0.003	0.126±0.001	2.50ns
CL	29.33±0	31.67±0	31.55±0.399	28.67±0	58.75**
CB	12.12±0.293	12.33±0	12.67±0	12.00±0.386	1.44ns
PL	22.67±0.193	24.40±0.057	22.67±0.839	23.56±0.113	4.43ns
PB	9.44±0.113	9.22±0.223	9.78±0.11	8.55±0.294	6.15*
PW	816.56±10.159	824.33±4.599	882.00±1.964	865.00±0.695	39.45**

* = 5% level of significance, ** = 1% level of significance, ns= not significant.

Table 3. Mean performance of different lines of *B. mori* in the R_2 generation isolated from UV-irradiated pupae for different traits.

Traits	Lines				F-values
	UI-DW	U1-LW	U10-LD	0(Control)	
LW-3	106.11±0.986	107.11±0.294	99.00±1.154	101.78±0.446	20.93**
LW-4	341.67±1.072	317.11±3.443	374.11±4.722	376.00±1.676	62.66**
LW-5	457.11±0.775	474.67±0.837	485.11±0.775	508.67±1.642	387.91**
LW-M	1498.0±1.216	1470.47±1.31	1493.50±2.31	1457.67±3.41	78.00**
LL-4	31.89±0.0587	32.89±0.294	31.33±0.510	28.78±0.11	15.58**
LL-5	41.10±0.472	42.43±0.384	44.06±0.635	50.87±0.669	41.28**
LL-M	46.00±0.529	49.20±0.321	47.83±0.375	45.13±0.578	11.78**
LM	27.00±3.785	22.33±1.201	26.00±2.081	30.67±2.185	1.43ns
CW	926.57±2.748	970.50±1.357	1015.33±1.848	921.73±5.495	144.40**
SW	125.90±1.417	131.87±0.466	141.43±0.617	123.77±1.065	56.02**
SR%	0.138±0.001	0.136±0.002	0.135±0.002	0.128±0.0008	0.20ns
CL	29.90±0.577	31.00±0.461	32.20±0.513	29.23±0.145	14.94**
CB	11.60±0.057	12.37±0.185	12.60±0.057	12.37±0.033	14.25**
PL	23.47±0.088	23.10±0.251	22.50±0.251	23.37±0.120	4.07ns
PB	9.20±0.057	9.53±0.033	10.0±0.057	9.27±0.088	5.71*
PW	837.00±1.006	837.73±1.072	885.17±1.416	868.80±0.737	880.46**

* = 5% level of significance, ** = 1% level of significance, ns= not significant.

Results and Discussion

Results on the effect of UV-radiation on different characters of silkworm variety, Urboshi-1 were presented in Table 1. Analysis of variance of the experimental data revealed that all the characters except larval mortality, silk cocoon ratio, pupal length and pupal breadth varied significantly due to UV-radiation exposed at pupal stage (Table 1), indicating that UV-radiation can be effective in improving different economic traits of *B. mori*. Sengupta *et al.* (1973), Datta and Roy (1976) and Sengupta *et al.* (1977) also recorded positive results at low doses of irradiation to improve their local silkworm races through X-ray and γ-ray induced mutagenesis. But Faruki and Kundu (2005) reported negative effects on economic traits in *B. mori* due to UV-irradiation exposed at larval stage. Hosagoudar and Manjunatha (2006) reported positive and negative affects of Helium-Neon laser on *B. mori* at different stages of embryo. Similarly Kotani *et al.* 2002 stated that diapause eggs exposed to X-rays displayed significant differences in mutation in different doses however; no differences were observed for non diapause eggs. Earlier on Tazima (1978) also noted that sensitivity to radiation varies according to species, strains, individuals and even different stages of the same species. Dose dependent sensitivity of silkworm to different forms of ionizing radiation has also been reported by Sado (1963), Murakami and Kondo (1964), Molnar *et al.* (1964), Shankaranarayanan (1982), Singh *et al.* (1990), Hasan *et al.* (1998) and Faruki (2004).

Table 4. Mean performance of different lines of *B. mori* in the R_3 generation isolated from UV-irradiated pupae for different traits.

Traits	Lines				F-values
	UI-DW	U1-LW	U10-LD	0(Control)	
LW-3	113.63±0.845	107.43±0.611	99.23±0.433	108.33±1.162	60.34**
LW-4	318.23±0.876	351.10±0.608	381.70±0.880	367.10±1.517	658.41**
LW-5	478.77±3.989	512.40±1.862	518.33±1.424	505.51±1.591	38.21**
LW-M	1490.00±0.461	1474.73±2.37	1502.47±1.702	1451.80±0.305	253.55**
LL-4	30.97±0.376	33.66±0.277	32.62±0.207	28.98±0.290	35.77**
LL-5	46.93±0.317	50.51±0.317	51.43±0.088	48.60±0.266	46.81**
LL-M	41.03±0.384	43.17±0.185	45.33±0.088	51.60±0.200	892.14**
LM	30.67±0.666	27.00±0.577	21.67±1.666	26.67±1.732	12.62**
CW	931.67±0.520	982.50±1.242	1000.27±0.819	969.20±0.808	517.93**
SW	126.80±0.461	131.73±0.959	139.5±0.529	121.43±0.617	148.58**
SR%	0.134±0.002	0.138±0.002	0.147±0.002	0.125±0.001	12.42**
CL	30.77±1.134	30.53±0.260	31.43±0.120	29.77±0.120	1.61ns
CB	11.60±0.057	12.37±0.272	12.20±0.057	12.27±0.145	4.00ns
PL	22.90±0.057	22.67±0.088	22.83±0.120	23.06±0.066	8.00*
PB	9.23±0.577	9.43±0.033	9.67±0.339	9.06±0.666	2.22ns
PW	834±0.814	836.90±0.458	881.57±0.405	868.37±0.520	4447.30**

* = 5% level of significance, ** = 1% level of significance, ns= not significant, weight of 3rd instar larvae = LW-3, weight of 4th instar larvae = LW-4, weight of 5th instar larvae = LW-5, weight of mature larvae = LW-M, length of 4th instar larvae = LL-4, length of 5th instar larvae = LL-5, length of mature larvae = LL-M, larval mortality =LM, weight of cocoon = CW, weight of shell = SW, shell ratio = SR%, length of cocoon = CL, breadth of cocoon = CB, length of pupa = PL, breadth of pupa =PB, weight of pupa = PW.

It is interesting to note that UV-irradiated silkworms produced cocoons with heterogeneous shape and size. Depending on the variation in the shape and size of the cocoon three lines, *viz*. U1-DW, U1-LW and U10-LD were selected. The selected lines were again assessed and compared with that of the mean rearing performance of the control batches. Mean performances on cocoon and pupal characters of different lines are shown in Table 2. The differences among the lines were highly significant for majority of characters except shell ratio, cocoon breadth and pupal length.

The rearing performances of the selected lines in the R_2 and R_3 generations were presented in the Tables 3 and 4, respectively. Analysis of variance showed highly significant result in all the characters except larval mortality (LM) and pupal length (PL) for R_2 generation and cocoon length (CL), breadth (CB) and pupal length (PL) for R_3 generation (Table 3). Results suggested that the shape and size of the selected lines persisted up to R_3 generation.

Results of the final rearing in the R_3 generation clearly indicate that the cocoon characters in the selected lines are much better than those of the control. The performance in respect of the cocoon characters of the selected lines showed that the line U10-LD was the best and the next one was U1-LD. The former also showed the lowest larval mortality. These advantages can be utilized in commercial rearing of the silkworms as the present results clearly indicate that UV-rays could be utilized as a potential source for improving the economic traits in *B. mori*.

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