

[Research]

## Effect of Salicylic Acid on Commercial Traits of the Bivoltine Crossbreed Races of the Silkworm, *Bombyx mori* L.

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### ABSTRACT

Topical application with 100, 200 and 300 ng/ml phytohormone salicylic acid on commercial traits was analysed in bivoltine CSR<sub>2</sub>, CSR<sub>4</sub> and CSR<sub>2</sub>XCSR<sub>4</sub> crossbreed races of the silkworm, *Bombyx mori* L. The results showed that there was significant increase in larval weight female cocoon weight, male cocoon shell weight, and hatching percentage with 100 and 200 ng/ml, silk gland weight, female cocoon shell ratio, male cocoon shell ratio, filament length, in all the treated groups in CSR<sub>2</sub> race of the silkworm, *B. mori* when compared over the respective carrier controls. There was significant increase in larval weight and number of eggs per ovariole with 100 ng/ml, female cocoon weight, male cocoon weight, moth emergence percentage and egg productivity with 200 ng/ml and female cocoon shell weight, female cocoon shell ratio, male cocoon shell weight, male cocoon shell ratio, filament length, filament weight denier and moth emergence percentage with all the treated groups in CSR<sub>4</sub> race of the silkworm, *B. mori* when compared over the respective carrier controls. There was also significant increase in larval weight, silk gland weight, female cocoon shell weight, female cocoon shell ratio, male cocoon shell weight, male cocoon shell ratio, egg productivity and length of the ovariole in all the treated groups, whereas filament weight, denier, number of eggs per ovariole and moth emergence percentage with 100 and 200 ng/ml, male cocoon weight with 200 and 300 ng/ml in CSR<sub>2</sub>XCSR<sub>4</sub> crossbreed race of the silkworm, *B. mori* when compared over the respective carrier controls. These results suggest that the CSR<sub>2</sub>XCSR<sub>4</sub> and CSR<sub>4</sub> races showed good response to phytohormone salicylic acid when compared with that of CSR<sub>2</sub> race of the silkworm, *B. mori*.

**Keywords:** *Bombyx mori*, Commercial traits, Phytohormone, Salicylic acid

### INTRODUCTION

The substances which are regulating the growth and yield in plants are called plant growth regulators. It has been suggested that the plant growth regulators such as gibberellins, auxins, cytokinines, abscissic acid and ethylene participate decisively in complex bioprocesses. Administration of plant growth regulators are reported to influence upon the developmental process of insects (Carlisle *et al.*, 1963). Panitz, (1967) has found a specific effect of gibberlic acid GA<sub>3</sub> upon the activity of the genome exposed by puffs in the polytene chromosomes of larvae of midge, *Acricotopus indicus*. Supplementation of GA<sub>3</sub> increased larval duration, larval weight, decreased fecundity and hatching in the bollworm, *Heliothis virescens*

(Guerra, 1970), increased larval and pupal periods, emergence percentage and decreased pupal weight longevity, fecundity and hatching in *Spodoptera littoralis* (Salama and El Sharaby, 1972); absorption of plant materials in phytophagous insects influences development and physiology increased fecundity and viable eggs in the grass hopper, *Aulocara eliotti* (Neumam, 1982). It has been reported that the treatment with chlormephenicol increases the larval weight and shell ratio in the silkworm, *B. mori* (Krishnaswami, 1978). Feeding of mulberry leaves sprayed with GA<sub>3</sub> to IV instar larvae was reported to increase the larval weight and cocoon weight in the silkworm, *B. mori* (Kamada and Ito 1984) Pai *et al.*, (1986) have reported that topical application with

Paraminobenzoic acid causes a significant reduction in hatchability of eggs of NB<sub>18</sub> race of the silkworm, *B. mori*. Magadum and Hooli (1989, 1991 a, b) have reported that topical application with IAA, IBA, GA<sub>3</sub> and IPA in different larval stadium of pure Mysore multivoltine breed of the silkworm, *B. mori*, resulted in a significant increase in the larval weight, silk gland weight, cocoon weight and its shell weight in bivoltine silkworm, *B. mori* (Hugar and Kaliwal, 1997). Goudar and Kaliwal (2001a, b) have reported that plant growth regulators 2, 4-dichlorophenoxy acetic acid (2, 4-D) and naphthoxy-acetic acid (NOA) enhance the economic traits like larval weight, silk gland weight, cocoon weight, filament length and denier in the silkworm, *B. mori*. Therefore, the present investigation was undertaken to study and compare the effect of plant growth regulator salicylic acid on various economic parameters of the bivoltine CSR<sub>2</sub>, CSR<sub>4</sub> and CSR<sub>2</sub> x CSR<sub>4</sub> crossbreed races of the silkworm.

#### MATERIALS AND METHODS

Disease free layings (DFLS) of the bivoltine CSR<sub>2</sub>, CSR<sub>4</sub> and CSR<sub>2</sub>xCSR<sub>4</sub> crossbreed races of the silkworm, *B. mori* used in this experiment were obtained from the Government grainage center Rayapur, Dharwad, Karnataka State and reared in the laboratory according to the improved method of rearing techniques (Krishnaswami, 1978). The three races were selected to compare the responsiveness of silkworm to salicylic acid each races. The fifth instar larvae weighing an average of 2.5 g selected randomly and grouped into different batches for the experiment. Each group consisted of five replications each with 20 larva. The synthetic phytohormone salicylic acid procured from Hi Media, Chemical Co. Pvt Ltd., Mumbai, India.

The plant growth regulator salicylic acid was dissolved in small quantity of acetone and diluted to form 100, 200 and 300 ng/ml salicylic acid in distilled water. This was topically applied to each silkworm, on first day of 5<sup>th</sup> instar larvae on the dorsal side. In each application 50 µl of salicylic acid was used to treat one silkworm larva. The larvae of carrier controls were topically applied with distilled water while the normal controls did not receive any treatment. The larval, cocoon and adult parameters were

determined and subjected to statistical analysis. The larval parameters such as larval and silk gland weights were recorded before commencement of spinning activity. The cocoon parameters such as female and male cocoon weights and their shell weights were recorded on the 5<sup>th</sup> day after the completion of spinning activity. Filament length was recorded with eppovette by reeling single cocoon. The reeled silk was dried in hot air oven and weight was taken in an electrical balance, Citizen Germany make model DJ 300. The cocoon shell ratio and denier of the filament was calculated. The fecundity was recorded in adult after mating. The mating duration was 24 hours. The cocooning, moth emergence and hatching percentage were also calculated by the formulas were reported by Goudar and Kaliwal (2001a)

#### Statistical analysis

The data collected were subjected to analysis of variance test to find out the significance between the parameters of the untreated and treated groups. The percent values for cocooning, female and male cocoon shell ratio and hatching percentage were transformed in to sine angular values for statistical analysis. The percent index was calculated for each parameter of the experimental groups over that of the corresponding parameters of the control group (Raghava Rao, 1983).

#### RESULTS

The results of the effects of plant growth regulator salicylic acid on commercial traits of the bivoltine CSR<sub>2</sub>, CSR<sub>4</sub> and CSR<sub>2</sub>xCSR<sub>4</sub> crossbreed races of the silkworm, *B. mori* are presented in Table 1-6.

#### Larval Parameters

There was significant increase in larval weight of 11, 9, and 6 percent in all the treated groups in CSR<sub>2</sub> race, with 100 ng/ml in CSR<sub>4</sub> race and 20, 22, and 28 percent in all the salicylic acid treated groups in CSR<sub>2</sub>xCSR<sub>4</sub> crossbreed race of the silkworm, *B. mori* respectively when compared over the respective carrier controls. There was no significant change in other treated groups. The CSR<sub>2</sub>xCSR<sub>4</sub> race showed good response to salicylic acid as compared to CSR<sub>2</sub> and CSR<sub>4</sub> races of the silkworm, *B. mori* (Table 1).

**Table 1. Effect of salicylic acid on the larval parameters of silkworm, *B. mori*.**

Dose ng/ml	Larval weight (g)			Silkgland weight (g)			Larval period (hr)			Cocooning (%)		
	CSR <sub>2</sub>	CSR <sub>4</sub>	Hybrid	CSR <sub>2</sub>	CSR <sub>4</sub>	Hybrid	CSR <sub>2</sub>	CSR <sub>4</sub>	Hybrid	CSR <sub>2</sub>	CSR <sub>4</sub>	Hybrid
100	3.020*	2.344*	4.320*	1.124*	0.670	1.110*	595	590	603	91	93	94.6
	(11)	(12)	(20)	(14)	(07)	(13)	(-01)	(00)	(00)	72.54**	74.65**	76.56**
200	2.970*	2.230	4.390*	1.350*	0.624	1.216*	599	593	606	92.2	90.4*	96.2
	(09)	(07)	(22)	(37)	(-01)	(24)	(00)	(01)	(01)	73.78**	71.95**	78.75**
300	2.868*	2.118	4.590*	1.140*	0.506	1.316*	607	599	609	88.0*	90*	89.6*
	(06)	(01)	(28)	(16)	(-20)	(34)	(01)	(02)	(02)	69.73**	71.56**	71.18**
DW (CC)	2.710	2.082	3.580	0.982	0.628	0.980	597	589	601	94.0	93	96.1
	(100)	(100)	(100)	(100)	(100)	(100)	(00)	(100)	(100)	75.82**	74.65**	78.61**
NC	2.090	2.028	3.210	0.610	0.580	0.886	596	586	596	93.3	92	95.00
	(-23)	(-03)	(-11)	(-38)	(-08)	(-10)	(00)	(-01)	(-01)	74.99**	73.57**	77.07**
±SEM	0.075	0.062	0.059	0.032	0.053	0.035	1.231	2.023	1.940	0.678	0.902	0.582
C.D.	0.254	0.191	0.173	0.104	0.168	0.117	3.773	6.588	6.20	2.073	1.528	1.899

\* Significant increase/ decrease at 5% \*\* Angular transformed values ±SEM: Standard error mean  
C.D: Critical difference at 5% Percentage increase or decrease(-) over that of the carrier control (CC) in parenthesis.

There was a significant increase in silkgland weight of 14, 37 and 40 percent in CSR<sub>2</sub> race and 13, 24 and 34 percent in all the salicylic acid treated groups in CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed race of the silkworm, *B. mori* respectively when compared over the respective carrier controls. However, there was no response of silkgland to salicylic acid treatment in CSR<sub>4</sub> race. These results indicated that the silkgland of both CSR<sub>2</sub> and CSR<sub>2</sub>×CSR<sub>4</sub> races showed good response to salicylic acid.

There was no significant change in larval duration in all the salicylic acid treated groups in all the three races of the silkworm, *B. mori* when compared over the respective carrier controls (Table 1).

Also, there was a significant decrease in cocooning percentage of 7 percent with 300 ng/ml in CSR<sub>2</sub> race, 3 and 3 percent with 200 and 300 ng/ml in CSR<sub>4</sub> race respectively and 7 percent with 300 ng/ml salicylic acid treated group in CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed race of the silkworm, *B. mori* when compared over the respective carrier controls. These results suggest that the used concentrations have affected the cocooning percentage more in CSR<sub>4</sub> race as compared with other two races of the silkworm, *B. mori* (Table 1).

#### Cocoon Parameters

There was significant increase in female cocoon weights of 7 and 6 percent with 100 and 200 ng/ml salicylic acid respectively, in

female shell weight of 27 percent with 300 ng/ml, in male shell weight of 23 and 23 percent with 100 and 200 ng/ml respectively (Table 2), in female cocoon shell ratio of 5 and 26 percent with 200 and 300 ng/ml, in male shell ratio of 18 and 8 percent with 100 and 200 ng/ml respectively in CSR<sub>2</sub> race when compared over the respective carrier control (Table 2).

There was a significant increase in female and male cocoon weight of 5 and 36 percent with 200 ng/ml respectively, in female cocoon shell weight of 25, 30 and 44 percent, in male cocoon shell weight of 38, 62 and 61 percent with 100, 200 and 300 ng/ml respectively in CSR<sub>4</sub> race of the silkworm, *B. mori* when compared over the respective carrier controls (Table 3).

However, there was a significant decrease in male cocoon weight of 10 and 16 percent with 200 and 300 ng/ml respectively, in female cocoon shell weight of 70, 55 and 50 percent, in male cocoon shell weight of 68, 52 and 42 percent in all the salicylic acid treated groups respectively, in female cocoon shell ratio of 66, 49 and 44 percent, in male cocoon shell ratio of 76, 69 and 69 percent in all the salicylic acid treated groups respectively in CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed race of the silkworm, *B. mori* when compared over the respective carrier controls (Table 4). These results indicate that CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed showed good response to salicylic acid compared to other two races of the silkworms.

**Table 2. Effect of salicylic acid on the cocoon parameters of the CSR2 silkworm, *B. mori*.**

Dose ng/ml	Female cocoon			Male cocoon			Silk filament character		
	Weight (g)	Shell weight (g)	Shell ratio (%)	Weight (g)	Shell weight (g)	Shell ratio (%)	Length (m)	Weight (g)	Denier
100	1.29*	0.232	17.757* 24.92**	0.99	0.21*	21.210* 27.42**	680.6	0.143	1.892
	(7)	(-11)	(-18)	(-09)	(23)	(18)	(01)	(02)	(01)
200	1.276*	0.292	22.88* 28.57**	1.084	0.21*	19.352* 26.09**	699*	0.160*	2.060*
	(6)	(12)	(05)	(14)	(23)	(08)	(04)	(14)	(10)
300	1.210	0.330*	27.274* 31.48**	1.180	0.18	15.25* 22.98**	783*	0.200*	2.298*
	(00)	(27)	(26)	(24)	(06)	(-15)	(16)	(43)	(22)
DW (CC)	1.204 (100)	0.260 (100)	21.59 27.68** (100)	0.95 (100)	0.17 (100)	17.89 25.02** (100)	672 (100)	0.140 (100)	1.875 (100)
NC	1.210 (00)	0.248 (-05)	20.49 26.914** (-05)	0.88 (-08)	0.17 (00)	19.318 26.07** (08)	650 (-03)	0.130 (-07)	1.800
SEM ±	0.014	0.018	0.018	0.022	0.011	0.011	1.587	0.008	0.005
C.D	0.045	0.0544	0.04	0.299	0.037	0.041	4.999	0.028	0.029

\* Significant increase/ decrease at 5% \*\* Angular transformed values ±SEM: Standard error mean

C.D: Critical difference Percentage increase or decrease(-) over that of the carrier control (CC) in parenthesis.

### Filament Parameters

There was significant increase in filament length of 4 and 16 percent filament weight of 14 and 43 percent and denier of 10 and 22 percent with 200 and 300 ng/ml salicylic acid treated groups respectively in CSR<sub>2</sub> race of the silkworm, *B. mori* when compared over the respective carrier controls (Table 2). There

was significant increase in filament length of 5 percent with 200 ng/ml, filament weight of 5, 11 and 8 percent and denier of 3, 6 and 6 percent in 100, 200 and 300 ng/ml in salicylic acid treated groups respectively in CSR<sub>4</sub> race of the silkworm, *B. mori* when compared over the respective carrier controls (Table 3). There was also a significant increase in filament length of 34 percent with 200 ng/ml, filament

**Table 3. Effect of salicylic acid on the cocoon parameters of the CSR4 silkworm, *B. mori*.**

Dose ng/ml	Female cocoon			Male cocoon			Silk filament character		
	Weight (g)	Shell weight (g)	Shell ratio (%)	Weight (g)	Shell weight (g)	Shell ratio (%)	Length (m)	Weight (g)	Denier
100	1.235	0.250*	20.242* 26.73**	1.06*	0.29*	27.355* 31.53**	668	0.145*	1.953*
	(02)	(25)	(22)	(16)	(38)	(18)	(01)	(05)	(03)
200	1.270*	0.260*	20.472* 26.90**	1.244*	0.34*	27.331* 31.51**	690*	0.153*	1.996*
	(05)	(30)	(24)	(36)	(62)	(18)	(05)	(11)	(06)
300	1.220	0.288*	23.606* 29.06**	0.818	0.338*	41.31* 39.99**	692	0.149*	1.995*
	(01)	(44)	(43)	(90)	(61)	(79)	(105)	(08)	(106)
DW (CC)	1.21 (100)	0.200 (100)	16.52 23.98** (100)	0.910 (100)	0.210 (100)	23.07 28.70** (100)	659 (100)	0.138 (100)	1.884 (100)
NC	1.18 (-03)	0.212 (06)	17.96 25.07** (08)	0.830 (-09)	0.250 (19)	30.126 33.28** (30)	655 (-01)	0.132 (-05)	1.813 (-04)
SEM ±	0.017	0.013	0.005	0.0675	0.013	0.008	1.682	0.001	0.002
C.D	0.052	0.041	0.033	0.254	0.044	0.152	5.058	0.005	0.014

\* Significant increase/ decrease at 5% \*\* Angular transformed values ±SEM: Standard error mean

C.D: Critical difference Percentage increase or decrease(-) over that of the carrier control (CC) in parenthesis.

weight of 24 and 104 percent denier of 15 and 51 percent with 100 and 200 ng/ml salicylic acid treated groups respectively in CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed of the silkworm, when compared over the respective carrier controls (Table 4). These results indicate that CSR<sub>4</sub> race of the silkworm showed good response to salicylic acid as compared to other two races of the silkworms in enhancing the silk filament characters.

#### Adult parameters

There was significant increase in moth emergence percentage of 6 and 4 percent in CSR<sub>4</sub> race and 5 and 6 percent with 100 and 200 ng/ml salicylic acid in CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed of the silkworm, respectively when compared over the respective carrier

controls. This indicates that both CSR<sub>4</sub> and CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed races of the silkworm showed that salicylic acid has stimulatory effect on the cocoon crop as compared with that of CSR<sub>2</sub> race of the silkworm (Table 5).

#### Eggs production

There was significant increase in eggs production of 4 percent with 200 ng/ml in CSR<sub>4</sub> race and 11, 6 and 4 percent with 100, 200 and 300 ng/ml salicylic acid treated groups respectively in the silkworm, *B. mori* as compared over the respective carrier controls. These results indicate that CSR<sub>2</sub> race do not showed any response to salicylic acid in eggs production as compared to CSR<sub>4</sub> and CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed races of the silkworm, *B. mori* (Table 5).

**Table 4. Effect of salicylic acid on the cocoon parameters of the CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed race of silkworm, *B. mori*.**

Dose ng/ml	Female cocoon			Male cocoon			Silk filament character		
	Weight (g)	Shell weight (g)	Shell ratio (%)	Weight (g)	Shell weight (g)	Shell ratio (%)	Length (m)	Weight (g)	Denier
100	1.330 (02)	0.34* (70)	25.56* 30.36** (66)	1.092 (-05)	0.276* (68)	25.27* 30.17** (76)	747 (108)	0.177* (24)	2.132* (15)
200	1.40 (07)	0.31* (55)	22.902* 28.591** (49)	1.030* (-10)	0.250* (52)	24.272* 29.515** (69)	930* (34)	0.290* (104)	2.806* (51)
300	1.310 (01)	0.30* (50)	22.183* 28.10** (44)	0.960* (-16)	0.233* (42)	24.270* 29.51** (69)	699 (01)	0.15 (05)	1.852 (00)
DW (CC)	1.300 (100)	0.20 (100)	15.384 23.09** (100)	1.144 (100)	0.164 (100)	14.335 22.24** (100)	690 (100)	0.142 (100)	1.851 (100)
NC	1.14 (-13)	0.168 (-16)	14.736 22.57** (-04)	1.000 (-13)	0.170 (03)	17.00 24.35** (18)	659.2 (-05)	0.132 (-07)	1.802 (-03)
SEM ±	0.097	0.017	0.015	0.020	0.011	0.011	24.903	0.005	0.001
C.D	0.122	0.052	0.444	0.061	0.037	0.033	96.569	0.012	0.053

\* Significant increase/ decrease at 5% \*\* Angular transformed values ±SEM: Standard error mean  
C.D: Critical difference Percentage increase or decrease(-) over that of the carrier control (CC) in parenthesis.

**Table 5. Effect of salicylic acid on the adult parameters of silkworm, *B. mori*.**

Dose ng/ml	Moth emergence (%)			Eggs production (Nos)			Hatching (%)		
	CSR2	CSR4	CSR2×CSR4	CSR2	CSR4	CSR2×CSR4	CSR2	CSR4	CSR2×CSR4
100	91 (03)	92* (06)	93* (05)	577.00 (01)	581 (03)	660* (11)	91.6* (04)	87.6 (01)	93* (04)
200	90 (02)	91* (04)	94.2* (06)	578.80 (01)	586* (04)	631* (06)	93.0* (06)	87.0 (00)	91.7 (02)
300	87 (-02)	87.6 (00)	89 (100)	583.00 (02)	558 (-01)	616* (04)	88.0 (00)	84.2 (-03)	90 (00)
DW (CC)	88.4 (100)	87.0 (100)	88.6 (100)	570.00 (00)	563 (100)	592.4 (100)	87.5 (100)	87 (100)	89.5 (100)
NN	86 (-03)	86.0 (-01)	87.4 (-02)	563.00 (-01)	560 (-01)	588 (-01)	86.0 (-02)	84.8 (-03)	89.0 (-01)
SEM ±	0.954	1.178	0.978	1.118	1.846	1.372	1.105	1.393	0.764
C.D. at 5%	2.908	3.698	3.112	4.096	5.750	5.204	3.54	4.900	2.525

\* Significant increase/ decrease at 5% ±SEM: Standard error mean C.D: Critical difference  
Percentage increase or decrease(-) over that of the carrier control (CC) in parenthesis.

**Table 6. Effect of salicylic acid on female ovariole characteristics of silkworm**

Dose ng/ml	Length of the Ovariole (mm)			Eggs per ovariole (No.)		
	CSR <sub>2</sub>	CSR <sub>4</sub>	CSR <sub>2</sub> ×CSR <sub>4</sub>	CSR <sub>2</sub>	CSR <sub>4</sub>	CSR <sub>2</sub> ×CSR <sub>4</sub>
100	112 (03)	108 (03)	122* (13)	76.6* (05)	75* (05)	82* (11)
200	116* (07)	105 (00)	118.4* (09)	75 (03)	72.8 (02)	80* (08)
300	120* (11)	102 (-03)	115.4* (07)	73 (00)	71.0 (00)	75 (01)
DW (CC)	108 (100)	105 (00)	108 (100)	72.8 (100)	71.0 (100)	74 (100)
NN	102 (-06)	100 (-02)	104.6 (-03)	72.6 (-01)	69.0 (-03)	70 (-06)
SEM ±	1.162	1.096	1.223	0.847	1.207	1.432
C.D. at 5%	4.066	3.389	4.656	2.723	3.764	4.589

\* Significant increase/ decrease at 5% ±SEM: Standard error mean C.D: Critical difference  
Percentage increase or decrease(-) over that of the carrier control (CC) in parenthesis.

### Hatching percentage

There was significant increase in hatching percentage of 5 and 6 percent with 100 and 200 ng/ml in CSR<sub>2</sub> race respectively and 4 percent with 100 ng/ml salicylic acid in CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed race of the silkworm, *B. mori* as compared over the respective carrier controls. These results suggest that CSR<sub>4</sub> race do not showed any response to salicylic acid as compared to CSR<sub>2</sub> and CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed races of the silkworm, *B. mori*.

### Female ovariole characteristics

There was significant increase in length of the ovariole of 16 and 20 percent with 200 and 300 ng/ml in CSR<sub>2</sub> race 13, 9 and 7 percent with 100, 200 and 300 ng/ml salicylic acid treated groups respectively in the silkworm, *B. mori* as compared to that of carrier controls (Table 6). There was no significant change in length of the ovariole with salicylic acid in CSR<sub>4</sub> race of the silkworm, *B. mori*. There was significant increase in eggs per ovariole of 5 and 5 percent with 400 ng/ml in both CSR<sub>2</sub> and CSR<sub>4</sub> race of the silkworm, and 11 and 8 percent with 100 and 200 ng/ml salicylic acid treated groups respectively in the silkworm, *B. mori* as compared over the respective carrier controls. These results suggest that all the three races of the silkworm showed good response to salicylic acid (Table 6).

The results also suggested that the topical application with distilled water to fifth instar silkworm larvae in carrier controls resulted in an increase of commercial traits of the silkworm, *B. mori* when compared over the respective normal controls. This indicates that the distilled water itself has stimulatory

effect on the silkworm to enhance the commercial traits.

### DISCUSSION

The results of the present study showed that with all salicylic acid treated groups in CSR<sub>2</sub>, with 100 ng/ml in CSR<sub>4</sub> and in all the salicylic acid treated groups CSR<sub>2</sub>×CSR<sub>4</sub> in cross breed race showed significant increase in larval weight. The results obtained in the present study are similar with those reported for the Japanese and Indian multivoltine race of the silkworm, *B. mori* after the treatment with IAA and GA<sub>3</sub> (Kamada and Ito, 1984; Magadum and Hooli, 1989, 1991) and IAA in bivoltine silkworm, *B. mori* (Hugar and Kaliwal, 1997). It has also been reported that there was a significant increase in the larval weight in the silkworm, *B. mori* after the treatment with 2, 4-D and NOA (Goudar and Kaliwal, 2001 a, b). The increase in the larval weight obtained in the present study might possibly be due to altering the rate of the DNA synthesis which may helps in protein synthesis and /or the rate of synthesis of insect moulting hormone (De Man *et al.*, 1981). The results also suggested that the CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed race showed good response to phytohormone salicylic acid as compared with those of CSR<sub>2</sub> and CSR<sub>4</sub> races of the silkworm, *B. mori*.

The results of the present study showed that the silk gland weight was significantly increased in CSR<sub>2</sub> and CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed races in all the treated groups. However, there was no significant change in silk gland weight in CSR<sub>4</sub> race treated with salicylic acid. Similar results have been reported after the topical application with IAA and GA<sub>3</sub> to the silkworm, *B. mori* (Kamada and Ito, 1984, Magadum and Hooli, 1989, 1991; Hugar and Kaliwal, 1997). It has also been reported that

there was a significant increase in the silk gland weight in the silkworm, *B. mori* after the treatment with 2,4-D but there was no significant change in the wet weight of the silk gland in the silkworm, *B. mori* after the treatment with NOA (Goudar and Kaliwal, 2001a, b). The increased silk gland weight obtained in the present study might be due to the increased DNA synthesis which helps protein synthesis in the silk gland. Since, the plant growth promoting hormones are suggested to alter the DNA synthesis in insects (Neumann, 1982). The present results also suggest that the CSR<sub>2</sub> and CSR<sub>2</sub>×CSR<sub>4</sub> crossbreed race showed good response to salicylic acid as compared with that of CSR<sub>4</sub> race of the silkworm, *B. mori*.

The results of the present study showed that the larval duration was not changed significantly with all the salicylic acid treated groups in all the three races of the silkworm, *B. mori*. In contrast to our study the larval duration was increased significantly after the topical application with IAA in bivoltine silkworm, *B. mori* (Hugar and Kaliwal, 1997). It has also been reported that the larval duration was decreased significantly in all the groups treated with 2,4-D and naphthoxy acetic acid in the silkworm, *B. mori* (Goudar and Kaliwal, 2001a, b). The no change in larval duration observed in the present study might possibly be due to no change in the synthesis of moulting hormone. Since the treatment with plant hormones reported to alter the rate of synthesis of the insect moulting hormone (Neumann, 1982). However, further study is required to understand the mechanism of action of plant hormones on the synthesis of moulting hormone. There was significant decrease in cocooning percentage with 300 ng/ml of salicylic acid treated groups in CSR<sub>2</sub> race with 200 and 300 ng/ml CSR<sub>4</sub> and with 300 ng/ml treated groups in CSR<sub>2</sub>×CSR<sub>4</sub> cross breed race of the silkworm, *B. mori*. It has been reported that topical application with 2,4-D and naphthoxy acetic acid has no effect on the cocooning percentage (Goudar and Kaliwal, 2001a, b). The present results suggest that the used concentrations in CSR<sub>4</sub> have affected the cocooning percentage more than in CSR<sub>2</sub> and CSR<sub>2</sub>×CSR<sub>4</sub> races of the silkworm, *B. mori*.

The results of the present study showed that the female and male cocoon weight

significantly increased with 100 and 200 ng/ml, female cocoon shell weight with 300 ng/ml and female and male cocoon shell ratio in all the treated groups in CSR<sub>2</sub> race of the silkworm, *B. mori*. There was significant increase in female and male cocoon weight with 200 ng/ml, female and male cocoon shell weight and its ratio in all the treated groups in CSR<sub>4</sub> race of the silkworm, *B. mori*. There was also a significant increase in male cocoon weight with 200 and 300 ng/ml and female and male cocoon shell weight and its shell ratio in all the treated groups in CSR<sub>2</sub>×CSR<sub>4</sub> race of the silkworm, *B. mori*. Similar increase in these parameters was reported after treating with IAA and GA<sub>3</sub> in Mysore breed of the silkworm, *B. mori* (Magadum and Hooli, 1989, 1991), IAA, 2,4-D and NOA in bivoltine silkworm, *B. mori* (Hugar and Kaliwal, 1997; Goudar and Kaliwal, 2001a, b).

The results of the present study showed that the topical application with salicylic acid increased significantly in filament length and its weight and denier with all the treated groups in CSR<sub>4</sub>, filament length in all the treated groups, filament weight with 300 ng/ml and denier with 200 and 300 ng/ml salicylic acid treated groups in CSR<sub>2</sub> silkworm, *B. mori*. There was also a significant increase in filament length with 200 ng/ml, filament weight and denier with 100 and 200 ng/ml treated groups in crossbreed CSR<sub>2</sub>×CSR<sub>4</sub> silkworm, *B. mori*. Similar results have been reported after the topical application with IAA, 2,4-D and NOA to bivoltine silkworm, *B. mori* (Hugar and Kaliwal, 1997; Goudar and Kaliwal 2001a, b). These results also suggest that CSR<sub>4</sub> showed good response to phytohormone salicylic acid as compared with those of crossbreed CSR<sub>2</sub> and CSR<sub>2</sub>×CSR<sub>4</sub> races of the silkworm, *B. mori*.

The results of the present study showed that there was significant increase in moth emergence percentage with 100 and 200 ng/ml salicylic acid in CSR<sub>4</sub> and crossbreed CSR<sub>2</sub>×CSR<sub>4</sub> races of the silkworm, *B. mori*. However, there was no significant change in the moth emergence percentage with salicylic acid in CSR<sub>2</sub> race of the silkworm, *B. mori*. This suggests that salicylic acid has stimulatory effect on the cocoon crop. Similar results were reported in the bivoltine silkworm, *B. mori* after the treatment with 2,

4-D and NOA (Goudar and Kaliwal, 2001). The results of the present study showed that there was significant increase in fecundity in all the salicylic acid treated groups in CSR<sub>4</sub> and crossbreed CSR<sub>2</sub>×CSR<sub>4</sub> and there was no significant change in the moth emergence percentage with salicylic acid in CSR<sub>2</sub> race of the silkworm. Similar results were found after the topical application with IAA, GA<sub>3</sub>, 2,4-D and NOA in the bivoltine silkworm, *B. mori* (Magadum and Hooli, 1989, 1991; Hugar and Kaliwal, 1997; Goudar and Kaliwal, 2001a, b). These results suggest that the used concentrations have stimulatory effect on the fecundity of the silkworm, *B. mori*. The results of the present study showed that there was significant increase in hatching percentage with 100 and 200 ng/ml salicylic acid in crossbreed CSR<sub>2</sub>×CSR<sub>4</sub> races of the silkworm, *B. mori*. However, there was no significant change in the hatching percentage with salicylic acid treatment in CSR<sub>4</sub> race of the silkworm, *B. mori*. The increased hatching percentage was similar to those reported in the bivoltine silkworm, *B. mori* treated with IAA and 2, 4-D (Hugar and Kaliwal, 1997; Goudar and Kaliwal, 2001a). This suggest that the salicylic acid has stimulatory effect on hatching percentage in CSR<sub>2</sub> and crossbreed CSR<sub>2</sub>×CSR<sub>4</sub> compared with that of CSR<sub>4</sub> race of the silkworm, *B. mori*.

The results of the present study suggested that there was significant increase in eggs per ovariole with 100 ng/ml salicylic acid in CSR<sub>2</sub> and CSR<sub>4</sub> with 100 and 200 ng/ml in crossbreed CSR<sub>2</sub>×CSR<sub>4</sub> races of the silkworm, *B. mori*. There was also significant increase in length of the ovariole with 200 and 300 ng/ml salicylic acid in CSR<sub>2</sub> and in all treated groups in crossbreed CSR<sub>2</sub>×CSR<sub>4</sub> races of the silkworm, *B. mori*. However, there was no significant change in length of the ovariole with salicylic acid in CSR<sub>4</sub> race of the silkworm, *B. mori*. The results indicate that the used concentrations of salicylic acid have stimulatory effect on the eggs and length of the ovariole.

The phytohormones have influences the insect growth by stimulating the DNA synthesis acting on the genome or insect moulting hormone (De Man *et al.*, 1981). The phytohormones restrict the insect growth since, they mimics the moulting hormones (Alonso, 1971). The precise mechanism of action of phytohormones is still obscure

although the effect of phytohormones has been investigated in insects. In our study, it is interesting to note that the phytohormone salicylic acid influences the commercial traits of the silkworm, *B. mori*. The results also suggest that the crossbreed CSR<sub>2</sub>×CSR<sub>4</sub> and CSR<sub>4</sub> showed good response to salicylic acid as compared with that of CSR<sub>2</sub> race of the silkworm, *B. mori*.

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