International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 19-10-2025, Accepted: 18-11-2025, Published: 03-12-2025
Volume 10, Issue 12, 2025, Page No. 13-21

Enhancement of Mulberry leaves using some foliage fertilizers for sustainable Silkworm, *Bombyx mori* L. cocoons crops

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Abstract
Mulberry trees and their leaves are considered one of the important economic crops due to their connection with feeding silkworm, *Bombyx mori* L., and producing raw silk. Two types of foliage fertilizers were used. Four concentrations were prepared from each fertilizer. Mulberry leaves were soaked in each concentration. Then leaves were dried and offered to silkworm larvae for one time daily the remaining feeding time were offered without any treatment. Leaves treated were used during whole instars, four instars only, three young instars, first and second instars and only first instar. Data were registered for fourteen silkworm traits. The treatments of T_1 and T_2 earned superior data for all characters comparing the blank and control. As well as, highest results were obtained for the height concentrations. Increasing the period of treatments was better than the short period. It could be concluded that, during rearing larvae of silkworm using scattered huge trees. These trees did not support by fertilize so the quality of leaves was low. It was recommended using super mix Boro Pota with highest concentrations for whole larvae duration or first four instars or at least the first, second and third instars.

Keywords: Silkworm *Bombyx mori* L., foliar fertilizers, Mulberry leaves, larvae characters, economic characters

Introduction

Silk is a sturdy, biodegradable material used in different products, including clothing, furniture, and medical supplies, highlighting its potential. Mulberry trees and their leaves are considered one of the important economic crops due to their connection with feeding silkworm, *Bombyx mori* L., larvae and producing raw silk. The goodness and nutritious mulberry leaves are critical for rearing silkworm, affecting the feeding behavior, digestion efficiency, and silk production in *B. mori* L., due to various physiological, biochemical, and morphological characteristics (Datta, 1992 and Kruthika *et al*. 2025) [1, 2].

The silkworm *Bombyx mori*'s physiological function, growth development to make silk are all directly impacted by nutrition case and quality of mulberry leaf. Because leaf nutrition and silkworm development are closely related, raising the nutrition rating of mulberry leaves offers a sustained and strategic way to improve cocoon output. The practice of adding nutrients to mulberry leaves for improve the leaf quality and to silkworm larvae is a neoteric method of increasing the commercial output of cocoons (Rahmathulla *et al*. 2007)[3]. Silkworm larvae rely on nutrient-rich host plants, with nitrogen and phosphorus essential for their growth. The rising use of bio-fertilizers offers a sustainable solution, enhancing crop yield while protecting soil and water quality (Borah and Singha,2022) [4]. The nutritional value of the mulberry leaves that silkworms eat immediately affects their performance, and scientists have repeatedly demonstrated that fertilizers greatly enhances the output and quality of mulberry leaves by enhancing soil fertility and plant metabolism through microbial interactions. (Vijaya *et al*. 2009, Etebari, 2002, and Qadri, 2011) [5, 6, 7].

The absorption of essential elements occurs fundamentally through leaf stomata and epidermis but repeated silkworm rearing seasons lead to repeated harvesting of mulberry leaves, which affects nutrition importance of the mulberry leaf so, applied foliar fertilizers is an effective method requires to be framed for maintaining order permanent provide of micronutrients to enhanced quantum of mulberry leaf and quality to raising cocoon output (Wani *et al*. 2017 & Nazar *et al*. 2019) [8, 9].

The goal of this experiment intentend to raising quality mulberry leaves by applied two foliar fertilizer to increase output of cocoon crops in order to boost rears' income, improve their living standards, and ensure stable production.

Materials and Methods

The silkworm eggs of hybrid Giza C were collected from the breeding program of the Sericulture Research Department - Plant Protection Research Institute-Agriculture Research Center. The investigation was conducted in the Sericulture Research Department-Plant Protection Research Institute. Two types of foliage fertilizers were collected from the General Organization for Agriculture Equalization Fund (G. O. A. E. F.) Ministry of Agriculture and Land reclamation. Super mix is a superior, balanced blend (containing 12% potassium, magnesium, and micronutrients, fortified with amino acids) coded as T_1. Boro Pota fertilizer,) containing molybdenum and amino acids) coded as T_2. Four concentrations were prepared from the Super mix fertilizer there were C_1 (1.668ml/Liter), C_2 (3.335 ml/Liter), C_3 (6.670ml/Liter), and C_4 (13.340ml/Liter). As well as Boro Pota fertilizer, C_1 (0.418ml/Liter), C_2 (0.835 ml/Liter), C_3 (1.670ml/Liter), and C_4 (3.340ml/Liter). The Blank treatment was dipping mulberry leaf in distilled water. The Leaves of control treatment offered without any application. Each concentration represented by three replicates. Each replicate contains 300 larvae.

The larvae were brushed at plastic trays (60X90X10 cm). Surrounded by wet foam and covered with plastic sheets for young instar larvae (Ghazy, 2008) [10]. Mulberry leaves of *Morus alba* var canava-2 are hired to feeding silkworm larvae. The larva was disinfectant with Serillim collected

from Specialized Sericulture Component; the usage dose was as described by Hosny *et al*. (2002) [11]. Chopped mulberry leaves were offered to young larvae (1st instar, 2nd instar, and 3rd instar) four times daily. Whereas the full leaves were presented to grown larvae (4th instar, and 5th instar). The treated mulberry leaves were offered to larvae once daily as follows: treated leaves introduced to larvae for 1st instar only (I_1), 1st and 2nd instar only (I_2), 1st, 2nd and just 3rd instar (I_3). From 1st instar till 4th instar (I_4) only, and from 1st to 5th instar (I_5). Mature larvae were collected and put on to collapsible frames. The cocoons collected after 7 days from mountage. The average of room temperature and humidity was 21.540 °C ± 1.605 and 59.27% ± 7.350.

Traits of silkworm, *Bombyx mori* were recorded, there were fifth duration (FD), whole larvae duration (WLD), mortality percentage (MP), double cocooning % (DCP), cocoons numbers/liter (C/L), cocooning percentage (CP), pupation ratio (PR), crop of cocoons by number (Crop/N) and weight (Crop/W). Cocoon (CW), cocoon shell (CSW), and pupa (PW) were weighed for females and males, as well as the cocoon shell rate (CSR), and silk productivity (SP).

Percentage of double cocoon and pupation rate were reckoned according to the next equations of Lea (1996) [12]:

$$\text{Double cocoon percentage} = \frac{\text{Number of pupae made double cocoon}}{\text{Total number of pupae harvested}}$$

$$\text{Pupation ratio (\%)} = \frac{\text{Number of health pupae}}{\text{Corrected basic number of examined}} \text{X } 100$$

Results were registered and calculated by ANOVA two ways and multi ways by SAS program (1998) [13].

Results and Discussion

Data of Table 1 showed that, effect of different fertilizer treatments on some silkworm characters. There were high significant differences between treatments. Blank and control treatments earned worst averages. While, best results were appeared for T_1 and T_2. These may be due to the fertilizers enhanced the quality of mulberry leaves. These results coincidence with data of El-Khayat *et al*. (2013) [14] proved that, fertilizer, raised traits of cocoon weight, shell weight, shell ratio, whole larvae duration, hatchability %, silk gland weight, also enhanced the length of filament, weight and size. Devamani *et al*. (2024) [15] stated that, micro-nutrients enhanced yield characters and composition mulberry leaves. As well as, larval weight, cocoon, and shell weight.

Table 1: Effect of different fertilizers treatments on some silkworm characters

Character Treatment	FD (days)	WLD (days)	LMP (%)	C/L (No)	DCP (No)	CP (%)	PR (%)	Crop/N (No)	Crop/W (g)
T_1	9.455	27.368	10.236	163.005	0.032	86.678	97.950	8697.790	10202.360
T_2	9.385	27.520	11.887	142.100	0.032	85.639	97.750	8563.660	10151.210
T_3	9.895	28.474	13.419	199.020	0.014	69.647	95.000	6966.070	7120.920
Control	10.056	28.443	13.717	212.000	0.007	66.237	88.000	6623.700	5726.190
F between Treatment	14.150**	11.050**	9.560**	347.060**	38.850**	897.450**	53.260**	737.620**	2425.160**
LSD 5%	0.244	0.495	1.446	4.796	0.006	0.990	1.769	110.100	127.100

Where: T_1, T_2, Blank, Control, (TRT= Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 2 represented the results of the effect of concentrations of different fertilizers on the silkworm characters. Highly significant differences were detected for characters of larval mortality percentage, cocooning percentage, crop by number & weight. Significance difference was obtained of double cocooning %. While insignificance difference was detected for 5th duration, whole larval duration, and pupation ratio. Mostly the concentrations of C_4, C_3, and C_2 were earned better results for 5th duration, whole larvae duration, larval mortality percentage, number of cocoons/liters, cocooning ratio, pupation rate, crop by number and crop by weight. Highest concentrations may be raising the quality of mulberry leaves. These data are going in line with experiment conducted by Ghazy *et al*. (2018) [16] who proved that, treated leaves with foliar fertilizer Ascobein with highest concentration gained the best data for economic characters of cocoons number/liter, cocooning %, pupation rate, weight of cocoon, shell, and pupae. Also, cocoon shell ratio, silk productivity, yield by number and weight.

Table 2: Effect of some concentrations of different fertilizers on silkworm characters

Character Treatment	FD (days)	WLD (days)	LMP (%)	C/L (No)	DCP (No)	CP (%)	PR (%)	Crop/N (No)	Crop/W (g)
C_1	9.712	27.964	13.931	181.990	0.022	74.733	94.300	7473.620	7942.800
C_2	9.694	27.914	11.545	179.965	0.025	77.275	94.450	7727.530	8321.310
C_3	9.697	27.905	12.174	176.355	0.016	77.288	95.200	7757.490	8360.920
C_4	9.689	28.021	11.608	177.815	0.023	78.906	94.750	7892.580	8575.660
F between Concentrations	0.010	0.090	4.630**	2.040	3.020*	23.670**	0.390	19.680**	33.450**
LSD 5%	-	-	1.446	-	0.006	0.990	-	110.100	127.100

Where: C_1, C_2, C_3, C_4, C_5 (concentration), (*) significant at 0.05, (**) highly significant at 0.01

Effect of some different fertilizers treated for different instars of silkworm traits were illustrated in Table 3 highly significant differences were registered for number of cocoons per liter, double cocooning percentage, cocooning percentage, pupation ratio, crop by number and crop by weight. On the other hand, insignificant differences were found for fifth duration, whole larval duration, and larval mortality percentage. Generally, treated I_3, I_4, and I_5 earned superior results. These results are accordance with those found by (Fouad and Gad, 2022) [17] they noted that, treated whole instars of silkworm, *B. mori* with high concentration of three foliage fertilizers are superior haemolymph results of total protein, total lipids, and total carbohydrates than treated young instars. Also, Shweta *et al*. (2025) [18] resulted that foliar application was effective for enhancing various economic traits *viz*. larval weight, effective rearing rate, silk productivity, cocoon weight, pupal weight, fecundity,

filament length, filament weight, denier, and biochemical parameters.

Table 3: Effect of some different fertilizers treated for different instars of silkworm characters

Character Treatment	FD (days)	WLD (days)	LMP (%)	C/L (No)	DCP (No)	CP (%)	PR (%)	Crop/N (No)	Crop/W (g)
I_1	9.804	28.235	13.122	179.044	0.021	72.928	94.875	7296.680	7627.870
I_2	9.585	27.618	11.942	180.369	0.015	74.702	95.438	7505.650	7953.200
I_3	9.624	28.022	13.051	183.331	0.028	77.760	93.688	7775.990	8321.710
I_4	9.708	27.822	12.001	173.725	0.027	79.199	96.063	7919.910	8500.710
I_5	9.768	27.934	11.458	178.688	0.017	80.661	93.313	8065.800	9097.380
F Between Instars	0.900	0.930	1.620	3.250**	6.900**	64.740**	2.650*	49.890**	120.630**
LSD 5%	-	-	-	5.363	0.006	1.107	1.978	123.100	142.100

Where: (I_1, I_2, I_3, I_4, I_5 = Instar), (*) significant at 0.05, (**) highly significant at 0.01

Data demonstrated in Table 4 showed effect of interaction among fertilizer treatments and various treated instars on some mulberry silkworm traits. Treatments during I_4, and I_5 were the best results. Treatments of T_1, T_2 acquired the highest data compared with blank and control treatments. This may be due to raising of the component for mulberry leaves. These results were supported by Oukasha *et al*. (2025) [19] suggested that fortify of mulberry leaves with extracts some nutritional additives to fed fourth and fifth instars larvae significantly improving biological characteristics and productivity.

Table 4: Effect of interaction between fertilizer treatments and different treated instars on some silkworm characters

Character Treatment		FD (days)	WLD (days)	LMP (%)	C/L (No)	DCP (No)	CP (%)	PR (%)	Crop/N (No)	Crop/W (g)
T_1	I_1	9.542	27.503	6.356	170.575	0.028	79.777	97.000	7986.008	9083.476
	I_2	9.458	26.458	13.067	163.875	0.027	83.506	97.500	8492.225	9753.137
	I_3	9.536	28.159	12.263	161.275	0.031	87.753	98.250	8775.250	10193.662
	I_4	9.375	27.350	10.748	159.750	0.037	89.593	98.250	8959.303	10525.933
	I_5	9.365	27.372	8.748	159.550	0.034	92.762	98.750	9276.158	11455.583
T_2	I_1	9.425	27.365	16.167	148.000	0.042	77.600	97.500	7760.000	8786.290
	I_2	9.375	27.677	10.283	148.500	0.024	80.967	98.250	8096.667	9313.814
	I_3	9.375	27.505	9.617	148.050	0.047	88.850	98.500	8885.000	10558.908
	I_4	9.375	27.438	11.283	134.750	0.037	89.067	98.000	8906.650	10702.007
	I_5	9.375	27.613	12.083	131.200	0.013	91.714	96.500	9170.000	11395.054
Blank	I_1	10.292	29.198	15.833	185.600	0.006	68.100	97.000	6817.000	6915.506
	I_2	10.058	28.297	12.083	197.100	0.003	68.100	98.000	6810.000	7019.654
	I_3	10.042	28.377	13.729	212.000	0.019	68.200	90.000	6820.000	6808.065
	I_4	9.543	28.125	12.450	188.400	0.028	71.900	100.000	7190.000	7048.717
	I_5	9.542	28.375	13.000	212.000	0.015	71.933	90.000	7193.333	7812.679
Control		10.915	28.875	16.596	212.000	0.016	71.000	88.000	6623.700	5726.189
F TRT X Instar		0.880	1.070	4.330**	4.510**	3.180**	13.840**	2.910**	11.050**	26.970**
LSD 5%		-	-	3.989	16.638	0.017	8.402	4.300	850.760	1706.400

Where: (TRT= Treatments) & (I_1, I_2, I_3, I_4, I_5 = Instar), (*) significant at 0.05, (**) highly significant at 0.01

Table 5 appeared the impact of interaction among different fertilizer treatments and concentrations on some silkworm characters. Highly significant differences were detected for larval mortality percentage, cocoons number per liter, double cocooning %, cocooning percentage, cocoon crop by number. On the other hand, insignificant differences were detected of fifth duration, whole larval duration, and pupation ratio. Generally, all concentrations of T_1 and T_2 earned best averages comparing by blank, and control treatments. Concentration of C_4, C_3, and C_2 were best results for treatments of T_1 and T_2. These data are accomplished with Kannihalli *et al*. (2024) [20] stated that, application highest concentration of nano fertilizers to the mulberry leaves, exhibited favorable outcomes in terms of reduced 5th and total larval duration, increased mature larval weight, improved effective rate of silkworm rearing, silk productivity, silk gland weight, pupal weight, cocoon yield, cocoon weight, shell weight, cocoon shell ratio, filament length, finer denier, highest fibroin and lowest sericin protein.

Table 5: Effect of interaction between different fertilizer treatments and concentrations on some silkworm characters

Character Treatment		FD (days)	WLD (days)	LMP (%)	C/L (No)	DCP (%)	CP (%)	PR (%)	Crop/N (No)	Crop/W (g)
T_1	C_1	9.504	27.488	13.333	157.180	0.025	83.147	97.400	8314.720	9581.042
	C_2	9.362	27.288	11.042	172.680	0.040	86.803	97.000	8680.347	10201.952
	C_3	9.513	27.302	10.693	163.040	0.024	85.829	98.600	8696.200	10165.494
	C_4	9.442	27.395	5.877	159.120	0.036	90.932	98.800	9099.889	10860.945
T_2	C_1	9.375	27.442	15.353	159.760	0.038	79.900	96.800	7990.000	9343.033
	C_2	9.375	27.482	7.707	136.160	0.044	86.411	97.800	8640.000	10236.181
	C_3	9.375	27.392	10.966	131.360	0.017	87.440	99.200	8744.000	10431.062
	C_4	9.414	27.762	13.520	141.120	0.030	88.807	97.200	8880.653	10594.583
T_3	C_1	9.842	28.485	13.320	199.020	0.017	69.647	95.000	6966.067	7120.924
	C_2	10.056	28.443	13.717	199.020	0.007	69.647	95.000	6966.067	7120.924

	C_3	9.842	28.485	13.320	199.020	0.017	69.647	95.000	6966.067	7120.924
	C_4	9.842	28.485	13.320	199.020	0.017	69.647	95.000	6966.067	7120.924
Control		10.056	28.443	13.717	212.000	0.007	66.237	88.000	6623.700	5726.189
F TRT X Conc		0.180	0.070	4.940**	4.960**	3.640**	9.380**	0.260	7.330**	12.420*
LSD 5%		-	-	3.546	14.753	0.016	7.675	-	776.080	1534.900

Where: (TRT= Treatments) & (C_1, C_2, C_3, C_4, C_5, Conc = concentration), (*) significant at 0.05, (**) highly significant at 0.01

The effect of the interactions of different fertilizer concentrations and treated instars on some silkworm characters were found in Table 6 high significant differences were observed for double cocooning %, cocooning percentage, cocoons crop by number and weight. While, other traits were insignificant. Mostly the data revealed that, highest concentration and instar treatments of I_5, I_4, and I_3 acquired better results. Similar data were detected by Kannihalli *et al*. (2023) [21] suggested that, highest concentration of nano-fertilizers was gained the superior data for various economic parameters related to larval traits, cocoon characteristics and silk characters. Rani, (2024) [22] indicated that foliar spray of Fe, Zn, Mn and Cu had a significant effect on many mulberry and rearing parameters. In the same line Maurya and Srivastava (2025) [23] stated that, the 0.5% concentration lactic acid as dietary additive offered the best balance between improved biochemistry and cocoon productivity in *B. mori*.

Table 6: Effect of interactions of different fertilizer concentrations and treated instars on some silkworm characters

Character Treatment		FD (day)	WLD (day)	LMP (%)	C/L (No)	DCP (No)	CP (%)	PR (%)	Crop/N (No)	Crop/W (g)
C_1	I_1	9.808	28.313	15.883	187.650	0.017	66.490	94.500	6650.725	6764.168
	I_2	9.627	27.960	13.833	186.825	0.017	71.884	94.750	7188.425	7458.279
	I_3	9.536	27.868	15.046	185.675	0.019	77.174	93.000	7717.375	8205.592
	I_4	9.708	27.779	12.683	171.450	0.035	78.719	95.750	7871.900	8422.090
	I_5	9.792	27.902	12.208	178.350	0.021	79.397	93.500	7939.683	8863.855
C_2	I_1	9.742	28.177	10.217	180.000	0.018	74.664	94.750	7468.175	7788.478
	I_2	9.712	27.625	11.150	179.375	0.012	75.309	95.000	7530.925	7966.986
	I_3	9.708	27.825	12.842	182.000	0.044	77.170	93.000	7716.975	8274.737
	I_4	9.708	27.850	11.546	177.350	0.025	79.215	96.250	7921.475	8559.813
	I_5	9.692	28.094	11.973	181.100	0.024	80.015	93.250	8000.092	9016.544
C_3	I_1	9.792	28.223	13.456	173.425	0.018	74.226	95.250	7424.300	7797.438
	I_2	9.477	27.929	11.000	176.950	0.014	74.857	96.250	7627.325	8130.054
	I_3	9.708	27.708	12.202	184.050	0.015	77.882	94.250	7788.150	8328.347
	I_4	9.708	27.792	12.246	172.950	0.024	79.259	96.750	7925.925	8512.337
	I_5	9.798	27.875	11.967	174.400	0.010	80.218	93.500	8021.758	9036.411
C_4	I_1	9.874	28.227	12.933	175.100	0.028	76.334	95.000	7643.508	8161.376
	I_2	9.527	27.460	11.783	178.325	0.016	76.759	95.750	7675.917	8257.476
	I_3	9.542	28.688	12.115	181.600	0.035	78.815	94.500	7881.450	8478.148
	I_4	9.708	27.868	11.527	173.150	0.022	79.604	95.500	7960.353	8508.606
	I_5	9.792	27.863	9.683	180.900	0.012	83.017	93.000	8301.658	9472.696
F Conc X Instar		0.170	0.420	0.840	0.830	2.690**	4.740**	0.100	3.960**	5.400**
LSD 5%		-	-	-	-	0.017	8.402	-	850.760	1706.400

Where: (TRT= Treatments) & (C_1, C_2, C_3, C_4, C_5, Conc = concentration), (I_1, I_2, I_3, I_4, I_5 = Instar), (*) significant at 0.05, (**) highly significant at 0.01

Effect of interactions between fertilizer treatments, concentrations, and treated different instars on some silkworm traits were tabulated in Table 7 there were highly significant differences for percentage of double cocooning, cocooning percentage, cocoon yield by number and weight. While there were insignificant differences of fifth duration, larval mortality percentage, cocoons per liter, and pupation ratio. Treatments of T_1 and T_2 earned the best results comparing with blank and control treatments. Treatments during I_4, and fifth instar have best averages. Also, the highest concentration earned highest averages that the lowest concentrations. In the same line Nazar *et al*. (2019) [6] reported that, micro-nutrients play an essential role in improvements contents of mulberry leaves which might be due to the micro-nutrients helped in obtaining better yields with along with silkworm productivity. Banuprakash *et al*. (2025) [24] enrichment mulberry leaves with fertilizers can be increased the quality and quantity *viz*. growth and output of mulberry also, improves larva, cocoon and reeling properties of silkworm, *B. mori*.

Table 7: Effect of interactions between fertilizer treatments, concentrations and treated different instars on some silkworm characters

Character Treatment			FD (days)	WLD (days)	LMP (%)	C/L (No)	DCP (No)	CP (%)	PR (%)	Crop/N (No)	Crop/W (g)
T_1	C_1	I_1	9.708	27.708	5.333	170.600	0.017	70.222	97.000	7022.200	7736.194
		I_2	9.708	27.708	20.00	161.000	0.012	80.600	97.000	8060.000	9115.188
		I_3	9.352	27.275	17.00	154.500	0.006	86.458	97.000	8645.800	9897.424
		I_4	9.375	27.375	13.333	150.400	0.052	88.539	97.000	8853.900	10458.079
		I_5	9.375	27.375	11.000	149.400	0.036	89.917	99.000	8991.700	10698.325
	C_2	I_1	9.375	27.375	5.933	184.000	0.030	81.520	97.000	8152.000	9277.397
		I_2	9.375	27.042	13.133	170.800	0.020	82.500	97.000	8250.000	9460.550
		I_3	9.375	27.375	12.333	170.400	0.050	87.442	97.000	8744.200	10132.823

		I_4	9.375	27.275	11.917	169.800	0.036	90.722	97.000	9072.200	10745.688
		I_5	9.308	27.375	11.891	168.400	0.064	91.833	97.000	9183.333	11393.302
	C_3	I_1	9.375	27.352	11.957	165.700	0.026	79.565	97.000	7956.500	8982.862
		I_2	9.375	27.042	10.000	165.100	0.036	81.889	99.000	8755.600	9957.744
		I_3	10.042	27.365	10.733	162.600	0.016	87.689	99.000	8768.900	10152.632
		I_4	9.375	27.375	10.410	161.800	0.032	89.000	99.000	8900.000	10485.268
		I_5	9.400	27.375	10.366	160.000	0.012	91.000	99.000	9100.000	11248.965
	C_4	I_1	9.708	27.575	2.200	162.000	0.040	87.800	97.000	8813.333	10337.452
		I_2	9.375	24.042	9.133	158.600	0.040	89.033	97.000	8903.300	10479.065
		I_3	9.375	30.620	8.983	157.600	0.052	89.421	100.000	8942.100	10591.768
		I_4	9.375	27.375	7.333	157.000	0.026	90.111	100.000	9011.110	10414.696
		I_5	9.375	27.361	1.733	160.400	0.024	98.296	100.000	9829.600	12481.741
T_2	C_1	I_1	9.375	27.250	27.667	182.400	0.040	61.400	96.000	6140.000	6678.785
		I_2	9.375	27.708	11.000	177.200	0.048	72.600	96.000	7260.000	7972.085
		I_3	9.375	27.442	12.800	164.200	0.034	87.800	97.000	8780.000	10390.691
		I_4	9.375	27.324	12.800	135.000	0.046	88.200	98.000	8820.000	10455.375
		I_5	9.375	27.483	12.500	140.000	0.024	89.500	97.000	8950.000	11218.228
	C_2	I_1	9.375	27.250	6.667	138.400	0.032	82.800	97.000	8280.000	9234.822
		I_2	9.375	27.375	6.800	137.600	0.020	84.400	97.000	8440.000	9661.549
		I_3	9.375	27.162	2.800	133.600	0.092	86.800	97.000	8680.000	10431.870
		I_4	9.375	27.375	10.267	139.200	0.056	88.000	100.000	8800.000	10718.658
		I_5	9.375	28.250	12.000	132.000	0.022	90.055	98.000	9000.000	11134.005
	C_3	I_1	9.375	27.583	11.333	130.400	0.036	83.000	99.000	8300.000	9565.1967
		I_2	9.375	27.250	9.667	133.600	0.012	83.200	100.000	8320.000	9816.629
		I_3	9.375	28.375	10.733	149.600	0.036	89.400	100.000	8940.000	10626.501
		I_4	9.375	27.375	10.933	129.600	0.012	89.900	100.000	8990.000	10789.173
		I_5	9.375	27.375	12.167	113.600	0.009	91.700	97.000	9170.000	11357.809
	C_4	I_1	9.372	27.375	19.000	140.800	0.024	83.200	98.000	8320.00	9666.356
		I_2	9.575	28.375	13.667	145.600	0.004	83.667	100.000	8366.667	9804.994
		I_3	9.375	28.042	12.133	144.800	0.060	91.400	100.000	9140.000	10786.571
		I_4	9.375	27.678	11.133	135.200	0.015	90.166	94.000	9016.600	10844.821
		I_5	9.375	27.342	11.667	139.200	0.052	95.600	94.000	9560.000	11870.174
Blank		I_1	10.108	29.042	14.133	185.600	0.005	68.100	97.000	6817.000	6915.506
		I_2	10.048	28.042	12.333	197.100	0.005	68.100	98.000	6810.000	7019.654
		I_3	10.042	28.382	18.117	212.000	0.016	68.200	90.000	6820.000	6808.065
		I_4	10.042	28.375	12.000	188.400	0.005	71.900	100.000	7190.000	7048.717
		I_5	10.042	28.375	12.000	212.000	0.005	71.933	90.000	7193.333	7812.679
Control			10.108	29.042	18.117	212.000	0.016	68.100	88.000	6817.000	5726.189
F TRTX Conc X Instar			0.170	0.720	1.420	0.490	1.790**	2.220**	0.150	1.870**	2.670**
LSD 5%			-	-	-	-	0.025	1.527	-	157.940	230.400

Where: (TRT= Treatments) & (C_1, C_2, C_3, C_4, C_5, Conc = concentration), (I_1, I_2, I_3, I_4, I_5 = Instar), (*) significant at 0.05, (**) highly significant at 0.01

Results are registered in Table 8 revealed that, the effect of various treatment of fertilizers on some silkworm cocoon characters. There were highly significant differences for all traits *viz*. cocoon, shell, and pupa weight also, cocoon sell ratio and silk productivity. Treatments of T_1 and T_2 have the highest averages compared with blank and control treatments. Ahmed *et al*. (2018) [25] proved that, foliar fertilizer management practices in mulberry 3 times spray raises biochemical constituents in mulberry leaf, leaf crop, silkworm development as well as cocoon characteristics. So, our studies go in line with the former results i.e. foliar fertilizers have a superior effect on silkworm output productivity. Pooja *et al*. (2022) [26] proved that, applied the foliar fertilizer nano nitrogen to mulberry leaves has positive effect in silkworm larval characters.

Table 8: Effect of different treatments of fertilizers on some cocoon silkworm characters

Character Treatment	CW (g)	CSW (g)	CSR (%)	PW (g)	SP (cg/day)
T_1	1.171	0.220	18.923	0.955	2.351
T_2	1.181	0.223	19.014	0.965	2.376
Blank	1.019	0.173	17.083	0.817	1.846
Control	0.865	0.158	18.701	0.701	1.684
F between TRT	1474.780**	1500.360**	98.420**	1482.280**	1499.2300**
LSD 5%	0.011	0.002	0.254	0.009	0.025

Where: T_1, T_2, Blank, Control, (TRT= Treatments) & (*) significant at 0.05, (**) highly significant at 0.01

Table 9 represents the average of effect of various concentrations of some fertilizers on silkworm cocoon characters. Concentration C_4, C_3, and C_2 were the highest concentration for traits of cocoon weight, cocoon shell weight, cocoon shell %, pupa weight, and silk productivity these results may be due to the micronutrients in foliage fertilizers. The results are accordance with (Vitti *et al*. 2014 & Gowda *et al*. 2000) [27, 28]. who noted that,

which play a positive effect part in plant growth and development.

Table 9: Effect of different concentrations of some fertilizers on cocoon silkworm characters

Character Treatment	CW (g)	CSW (g)	CSR (%)	PW (g)	SP (cg/day)
C_1	1.049	0.187	18.081	0.852	1.999
C_2	1.060	0.193	18.363	0.860	2.060
C_3	1.060	0.196	18.601	0.862	2.085
C_4	1.067	0.198	18.676	0.863	2.113
F between Concentrations	3.770*	28.410**	8.590**	2.220	28.380**
LSD 5%	0.011	0.002	0.254	-	0.025

Where: C_1, C_2, C_3, C_4, C_5 (concentration), (*) significant at 0.05, (**) highly significant at 0.01

The effect of some fertilizers treated for different instars of silkworm cocoon characters were found in Table 10 highly significant differences were obtained for cocoon weight, cocoon shell weight, cocoon shell ratio, pupa weight, and productivity of silk. Lowest results were registered for I_1 and I_2. on the other hand, highest averages were recorded for I_5, I_4, and I_3. The former results may be due to the fertilizer works to absorb liquid formula treats growth retardation and micro-nutrient deficiencies. Fortification techniques, dipping or foliar application of micronutrients is succeeding way to increasing leaf quality just before silkworm feeding this application led to success in the field of silk production whereas, enhanced the larval development and cocoon characters as well as enhance raw silk output and quality (Kruthika *et al*. 2025) [2]. Foliar fertilization increases the nutrition amount and mulberry leaves constitutes, which leads to healthy, disease-free silkworm larvae and gain a good cocoon yield. These data go in line with Shifa *et al*. (2020) & Kumar *et al*. (2024) [29, 30] who demonstrated that, the essential nutrients in foliar fertilization contribute to the improvement of sericulture by providing the necessary elements for growth and development silkworm larvae. Foliar fertilization of mulberry leaves, which transfers nutrients mainly to leaf consumed by *B. mori* larvae, enhances the health of larvae and leads to improved cocoon output. Hence favorable association between the micronutrient elements of mulberry varieties and the rearing performance of mulberry silkworm.

Table 10: Effect of some fertilizers treated for different instars of silkworm cocoon characters

Character Treatment	CW (g)	CSW (g)	CSR (%)	PW (g)	SP (cg/day)
I_1	1.036	0.183	17.903	0.843	1.956
I_2	1.046	0.191	18.535	0.835	2.034
I_3	1.054	0.193	18.435	0.861	2.055
I_4	1.056	0.193	18.261	0.862	2.055
I_5	1.104	0.208	19.018	0.896	2.221
F Between Instars	36.980**	90.720**	15.840**	40.750**	90.740**
LSD 5%	0.012	0.003	0.284	0.010	0.028

Where: Instar (I_1, I_2, I_3, I_4, I_5), (*) significant at 0.05, (**) highly significant at 0.01

Table 11 obvious effect of interaction between fertilizer treatments, and concentrations for some silkworm, *Bombyx mori* L. cocoon characters' interaction between treatments and concentrations were highly significant for cocoon shell weight, cocoon shell ratio, and silk productivity for both sexes. While insignificant differences were noted for cocoon and pupa weight. Data revealed that, highest concentration of both fertilizer treatments registered best results comparing with blank and control. In the same line Shweta *et al*. (2025) [18] recorded that, spraying mulberry leaves with nano foliar nutrient at a concentration of 4 ml/L was effective for improved the quality of mulberry leaves and enhancing silkworm economic traits with along with increase in silk production.

Table 11: Effect of the interaction between fertilizer treatments, and concentrations for some silkworm, *Bombyx mori* L. cocoon characters

Character Treatment		Cocoon weight (g)	Cocoon shell weight (g)	Cocoon shell ratio (%)	Pupae weight (g)	Silk productivity (C.g)
T_1	C_1	1.150	0.203	17.800	0.942	2.170
	C_2	1.174	0.217	18.613	0.960	2.319
	C_3	1.170	0.2278	19.652	0.954	2.430
	C_4	1.192	0.233	19.628	0.964	2.485
T_2	C_1	1.162	0.215	18.740	0.949	2.298
	C_2	1.183	0.224	19.056	0.963	2.392
	C_3	1.185	0.223	18.968	0.976	2.379
	C_4	1.192	0.229	19.290	0.970	2.437
Blank		1.020	0.173	17.083	0.817	1.846
Control		0.865	0.158	18.702	0.701	1.684
F TRT X Conc		1.380	13.500**	5.560**	1.030	13.480**
LSD 5%		-	0.007	0.545	-	0.074

Where: C_1, C_2, C_3, C_4, C_5 = CONC (concentration), (*) significant at 0.05, (**) highly significant at 0.01

Results of Table 12 showed effect of interactions among fertilizer treatments, concentrations and sexes on some cocoon silkworm characters. Regardless the insignificance differences appeared for the interactions between treatments, concentrations, and sexes the results revealed that highest concentration recorded the superior data for all

tested characters cocoon, shell, and pupa weights. Also, for shell ratio and productivity of silk. These data are compatible with Nazar *et al*. (2019) [9] who suggested that, combination of micronutrients and bio-fertilizers recorded superior growth and yield attributes of mulberry plants and silkworm characters *viz*. larva weight, effective rate of rearing of number and weight, cocoon and shell weight, number of cocoons per kilogram.

Table 12: Effect of the interactions between fertilizer treatments, concentrations and sexes on some cocoon of silkworm characters

Character Treatment		Cocoon weight (g)		Cocoon shell weight (g)		Cocoon shell ratio (%)		Pupae weight (g)		Silk productivity (C.g)	
		♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
T_1	C_1	1.246	1.054	0.205	0.202	16.512	19.089	1.035	0.848	2.190	2.150
	C_2	1.271	1.077	0.228	0.207	17.989	19.237	1.062	0.859	2.426	2.211
	C_3	1.273	1.067	0.238	0.218	18.746	20.558	1.059	0.849	2.535	2.326
	C_4	1.295	1.08	0.244	0.222	18.846	20.411	1.075	0.852	2.598	2.372
T_2	C_1	1.260	1.063	0.225	0.206	17.898	19.582	1.043	0.856	2.400	2.196
	C_2	1.287	1.080	0.234	0.214	18.257	19.855	1.066	0.860	2.498	2.285
	C_3	1.313	1.057	0.233	0.213	17.815	20.122	1.103	0.850	2.489	2.270
	C_4	1.315	1.070	0.240	0.217	18.325	20.255	1.088	0.851	2.562	2.313
Blank		1.096	0.943	0.181	0.165	16.624	17.542	0.909	0.724	1.930	1.761
Control		0.909	0.820	0.163	0.153	18.175	19.228	0.741	0.662	1.738	1.630
F TRT X Conc X Sex		0.780		1.420		0.790		1.260		1.410	
LSD 5%		-		-		-		-		-	

Where: C_1, C_2, C_3, C_4, C_5 = CONC (concentration), (*) significant at 0.05, (**) highly significant at 0.01

Table 13 showed the interactions between fertilizer treatments, concentrations, instars, and sexes. Insignificant differences were detected for all traits. Regardless the insignificant differences, T_1 and T_2 have best results comparing with blank and control treatments. Highest concentration acquired highest averages than the lowest concentration. Treatments during five, four, and three instars have better results comparing with first and second instars treatments for both sexes. Similar results were detected by Sujathamma *et al*. (2014) & Anusha *et al*. (2025) [31, 32] suggest that applying organic manures or foliar application with vermiwash and Poshan together greatly enhanced plant growth, raised biochemical content, and produced larger larval and cocoon weights. The application of fertilizers leads to improve the quantitative and qualitative parameters of silkworm larvae.

Table 13: Effect of the interactions between fertilizer treatments, concentrations, instars and sexes on some silkworm cocoon traits

Character Treatment			Cocoon weight (g)		Cocoon shell weight (g)		Cocoon shell ratio (%)		Pupae weight (g)		Silk productivity (C.g)	
			♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
T_1	C_1	I_1	1.213	0.991	0.192	0.182	15.906	18.435	1.003	0.804	2.052	1.943
		I_2	1.228	1.033	0.198	0.195	16.116	18.794	1.023	0.834	2.108	2.077
		I_3	1.249	1.041	0.205	0.197	16.424	18.875	1.0367	0.842	2.189	2.102
		I_4	1.265	1.097	0.215	0.215	17.019	19.608	1.047	0.875	2.298	2.292
		I_5	1.274	1.106	0.216	0.219	17.094	19.732	1.066	0.886	2.303	2.334
	C_2	I_1	1.235	1.042	0.220	0.191	17.768	18.275	1.040	0.836	2.340	2.033
		I_2	1.249	1.044	0.221	0.193	17.803	18.491	1.049	0.845	2.357	2.063
		I_3	1.258	1.060	0.224	0.195	17.896	18.570	1.037	0.840	2.394	2.083
		I_4	1.264	1.105	0.228	0.226	18.133	20.416	1.065	0.875	2.427	2.410
		I_5	1.348	1.133	0.245	0.231	18.344	20.434	1.116	0.897	2.614	2.466
	C_3	I_1	1.240	1.018	0.220	0.204	17.826	20.063	1.042	0.812	2.346	2.179
		I_2	1.250	1.025	0.226	0.207	18.111	20.233	1.044	0.825	2.406	2.206
		I_3	1.256	1.078	0.236	0.217	18.766	20.319	1.049	0.872	2.513	2.315
		I_4	1.265	1.092	0.241	0.221	19.222	20.636	1.062	0.864	2.570	2.358
		I_5	1.352	1.121	0.266	0.241	19.804	21.536	1.097	0.874	2.838	2.570
	C_4	I_1	1.267	1.079	0.229	0.217	18.085	20.079	1.053	0.796	2.441	2.309
		I_2	1.272	1.082	0.234	0.219	18.413	20.242	1.053	0.855	2.492	2.338
		I_3	1.285	1.084	0.237	0.220	18.452	20.337	1.046	0.856	2.529	2.346
		I_4	1.255	1.057	0.240	0.211	19.241	19.925	1.051	0.855	2.561	2.249
		I_5	1.397	1.143	0.278	0.246	20.037	21.471	1.174	0.899	2.968	2.618
T_2	C_1	I_1	1.182	0.993	0.206	0.183	17.536	18.353	0.992	0.791	2.198	1.947
		I_2	1.195	1.001	0.214	0.192	17.955	19.101	0.996	0.816	2.277	2.045
		I_3	1.302	1.065	0.233	0.213	18.002	20.109	1.067	0.846	2.488	2.276
		I_4	1.304	1.067	0.235	0.221	18.125	20.723	1.084	0.846	2.523	2.353
		I_5	1.317	1.190	0.235	0.221	17.871	19.625	1.079	0.979	2.511	2.358
	C_2	I_1	1.231	0.999	0.199	0.195	16.394	19.584	1.027	0.794	2.121	2.083
		I_2	1.243	1.046	0.232	0.205	18.651	19.598	1.026	0.832	2.474	2.182
		I_3	1.302	1.102	0.242	0.215	18.669	19.669	1.091	0.889	2.582	2.297
		I_4	1.312	1.124	0.243	0.222	18.539	19.694	1.094	0.898	2.596	2.368
		I_5	1.345	1.130	0.255	0.234	19.032	20.728	1.094	0.888	2.717	2.495
	C_3	I_1	1.287	1.018	0.220	0.201	17.146	19.649	1.062	0.813	2.341	2.143
		I_2	1.259	1.035	0.216	0.206	17.114	19.931	1.040	0.829	2.300	2.194

		I_3	1.328	1.049	0.239	0.210	18.034	20.038	1.115	0.852	2.552	2.237
		I_4	1.341	1.060	0.243	0.215	18.264	20.272	1.185	0.857	2.592	2.292
		I_5	1.352	1.126	0.249	0.233	18.515	20.724	1.113	0.899	2.658	2.485
	C_4	I_1	1.300	1.024	0.224	0.198	17.308	19.327	1.083	0.831	2.391	2.113
		I_2	1.303	1.041	0.230	0.209	17.664	20.088	1.067	0.829	2.450	2.232
		I_3	1.306	1.055	0.244	0.220	18.758	20.799	1.0747	0.830	2.605	2.341
		I_4	1.325	1.087	0.249	0.222	18.836	20.397	1.1126	0.8647	2.654	2.366
		I_5	1.342	1.141	0.254	0.235	19.061	20.661	1.103	0.900	2.707	2.510
Blank		I_1	1.072	0.957	0.166	0.166	15.522	17.363	0.881	0.767	1.766	1.768
		I_2	1.074	0.987	0.182	0.179	17.573	18.730	0.892	0.648	1.944	1.907
		I_3	1.076	0.919	0.171	0.168	15.950	18.196	0.902	0.745	1.819	1.792
		I_4	1.103	0.858	0.188	0.126	16.932	14.494	0.914	0.671	1.999	1.347
		I_5	1.156	0.995	0.199	0.187	17.143	18.929	0.954	0.792	2.120	1.994
Control			0.909	0.820	0.163	0.153	18.175	19.228	0.741	0.662	1.738	1.630
F TRTX Conc X Instar x Sex			0.260		0.580		0.330		0.370		0.570	
LSD 5%			-		-		-		-		-	

Where: C_1, C_2, C_3, C_4, C_5 = CONC (concentration), (I_1, I_2, I_3, I_4, and I_5) = Instars, (TRT) = Treatments & (*) significant at 0.05, (**) highly significant at 0.01

Conclusions

Foliar application of micronutrients is succeeding way to increasing mulberry leaf quality just before silkworm feeding this application led to success in the field of silk production whereas, using highest concentration of the two types of fertilizers under investigation increase the silkworm traits averages compering with blank and control treatments. So that if the rearers using the scattered mulberry trees or if any shortage of fertilizers it is recommended that using Super mix or Boro Pota fertilizers with high concentrations during whole larval duration or first four or three instars at least. This may be led to increase the cocoon crop by quality and quantity.

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