



Foliar Fertilization of Different Species of Mulberry Trees and Its Impact on Silkworm *Bombyx mori* Productivity from Cocoons and Eggs

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Abstract

Rearing mulberry silkworm was found to be dependent on leaves quality of mulberry trees, larvae of mulberry silkworm fed on two species of mulberry trees *Morus alba* and *Morus nigra* were treated with foliar fertilizer (Basfoliar 20-19-19 SP contains 20% N, 19% P₂O₅, 19% K₂O, 5% NO₃, 3.6% NH₄ and 11.4% NH₂) with three different concentrations, 1%, 3% and 6% in addition to control treatment for comparison. When larvae were fed on leaves of mulberry trees one day after Treatment, high mortality (up to 100%) was observed specially with 6% concentration. Mean weights of larvae, cocoons and cocoon shell and fecundity were negatively affected when compared to control. On the other hand, when larvae were fed on leaves of mulberry trees, no mortality occurred after two weeks of treatment in all concentrations, in addition, the mean weights of larvae at the end of 4th and 5th instar larvae, cocoons and cocoon shell s increased at 3% concentration compared with other concentrations and control. The highest fecundity occurred in female moths when larvae were fed on leaves of *M. nigra* compared with *M. alba* as well as 3% concentration compared with other concentrations and control.

Keywords: Foliar fertilization, Mulberry trees, Mulberry silkworm, *Morus alba*, *Morus nigra*, *Bombyx mori*

1 Introduction

Mulberry trees were cultivated in Egypt for the purpose of rearing mulberry silkworms for more than 200 years, and they were grown on the edges of canals, and farmers did not care to prune them (Pawan et al 2017) or control the pests that afflicted them (Shinde et al 2012, Łochyńska 2018) or even fertilize them (Mahmood et al 2001, Radi et al 2003, Shal et al 2003, József et al 2005, Asma et al 2007, Dhillon et al 2011, El-Khayat et al 2013, Kamel 2014, Sugiyama et al 2016) or take care of them, which led to the deterioration of the mulberry trees and the nutritional value of them became low, which Negatively affected silk production in terms of quantity and quality. Taking care of mulberry trees by introducing new types and varieties (Abdelmegeed 2016), improved nutrition value of leaves via food additions (Salman et al 2011, Abdelmegeed 2020), attention to pruning (Pawan et al 2017), cultivation distances (Shinde et al 2012, Łochyńska 2018), pest control (Sakthivel et al 2019), fertilization (Sugiyama et al 2016) and irrigation (Sudhakar et al 2018) has increased both quantity and quality of leaves.

The aim of the study is to follow up the effect of fertilizing mulberry trees with different concentrations of a foliar fertilizer and its effects on weight of mulberry silkworm larvae, production of cocoons, silk production, as well as the fecundity and fertility of eggs.

2 Materials and Methods

All laboratory and field experiments were conducted at the Plant Protection Department, Fac. Agric., Ain Shams Univ., Cairo, Egypt. Larvae of mulberry silkworm were reared from eggs obtained from the Sericulture Research Unit, Agric. Res. Center, MoA, Giza, Egypt, and rearing was carried out under appropriate breeding conditions in the laboratory during the spring season according to Krishanaswami (1983).

2.1 Mulberry trees treated with foliar fertilization

Two species of mulberry trees were selected for foliar fertilization treatment *Morus alba* and *Morus nigra*. Different concentrations (1 gm/liter, 3 gm/liter and 6 gm/liter) from the foliar fertilizer Basfoliar 20-19-19 SP Contains 20% N, 19% P₂O₅, 19% K₂O, 5% NO₃, 3.6% NH₄ and 11.4% NH₂ were prepared. Mulberry trees were sprayed early in the morning before sun rise weekly for four times in a row and 24 trees of mulberry trees were selected (12 trees of *M. alba* and 12 trees of *M. nigra*) and treated with the different concentrations of fertilizer, each concentration for three trees.

2.2 Mulberry silkworm rearing

Newly hatched larvae of mulberry silkworm were divided into two groups, each one consisted of 120 larvae fed on leaves treated with different concentrations (1%, 3%, 6% and control) of the fertilizer. The first group fed on treated leaves after one day of spraying with the fertilizer, and larvae of the second group were fed on treated leaves after two weeks of treatment.

Mortality percentages were calculated by the end of each larval instar, larvae in the end of 4th and 5th instars were weighted, weighted the cocoons and cocoon shells were also weighted, and fecundity after mating of moths and the eggs being laid was estimated.

3 Results and Discussions

3.1 Mortality

Mortality of larvae was affected by different concentration of foliar fertilization when the larvae were fed on leaves after one day of treatment. On the other hand, no mortality occurred in the larvae when were fed on leaves after 2 weeks of treatment. The highest mortality (100%) occurred at 6% concentration when 2nd instar larvae were fed on leaves of *M. alba*. The highest mortality increased in 1st and 2nd instar larvae while it decreased in 3rd and 4th instar larvae until it reached zero in 5th instar larvae. **Table 1.**

3.2 Mean weights of larvae

Mean weights of larvae were negatively affected by feeding on leaves treated with different concentrations for the foliar fertilizer. After one day of treatment, mean weights of the larvae decreased at the end of the 4th and 5th instars with an increase in the concentration compared to the control. **Table 2**

On the other hand, mean weights of larvae at the end of 4th and 5th instars increased significantly at concentration 3% when compared with 1% and 6% and control **Table 3.**

3.3 Mean weights of cocoons and cocoon shells

Mean weights of cocoons and cocoon shells were affected by different concentrations of foliar fertilization when larvae of mulberry silkworm were fed on leaves of mulberry trees treated with foliar fertilization.

Table 1. Mortality of larvae fed on mulberry leaves treated with foliar fertilization one day after treatment

Conc	1 st instar larvae		2 nd instar larvae		3 rd instar larvae		4 th instar larvae		5 th instar larvae	
	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>
1	20	10	30	15	10	10	5	5	0	0
3	40	30	60	40	20	20	15	7	0	0
6	80	50	100	60	100	30	100	5	100	0
cont	0	0	0	0	0	0	0	0	0	0

Table 2. Weights of larvae in the end of the 4th and 5th instar larvae fed on mulberry leaves treated with foliar fertilization one day after treatment

Conc (gm/liter)	W. 4 th instar larvae		W. 5 th instar larvae	
	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>
1	0.6145 ^a ±0.0089	0.7457 ^a ±0.0095	3.5163 ^b ±0.056	3.6223 ^a ±0.0461
3	0.6012 ^a ±0.0078	0.6875 ^b ±0.0097	3.1146 ^c ±0.0732	3.2664 ^b ±0.0982
6	0.00 ^b ±0.00	0.5539 ^c ±0.0146	0.00 ^d ±0.00	2.9597 ^c ±0.0393
Cont	0.6128 ^a ±0.0051	0.6532 ^b ±0.0154	3.7946 ^a ±0.0438	3.471 ^a ±0.0327
F. Value	4444.87**	81.37**	2372.40**	45.69**
L.S.D.	0.0207	0.0404	0.1636	0.1921

Table 3. Weights of larvae in the end of the 4th and 5th instar larvae fed on mulberry leaves treated with foliar fertilization two weeks after treatment

Conc (gm/liter)	W. 4 th instar larvae		W. 5 th instar larvae	
	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>
1	0.6123 ^b ±0.0054	0.6636 ^b ±0.0062	3.7081 ^b ±0.0279	3.4580 ^b ±0.0139
3	0.6865 ^a ±0.0061	0.7213 ^a ±0.0106	3.7300 ^{ab} ±0.0041	3.6980 ^a ±0.0331
6	0.6149 ^b ±0.0075	0.6423 ^b ±0.0049	3.4727 ^c ±0.0095	3.3819 ^c ±0.0069
Cont	0.6128 ^b ±0.0051	0.6532 ^b ±0.0154	3.7946 ^a ±0.0438	3.471 ^b ±0.0327
F. Value	71.41**	23.94**	56.56**	61.83**
L.S.D.	0.0196	0.0326	0.0847	0.0785

Table 4 show mean weights of cocoons and cocoon shells when larvae were fed on leaves treated with different concentrations of foliar fertilization after one day of treatment, mean weights of cocoons and cocoon shell decreased at 6% concentration compared with control, and the increase was non-significant at 1% and 3% concentrations compared with control.

On the other hand, **Table 5.** show highly significant increase in mean weights of cocoons and cocoon shells when larvae were fed on leaves treated with different concentrations of foliar fertilization after 2 weeks of treatment. The highest mean weights of cocoons and cocoon shells were achieved at 3% concentration, while no significant increase was

achieved between control and other concentrations (1% and 6%).

3.4 Fecundity of female moths

The fecundity of female moths of mulberry silkworm was affected by type of mulberry trees and different concentrations of foliar fertilization. The highest fecundity (525 eggs) were occurred in female moths produced from larvae fed on leaves of mulberry trees *M. nigra* compared with *M. alba* at 3% concentration after two weeks of treatment. Fecundity was also negatively affected by different concentrations of foliar fertilization when the larvae were fed on leaves treated after one day of treatment, **Table 6.**

Table 4. Weights of cocoons, cocoon shell and shell ratio produced from larvae fed on mulberry leaves treated with foliar fertilization one day after treatment

Conc (gm/liter)	W. cocoons		W. cocoon shell		Shell ratio %	
	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>
1	1.3233 ^a	1.1822 ^a	0.3238 ^{ab}	0.282 ^a	24.47	23.85
	±0.0415	±0.0429	±0.0291	±0.0221		
3	1.3147 ^a	1.0829 ^b	0.2947 ^b	0.2743 ^a	22.41	25.33
	±0.0412	±0.0149	±0.0067	±0.0126		
6	0.00 ^b	0.00 ^c	0.00 ^c	0.00 ^b	0	0
	±0.00	±0.00	±0.00	±0.00		
Cont	1.3617 ^a	1.0559 ^b	0.3590 ^a	0.2850 ^a	26.36	26.99
	±0.0148	±0.0286	±0.0163	±0.0059		
F. Value	977.6**	858.1**	187.7**	230.6**		
L.S.D.	0.0966	0.086	0.0546	0.0418		

Table 5. Weights of cocoons, cocoon shell and shell ratio produced from larvae fed on mulberry leaves treated with foliar fertilization two weeks after treatment

Conc (gm/liter)	W. cocoons		W. cocoon shell		Shell ratio %	
	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>
1	1.3655 ^b	1.2519 ^a	0.3376 ^a	0.2950 ^a	24.72	23.56
	±0.0061	±0.0102	±0.0135	±0.0122		
3	1.4505 ^a	1.2800 ^a	0.3685 ^a	0.3126 ^a	25.41	24.42
	±0.0132	±0.0273	±0.0077	±0.0093		
6	1.0814 ^c	1.0043 ^b	0.2380 ^b	0.2573 ^b	22.01	25.62
	±0.0159	±0.0042	±0.0153	±0.0163		
Cont	1.3617 ^b	1.0559 ^b	0.3590 ^a	0.2850 ^{ab}	26.36	26.99
	±0.0148	±0.0286	±0.0163	±0.0059		
F. Value	302.6**	90.75**	38.72**	7.93**		
L.S.D.	0.0419	0.0657	0.0436	0.0372		

Table 6. Fecundity of female moths produced from larvae which fed on leaves treated with foliar fertilization one day and two weeks after treatment

Conc	After one day		After 2 weeks	
	<i>M. alba</i>	<i>M. nigra</i>	<i>M. alba</i>	<i>M. nigra</i>
1	400 ^b ±8.6538	467 ^a ±6.6833	451 ^b ±1.6329	507 ^b ±3.2659
3	424 ^a ±3.6817	455 ^b ±1.6329	488 ^a ±1.6329	525 ^a ±4.1096
6	0.00 ^c ±0.00	0.00 ^c ±0.00	383 ^d ±2.0548	505 ^b ±2.4944
Cont	436 ^a ±2.4494	477 ^a ±2.4494	436 ^c ±2.4494	477 ^c ±2.4494
F. Value	3758.2**	8167.1**	981.73**	78.02**
L.S.D.	15.561	11.693	6.3151	10.099

Balanced fertilization affects plants and fruit trees, which increases their production of the crop, whether it is in the leaves, the vegetative system, the fruits, or an increase in their nutritional value Carranca et al (2018). Also, yield of leaves and fruits of mulberry trees that are fertilized with a balanced fertilization are positively affected (Bose et al 2010, Ahmed et al 2018).

Venu et al (2019) sprayed leaf extracts of Panchagavya and vermiwash on mulberry trees. An increase of mulberry trees growth occurred and pest attack decreased, in addition to an increase in the nutritional value (Vijaya et al 2009, Bose et al 2011).

Baqual and Das (2006) inoculated mulberry trees with phosphate solubilizing microorganisms, nitrogen fixing bacteria and arbuscular mycorrhiza, and analyzed the leaves of mulberry trees treated. They found higher contents of nitrogen, phosphorus and potassium. The treatments also affected the length of silk filament (936.33 m/cocoon). Ghazy et al (2020) found that the number of shoots and length of shoots per tree and the number of leaves per shoot increased when mulberry trees were treated with vermicompost application.

The higher of nutritional value in mulberry leaves affects weights of mulberry silkworm larvae, cocoons, cocoon shell and length, weight and volume of silk filament, fecundity, hatchability of eggs, in addition to the larval duration and larval mortality (Vijaya et al (2009), Zannoon et al (2012), Chakraborty and Chakraborty (2016), Fathy et al (2016), Sudhakara et al (2017), Ahmed et al (2018), Ghazy et al (2018), Ghazy et al (2020)).

4 Conclusion

The productivity of mulberry silkworms from cocoons and the fertility of female moths can be improved by feeding the larvae on highly nutritious mulberry leaves with a balanced fertilization of NPK.

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