Study on the addition of balanced secondary and micronutrients to mulberry plantation under Egyptian conditions

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Abstract

The study was carried out at AgroMier Co. mulberry garden and silkworm-rearing houses on 11 silkworm breeds of different geographical and genetic origin.
The following experimental and control groups were tested by 4 replicates consisted of 100 larvae per each race: Control (N_{300}, P_{150}, K_{120}) units per hectare (ha) plus 15 tons of Farm Yard Manure (FYM). Experiment 1 Adding secondary (Ca_{230}, S_{150} & $Mg_{5.5}$) and micronutrients (Mn_8, Fe_2, $Zn_{3.5}$, $Cu_{0.4}$, $B_{0.35}$, $Mo_{0.54}$ & Cl) beside control regime and Experiment 2 excluding FYM but adding macro, secondary and micronutrients.
Results indicates that beside the main NPK fertilizers at 300:150:120 and 15 Ton of FYM/ha, adding 2ry and micronutrients to the mulberry field, lead to increase of silkworm pupation ratio by 6.81-13.67% and increase in cocoon yield per 1 box by 2.34-4.37 Kg (8.06-15.33%) over the control despite of the genetical and geographical origins of the breeds. Excluding FYM from the previous regime had a negligible decrease on these 2 characters, 2.14-2.84 % for pupation ratio and 0.21-0.38Kg respectively. Both regimes decreased larval duration by 48 hours and did not affect the single cocoon weight, shell weight and shell ratio.

Keywords: *silkworm, mulberry, nutrition, additional fertilizers*

Introduction

The paper presents the results of an experiment conducted by the silkworm breeding company AgroMier, Egypt, Asyut province, during 1995-1996. The experimental data were processed statistically by the Romanian collaborators. AgroMier is a private company involved in silkworm breeding and has its own silkworm gene bank.
The climate and soil characteristics specific to the Egyptian area where the experiment was conducted are of interest for the sandy soils in our country, for the silkworm breeders living in those

areas. The mulberry plantation owned by AgroMier company is located in Asyut, 320 km south of Cairo, in an area of desert, with sandy soil.

Silkworm breeding started in Egypt in the 18th century when mulberry plantations were established and the first silkworm batches were produced. Currently about 3000 to 3500 Egyptian farmers are involved in silkworm breeding, about 50% of them being women specialised in manual spinning and in weaving silk carpets and rugs. Most mulberry trees grow along the roads and irrigation channels and they are not exploited and maintained systematically. However, during the past few years about 150 mulberry plantations have been set up by the private producers. Farmers raise silkworms only once a year which they feed with mulberry leaves picked by hand; the cocoon yield ranges from 10 to 30 kg according to the ability and devotion of the farmers.

Due to the increasing demand for silk on the Egyptian market, silkworm breeding research intensified lately trying to improve and diversify the silkworm genetic fund.

The purpose of this paper is to present the effect of secondary fertilizers and microelements on mulberry plantations under the soil and climate conditions of Egypt, as well as the possibility of removing the natural organic fertilizers, available in low amounts and requiring extensive labour activities, without affecting the nutritive value of the mulberry leaves used in silkworm feeding.

Material and method

The biologic material consisted of:

- Kokuso 27 and Kanva 2 mulberry varieties grown as low bushes. The soil has pH 8.1, sandy texture with 51.4% dust, 8.8% clay and 39.8% sand. The field capacity for water of the soil is 24% and ground water is at a depth of over 3 m. The mulberry plantation was irrigated with water from the Nile, whose overall salinity is 300 ppm.
- 11 silkworm breeds used in 4 replicates of 100 larvae each. The breeds were supplied by AgroMier gene bank (3 Chinese, 3 Japanese, 3 European and 2 sex-marked breeds). These breeds grown and selected by AgroMier are kept in the gene bank under the following codes shown in Table 1.

Table 1 *Qualitative characters of the breeds used in experiments*

Breed code	Type	Egg colour	Cocoon shape
E2	Japanese	Blue grey	Rounded
E6	Japanese	Blue grey	Rounded
E15	Japanese	Blue grey	Rounded

E1	Chinese	Greenish	Oval
E5a	Chinese	Greenish	Oval
E14	Chinese	Greenish	Oval
E4b	European	Blue grey	Elongated
E8	European	Blue grey	Elongated
E9	European	Blue grey	Elongated
E22	Chinese	♂ Yellow ♀ Blue grey	Oval
E23	Japanese	♂ Yellow brown ♀ Blue grey	Rounded

The breeding rooms were fitted with an automatic device for temperature and humidity control, which provided the standard regime of temperature and humidity (Table 2) as mentioned in the literature from Bulgaria, Japan, Korea, India, Italy and Ukraine (Perkov *et al.*, 1989; Ajuzawa, 1972; Lim *et al.*, 1990, 1995; Krishnaswamy, 1993; Reali, 1990; Zlotin and Bolavin, 1998).

Table 2 *Temperature & humidity conditions to raise silkworms (Bombyx mori L.)*

Age	Temperature (°C)	Humidity (% RH)	Light (lux)	Air speed (m/s)
I and II	27	85	25	0.1
III	25	80	25	0.1
IV and V	23	70	25	0.3
Mounting & spinning	27	60	25	0.5

The silkworms were raised in 70 × 40 × 30 cm plastic trays for 100 larvae counted in age III. Throughout the experiment the larvae were fed on equal amounts of leaves from each mulberry variety. The raising area was cleaned daily after the first meal and the trays were cleaned and disinfected after each period of sleep (moulting). Current disinfecting was done with 3% formol solution.

Feeding the mulberry leaves by age was done according to the following design:

- I age – leaves from positions 1 and 2 on the shoot, chopped to 5 mm length;
- II age – leaves from positions 3 and 4 on the shoot, chopped to 10 mm length (the larvae of the I and II age were covered in a plastic knitwear to preserve the humidity);
- III age – with shoots of no more than 7 leaves;
- IV and V age – shoots of 50-70 days of vegetation

Plastic devices were used for mounting. Four batches were raised each year as follows: early spring (March – April); spring (May – June); autumn (September – October); late autumn (November – December).

The raising conditions were kept constant throughout the experiment, irrespective of the season, and the quality of the mulberry leaves remained unchanged with the use of irrigation, the difference not being significant between seasons. During 1995 – 1996 the mulberry plantation was fertilised according to the experimental variants, irrigated at regular intervals, cut to form the bush and maintained.

The following variants of fertilisation were used:

- V_0 control – fertilised with nitrogen, phosphorus and potassium (NPK) in amounts of 300 : 150 : 120 kg a.s./ha + 15 t/ha organic natural fertiliser;
- V_1 – fertilised with NPK, 300 : 150 : 120 kg a.s./ha + 15 t/ha organic natural fertiliser + secondary minerals + microelements;
- V2 – fertilised with NPK, 300 : 150 : 120 kg a.s./ha + secondary minerals + microelements;

The macroelements (NPK) were administered as follows:

N - 300 kg a.s./ha: ammonium sulphate 500 kg/ha; ammonium chloride 500 kg/ha; ammonium nitrate 300 kg/ha;

P - 150 kg a.s./ha: simple superphosphate 800 kg/ha;

K - 120 kg a.s./ha: potassium sulphate 125 kg/ha; potassium chloride 100 kg/ha.

The secondary minerals (Ca, S, Mg) were administered as follows:

Ca – from the simple superphosphate;

S – as sulphates from the fertilisers with macroelements and microelements;

Mg – as magnesium sulphate.

The microelements were adminstered as a mixture of the following amounts (Table 3):

Table 3 *Micronutrient mixture*

Salt	Amount (kg/ha)	Concentration (%)
Manganese sulphate ($MnSO_4$)	30.0	Mn 27
Ferrous sulphate ($FeSO_4$)	10.0	Fe 19
Zinc sulphate ($ZnSO_4$)	10.0	Zn 35
Copper sulphate ($CuSO_4$)	1.5	Cu 28
Boric acid (H_3BO_4)	2.0	B 17
Ammonium molibdate $(NH_3)_2MoO_4$	1.0	Mo 54
Total	54.5	-

The fertilisers (macro, secondary and microelements) were administered in three doses, in ditches dug between the mulberry rows, after each leaf cutting and irrigated thereafter.
The amount and proportion of nutrients were determined according to the literature (Horie *et al.*,1967, 1985).
Each experimental variant was applied to 1 ha of Kokuso 27 mulberry trees and 1 ha Kanva 2 mulberry trees under similar conditions of soil and density.

Results and discussion

During the experimental period (1995-1996), the use of macro, secondary and microelements in experimental variants provided an optimal nutritive balance in the mulberry plantation, which increased the pupation rate by 6.81 to 13.67% in 1995 compared to the control (Table 4). The table shows that the highest rates of pupation were observed in breeds E2 (Japanese), E8 and E9 (European) and sex-marked E23 (Japanese), being 7.53 to 9.05%, 10.5 to 16.9%, respectively 8.53 to 9.42% higher than the control. These results are in agreement with Sharkar (1994) who showed that pupation was higher when microelements (Fe, Zn and Mg) were used up to 20 kg/ha/year.
The balanced fertilisation (macro, secondary and microelements) of the mulberry plantation decreased significantly the larval duration in all breeds, by 48 hours, which is very important economically. Horie *et al.*(1997) explained this phenomenon by the stimulation of the metabolic activity of the silkworm due to Ca, Mg and Fe, which resulted in shorter larval duration and increased pupation rate.

Table 4 *Biological and technological parameters in silkworm breeding*

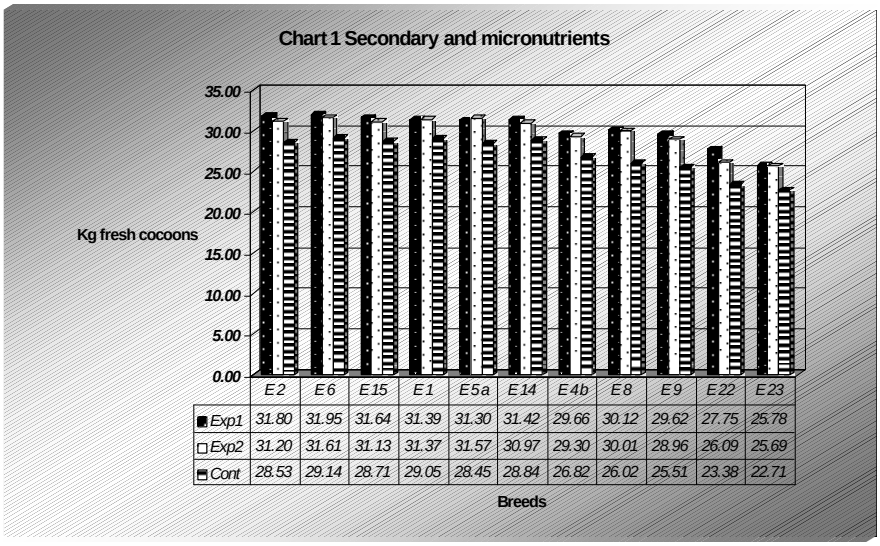
(1) Breed (2)Variant	**E2**	**E6**	**E15**	**E1**	**E5a**	**E14**	**E4b**	**E8**	**E9**	**E22**	**E23**
V_1	90.97∴∴∴	90.51∴∴	91.40**	89.74**	91.16**	91.11**	88.33*	89.65***	89.36***	88.72**	83.58**
V_2	89.45**	89.20*	90.55**	89.26**	89.95**	90.30*	88.19*	89.52***	88.17***	83.12**	82.69**
(3) Cont pupation (%)V_0	89.92	82.81	83.25	82.93	82.99	83.95	80.76	78.69	77.67	75.05	74.16
V_1	681*	681*	681*	657**	657**	657**	681*	681*	681*	681*	681*
V_2	681*	681*	681*	657**	657**	657**	681*	681*	681*	681*	681*
(4) Cont L. duration (hours) V_0	729	729	729	705	705	705	729	729	729	729	729
V_1	1.858	1.886	1.851	1.868	1.840	1.852	1.817*	1.796*	1.812	1.726	1.724
V_2	1.854	1.893	1.838	1.877	1.881	1.842	1.798	1.792	1.796	1.732	1.736
(5) Cont cocoon weight (g) V_0	1.851	1.880	1.844	1.871	1.837	1.845	1.797	1.768	1.796	1.719	1.711
V_1	0.396	0.423	0.401	0.400	0.407	0.411	0.409	0.406	0.414	0.336	0.348
V_2	0.396	0.426	0.398	0.403	0.417	0.409	0.404	0.401	0.406	0.345	0.346
(6) Cont shell weight (g) V_0	0.395	0.424	0.402	0.402	0.409	0.410	0.405	0.401	0.413	0.342	0.355
V_1	21.31	22.43	21.66	21.41	22.12	22.19	22.51	22.61	22.85	19.47	20.19
V_2	21.36	22.50	21.65	21.47	22.17	22.20	22.47	22.38	22.61	19.92	19.93
(7) Cont shell ratio (%) V_0	21.34	22.55	21.80	21.49	22.26	22.22	22.54	22.68	23.00	19.90	20.75

∴LD < 0.05, ∴∴ LD <0.01, ∴∴∴ LD < 0.001

Other researchers reported similar results. Thus, Magadum *et al.* (1992) reported that Cu supplementation of the mulberry leaves shortened the larval duration. Chamundeswari and Radhakrishnaiah (1994) showed that Ni and Zn supplementation shortened the larval period and increased significantly all economic parameters of the silkworms.

The experimental results from Asyut have shown that the secondary elements and the microelements do not influence the economic parameters of the cocoon but improve the health state and larval growth rate. These results can not be compared with the results of Sarkar and Absar (1995) who obtained a significant increase of the cocoon weight, of the shell weight and of the shell ratio, because they used polyvoltine and polybivoltine hybrids, which have much higher hereditary tolerance than the Egyptian monovoltine and bivoltine breedds.

Chart 1.shows the significant increase of cocoon yield/tray OVM in all studied breeds (2.34 to 4.37 kg cocoons/tray vor V_1 and 2.13 to 3.99 kg cocoons/tray for V_2); there are differences between breeds according to their origin.



	E2	E6	E15	E1	E5a	E14	E4b	E8	E9	E22	E23
Exp1	31.80	31.95	31.64	31.39	31.30	31.42	29.66	30.12	29.62	27.75	25.78
Exp2	31.20	31.61	31.13	31.37	31.57	30.97	29.30	30.01	28.96	26.09	25.69
Cont	28.53	29.14	28.71	29.05	28.45	28.84	26.82	26.02	25.51	23.38	22.71

Thus, the highest values backed up statistically for this trait were recorded in the sex-marked breeds E22 and E23 and in breeds E4b, E8 and E9 (European breeds), which were 18.69, 13.53, 16.11, 15.76, respectively 10.59% higher than the control.

Conclusions

The fertilisation with 300 : 150 : 120 kg a.s. NPK/ha = 15 t organic fertiliser/ha plus secondary elements and microelements (Ca, S, Mg, Mn, Fe, Zn, Cu, B, Mo) of the mulberry plantation increased pupation rate by 6.81 to 13.67% and the yield of cocoons by 2.34 to 4.37 kg more than the control.

The exclusion of organic fertilisers did not decrease the value of the technical parameters of the silk cocoons.

Both experimental variants shortened by 48 h the larval duration compared to the control.

References

Ajuzawa 1972 - Handbook of silkworm rearing. Fuji pub. Co. Ltd. Tokyo Japan.

Bajpeye C. M., Singh R. N., Thangavalu K 1991 - Supplementary nutrients to increase silk production, Indian silk, 30(7) 41-42.

Bose P. C. 1987 - Role of micronutrients in mulberry garden. Indian silk, 25(3) 22-23.

Chamundeswari P. Radhakrishnaiah K. 1994 - Effect of Zinc and Nickel on the larval and cocoon characters of the silkworm B.mori L. Sericologia 34(2) 327-330.

Horie Y., Watanabe K, Ito T. 1967 - Nutrition of the silkworm, B. mori XVIII. Quantitative requirements for the Potassium, Phosphorous, Magnesium and Zinc, Bul. Ser. Exp. St. (Tokyo) 22(2) 181-193.

Horie Y., Nakasone S., Watanabe K., Nakamura M., Suda H. 1985 - Daily ingestion and utilization of various kinds of nutrients by the silkworm Bombyx mori. Appl. Ent. Zool. 20(2) 159-172.

Ito T., Niminura M. 1966 - Nutrition of silkworm, B.mori Linn its specific nutrient requirements and its nutrition in relation to the mineral nutrition of its host plant mulberry Morus indica, Linn, Indian J. Exp. Bio, 4, 31-36.

Krishnaswamy S. 1993 - Special features of tropical sericulture and five crucial steps for successful silkworm rearing. Indian Silk, 1, 27-34.

Lim et al 1995 - Principles and practices in sericulture, RDA, KOICA, NSERI Suwon, 788.

Lim S. H., Kim Y. T., Lee S. P., Rhee I. J., Lim J. S., Lim B. H. 1990 - Sericulture Training manual, FAO, Rome 73pp.

Magadum S. B., Holli M. A., Magadum V. B. 1992 - Effect of feeding copper sulfate on the economic parameters of the polyvoltine silkworm Bombyx mori L., Sericologia, 32,3,395-399.

Petkov N., Petkov M., Manshev M., Natcheva Y., Alexandrov A. 1989 - Handbook of sericulture.

Qader M. A., Sarker A. A., Rab M. A., Barman A. C. 1993 - Effects of Potassium Iodide salt and Iodized salt on the larval growth and cocoon characters of the silkworm, B.mori L. Breed BSR-832, Sericologia 33(4) 495-598.

Ray D., Gupta B. K. 1974 - Effect of micronutrients on the yield and chemical composition of mulberry leaf. In annual report CSR & TI Berhampore India.

Reali G. 1990 - L'allevamento del baco da seta edizioni L'informatoreAgrario, 60 pp.

Sarkar A. A., Absar N. 1995 - Foliar treatment effect of urea and micronutrients on mulberry (Morus sp.) and silkworm (Bombyx mori L.). Sericologia 35(4) 713-720.

Sharkar M. A., Shivashankar K., Devaiah M. C. 1994 - Effect of feeding mulberry leaves deficient in secondary nutrients on larval growth, development, cocoon weight and silk quality, Sericologia, 34(3) 511-518.

Zlotin A. Z., Bolavin I. P. 1988 - Information about silkworm.