Mulberry *Mulberry (Morus bombycis Koidz., Morus alba L., Morus latifolia Poiret, Morus nigra L., etc.)*

French: Mûrier; Spanish: Morera; Italian: Gelso; German: Maulbeerbaum

Crop data

Perennial, Harvested part: leaves
Transplanted early spring.
Harvested late summer/autumn in first year from transplanting, three or more times during the growing season from third year onwards.
Plant density: 10 000 (traditional low cut) to 20 000 (intensive) per hectare. Adapted to warm-temperate to tropical conditions. Generally unirrigated.

Effective soil depth 50 cm or more. Prefers light to medium textured soil without hard pan or high ground water-table or stagnant water within 80 cm of surface, and pH 5.5-6.5. Liming improves soil condition and ensures calcium nutrition of plant. Organic fertilizer is also required to maintain or increase soil fertility.

Nutrient uptake in soil-mulberry-silkworm relationship

The supply of mulberry leaves of high nutritive value is essential for the healthy growth of silkworm larvae and leads to a good production of high-quality cocoons.

Nutrient uptake and flow in the soil-mulberry-silkworm metabolic pathway for a leaf yield of 24 800 kg/ha/year and a cocoon yield of 1 240 kg/ha/year is given in the following table:

Japan/Nutrient uptake - Macronutrients*					
	kg/ha/year				
	N	**P2O5**	**K2O**	**MgO**	**CaO**
Total uptake	242	46	211	51	238
- of which retained in supporting parts of the tree	10	-5	-2	-3	10
- of which removed in harvested parts					
- leaves	206	41	192	50	207
- shoots	26	9	22	5	21
To cocoons	66	7	12	5	14
To faeces and other waste from silkworm rearing	140	34	180	45	193
* Leaf yield = 24 800 kg/ha/year; cocoon yield = 1 240 kg/ha/year					
Data compiled by H. Takagishi, 1990					

Plant analysis data

Japan/Plant analysis data - Macronutrients/August							
Sampled leaves*	**Sampling time**	**% of dry matter**					
		N	**P**	**K**	**Mg**	**Ca**	**Na**
Upper young leaves	August	3.90 ± 0.72	0.42 ± 0.05	1.94 ± 0.18	0.21 ± 0.18	0.83 ± 0.33	0.07 ± 0.01
Middle (medium-aged) leaves		3.36 ± 0.86	0.28 ± 0.08	1.68 ± 0.33	0.21 ± 0.11	1.19 ± 0.25	0.15 ± 0.15

* grown on farmers' fields
Source: Takagishi et al, 1988

Japan/Plant analysis data - Macronutrients/September						
Sampled leaves*	**Sampling time**	**% of dry matter**				
		N	**P**	**K**	**Mg**	**Ca**
Middle position on shoot	Late autumnal silkworm					
- leaf blade	rearing season	3.31	0.19	1.73	0.31	1.57
- petiole	September	1.13	0.11	3.75	0.77	1.37
Source: Takagishi et al., 1985						

Japan/Plant analysis data - Macronutrients/November						
Sampled leaves*	**Sampling time**	**% of dry matter**				
		N	**P**	**K**	**Mg**	**Ca**
Leaves	Overmature leaf stage/ November	2.44	0.26	2.34	0.54	2.98
Shoots		0.69	0.13	0.33	0.10	0.44
Aerial part of stump		0.39	0.05	0.41	0.07	0.62
Subterranean part of stump with roots, except fine roots		0.62	0.10	0.45	0.10	0.39
Fine roots		1.08	0.17	0.83	0.18	0.50
Mean		0.84	0.12	0.71	0.16	0.85
Source: Takagishi et al., 1987						

Japan/Plant analysis data - Macronutrients/excess-optimum-deficiency ranges					
	% of dry matter				
Range	**N**		**P**	**K**	
	Blade	Blade	Petiole	Blade	Petiole
Excess	>5.0	>0.39	>0.70	>2.1	>4.7
Optimal to luxury	3.0-5.0	0.13-0.22	0.09-0.22	0.5-2.1	0.5-4.7
Deficient	<2.5	<0.13	<0.09	<0.25	<0.25
Sources: N: Takagishi and Matsuda 1970 - P and K: Takagishi and Kawauchi 1985					

To produce leaves of high yield and good quality, special attention must be paid to balanced NPK fertilization. As mulberry is a nitrate-loving plant, favourable conditions are required to promote nitrification and long-term supply of nitrate-N.

Fertilizer recommendations and practice in Japan

In Japan (a warm-termperate country) it is recommended, firstly, that 15 tons/ha rice straw compost or other suitable organic manures are applied in late autumn or winter to maintain or enhance soil fertility. Alternatively, 100 parts (by weight) rice straw and 3 parts calcium cyanamide are applied together and well mixed into the soil between the rows in winter, so that the straw will decompose in the soil as the temperature rises in the spring and summer. Inorganic (mineral) fertilizers are generally applied, in the first year of establishment, at 50 % of the full recommended rates; in the second year at 70 % of the full rates; and, from the 3rd year onwards, at the full rates as set out below.

Japan/Recommended rates of nutrients - Macronutrients				
Soil types	**Soil conditions**	**kg/ha/year**		
		N	**P2O5**	**K2O**
Non-volcanic				
- Alluvial	Lowland medium-textured	300	140	120
- Colluvial	Sloping, medium-textured	300	140	150

- Red and yellow soil	Hill or plateau, medium to heavy textured	300	160	160
Volcanic				
Typic volcanic ash soil (Andosol)	Plateau, medium-textured	300	160	200
- Alluvial volcanic ash	Plateau or lowland, medium textured	300	150	150
- Colluvial volcanic ash	Sloping or plateau, medium textured	300	150	160
Sources: Ito & Mori, 1967 - Raw Silk Bureau, Min. Agr., Japan, 1968				

These rates are appropriate for the cultivation of mulberry for the grown silkworm (fourth and fifth instar) which consumes almost 95 % of the total amount of leaves required for the entire larval stage, and relate to an expected production of 1.2 tons cocoons/ha/year from 24 tons leaves/ha/year.
In northern Japan 60 % of the total fertilizer N, P2O5 and K2O are given in spring before sprouting and the remainder in June/July after the spring silkworm rearing season is over; and in southern Japan 50 % at each stage.

Preferred nutrient forms in Japan

N: ammonium or urea form.
P2O5: mainly in water-soluble form, with some part of citric soluble form.
K2O: usually applied in sulphate form.

The peat ball fertilizer, i.e., an organo-mineral ball fertilizer which contains woody peat as a matrix to hold inorganic fertilizers such as ammonium sulphate, calcium superphosphate, potassium sulphate and micronutrients, is widely used by sericultural farmers. Various types of multinutrient compound fertilizers are also used.

Fertilizer recommendations and practice in China

The Sericultural Research Institute, National Academy of Agricultural Sciences, indicates the following relationship between nutrient application rates and mulberry leaf yield.

PR China - Relationship between nutrient application rates and mulberry yield			
Mulberry leaf yield kg/mu*	**Nutrient application rates kg/mu***		
	N	**P2O5**	**K2O**
500	11.20	6.29	9.77
1000	20.50	7.18	15.70
1500	33.60	13.40	26.20
2500	50.60	22.60	36.50
* 1 mu = 0.0667 ha			

Another report suggests that the amounts of nutrients required to produce 2 500 kg mulberry leaf/mu (37 480 kg/ha):

Nutrient	**kg/mu**	**kg/ha**
N	44.3-47.0	664-705
P2O5	15.7-18.2	235-273
K2O	27.4-30.8	411-462

The N : P2O5 : K2O ratio in annual applications of fertilizer to mulberry is usually 6 : 3 : 5 for the grown silkworm, and 5 : 3 : 4 for young silkworms requiring nutritious young leaves. Fertilizers are applied in split dressings through the year in order to ensure a good yield of

high-quality leaves from spring through to the autumn as well as to maintain the vitality of the trees as a perennial crop.

An example of fertilizer practice in Zhejiang province is given below:

PR China/Zhejiang province - Nutrient rates/Macronutrients					
Season	**Product and rate**	**t/ha**	**kg/ha**		
			N	**P2O5**	**K2O**
Spring	Ammonium carbonate	0.39	65.2	-	-
	Night soil	15.15	72.7	40.9	65.1
Summer	Broad bean (as green manure)	26.52	155.0	39.4	130.0
	Ammonium carbonate	0.19	33.3	-	-
	Night soil	11.36	54.5	31.8	50.0
Autumn	Ammonium chloride (or ammonium sulphate)	0.13	31.8	-	-
	Night soil	15.15	72.7	40.9	65.2
Winter	Canal mud	189.39	227.0	123.0	105.0
Annual total			712.0	276.0	415.0

An example of fertilizer practice in Jiangsu province:

PR China/Jiansu province - Nutrient rates/Macronutrients					
Season	**Product and rate**	**t/ha**	**kg/ha**		
			N	**P2O5**	**K2O**
Spring	Night soil	15.15	72.7	40.9	65.2
	Cattle excreta*	11.36	54.5	31.8	48.5
	Ammonium sulphate	0.11	22.7	-	-
Summer(1)	Green manure	37.88	189.0	48.5	152.0
	Ammonium sulphate	0.23	45.4	-	-
	Cattle excreta*	15.15	72.7	40.9	65.2
Summer(2)	Clover	7.58	39.4	4.5	22.7
	Ammonium sulphate	0.15	30.3	-	-
	Cattle excreta*	15.15	72.7	40.9	65.2
Autumn	Cattle excreta*	11.36	54.5	30.3	48.5
	Ammonium sulphate	0.08	15.2	-	-
Annual total			670.0	238.0	467.0
* Mixed with night soil					

Fertilizer practices in S.E. Asia

Less inorganic fertilizers are applied to mulberry than in the countries mentioned above. Among organic manures recommended are: rice straw, cut grass, cassava stalks, sugar cane waste, kenaf stalk cores, sawdust, mulberry shoots, twigs and branches, fallen leaves, kitchen waste, silkworm faeces and litter, fowl droppings and cattle dung. On the other hand, temporarily recommended rates of inorganic fertilizers would be in kg/ha/year: N = 200, P2O5 = 100 and K2O = 130.

In Sulawesi, Indonesia, most sericultural farmers have been reluctant to use fertilizers in the mulberry fields, but N. Mori et al., 1982, have reported that dressings of urea (providing a total of 100 kg/ha/year N) gave a remarkable yield increase in the fertilizer demonstration and trial field.

Further reading

OMURA, S.: Silkworm rearing technics in the tropics. (1983)

Authors: M.Ito , The Fertilization Research Foundation, Tokyo, Japan; H. Takagishi, Japan Intern. Cooperation System, Tokyo, Japan