

V. TEA

Tea, a species of *Camellia* genus (*Camellia*), is a typical plant of the sub-tropical evergreen broadleaved forest. It originated in south-east Asia, and is found in China in the sub-tropical mountains of Yunnan, Guizhou and Sichuan provinces.

China has a long history of tea utilization and cultivation. However, the history of tea cultivation is relatively short in the Hengduan Mountains and even shorter in the Himalayas of southern Tibet.

History of Tea Cultivation in the Himalayas

Tea is in great demand in Tibet, where there is tradition of tea drinking. Before 1956, tea was imported from far away Yunnan and Sichuan provinces through the long, rugged mountain terrain and was too expensive for ordinary people to consume. The demand increased quickly with the improvement of transportation and living standards after 1956, and the Chinese government decided to introduce and plant tea on the southern flank of the Himalayas and south-east Tibet, originally regarded as an unfavourable area for tea cultivation.

There were two stages for tea introduction and plantation. The first was an experimental period of small plantations before 1970. Because of mis-management, tea planted in 1956 was put into production as late as 1964. However, success was achieved in Zayu, Bomi, Cona and Nyingchi counties, which are now important centres for tea cultivation. Different methods of tea leaf processing, such as Maofeng, Meicha, Longjing and Biluochun, were also successively applied.

The second stage was large scale plantation after 1971. Tea plantations have now spread to twenty-eight counties among which Zayu, Bomi, Nyingchi and Cona counties have shown very good results. By 1986, the area under tea had reached over 133 ha and tea leaf production stood at 47,600kg.

Species and Varieties

There are many species of wild tea. Through human introduction, domestication and cultivation, many cultivars, mutations and crossbreeds have been developed and planted.

Tea is more abundant in the Hengduan Mountains than in the Himalayas. For example, in Miaoxi tea garden, cut across Tianguan, Lushan and Baoxing counties in Sichuan province north-east of the Hengduan Mountains, there are cultivars for green tea making like Sci No. 12 and those for black tea such as Shu-Yong No. 3, No. 307 and No. 808. Among these cultivars, Shu-Yong No.3, No. 307 and No. 808 have proved to be cold-resistant and productive. In the southern Hengduan Mountains, the 400 year old Fengqing tea garden in Yunnan province has five main species in cultivation, including reddish-bracted, small-clustered, rape-flowered, large-leaved and small-leaved teas.

In the Himalayas, tea species and varieties were mainly introduced from Sichuan and Yunnan provinces. Now both large-leaved and small-leaved species are cultivated. The two species are biologically and ecologically dissimilar. The small-leaved tea has a significant tree structure of strong trunk, high ramification and condensed tree crown. The internodal length in the new shoot is short and the attached new leaves are dense, the old leaves are dark green, leathery and small. Its white flowers blossom early in the year. It is more cold resistant than the large-leaved species, therefore, more widely adaptable and distributed. The large-leaved tea has a typical tree structure of great size with open crown. The new shoots are thick with long internodal length and large, fleshy new leaves. The leaf is well shaped, tipped and of pure flavour. It blossoms and bears late. Vulnerable to cold weather, it is not suited to all conditions.

Ecological Suitability and Distribution

Climatically, the tea bush requires high temperature and high humidity, with an average annual temperature of above 10°C, an accumulative temperature of over 3000°C, annual precipitation of above 1000mm and average relative moisture about 80 per cent. Tea begins to germinate at temperatures over 10°C and put out new shoots if adequate water is provided. The most suitable temperature for tea growth ranges from 20°C to 25°C, and it is unfavourable if the temperature is lower than 20°C or higher than 25°C. A temperature of over 35°C may cause damage, preventing growth and withering the shoots; lower than -15°C will cause most of the above ground parts to die. Its water requirement is at least 800mm/annual precipitation. Generally, the whole tea plant contains as much water as 50-60 per cent, and the tender leaves as high as 70-80 per cent. 100mm/m's rainfall and 80 per cent relative moisture will make the tea leaves of high quality. As regards soils, the tea plant prefers well-drained acid soils of pH 4.5-5.6; when the pH is over 7 or less than 4, the tea plant does not grow well.

Generally, the environment in the Himalayas and Hengduan Mountains can meet the needs of tea growth as described above. In the north-eastern and southern Hengduan Mountains, the conditions are very suitable. The yellow forest soil has pH values of 5.5-6.5. This may be seen from Table 9.

Table 9. Climatic Conditions in the Hengduan Tea Cultivation Areas

Location	Elevation m	Temperature (°C)						Rain- fall mm	RM %
		Jan. av.	July	min	max	> 10°C			
Yaan (NE)	800	16.2	6.1	25.4	-1.9	3.5	5058	1750	79
Miaoxi (NE)	1100	13.7	-	-	-5.5	34.6	-	1448	86
Fengqing (S)	1950	16.5	10.3	20.8	-0.9	32.7	-	1322	73

NE: Northeast Hengdua S: Southern Hengduan RM: relative moisture

In the Himalayas, the growing areas are heterogeneous. Thermal conditions vary greatly, as shown in Table 10. In the low elevation of Medog and Zayu areas, thermal conditions are within the most suitable range. In the areas lower than Zayu and south of Medog, conditions are even better, with rich precipitation. For instance, in Beibeng village at 600m asl, the average annual temperature can

be 21°C, >10°C accumulative temperature over 7000°C, the mean temperature in the coldest month is nearly 15°C, and the minimum temperature 4°C. Thermal conditions decline with the increase in elevation, though an elevation of 2500m is acceptable for tea cultivation, e.g. in Dongjiu tea garden, tea grows normally. The introduced tea varieties are so cold-resistant as to endure temperatures of -5°C to -16°C; and the small-leaved breed can even tolerate upto ten continuous days at temperature of -1°C to -16°C. Provided the more cold-resistant breeds are selected for cultivation, and with the adoption of anti-cold measures, tea can be grown even higher. Obviously, tea has reached its highest elevation here, compared with other areas in the same latitude.

Table 10. Thermal Conditions for Tea Gardens in the Himalayas

Location	Elevation m	Temperature (°C)					> 10°C	FD
		av.	Jan.	July	min	max		
Medog	1100	18.6	11.6	-0.2	24.6	33.8	5898.7	300
Lowerzayu	1590	51.3	8.3	-0.5	21.6	33.3	4729.9	284
Zayu	2328	11.6	3.9	-4.5	18.8	30.9	3140.4	205
Yigong	2250	11.4	3.3	-10.7	18.1	32.8	3109.6	210
Dongjiu	2500	11.9	4.4	-12.4	17.5	25.9	3080.9	-
Zhamu	2750	8.5	-0.4	-20.3	16.5	31.0	2286.9	161

FD: frost free days per year

The moisture regime for tea growing areas in the Himalayas is also varied with annual precipitation ranging from 700-2000mm, and relative moisture between 60-80 per cent. In some areas, moisture conditions are lower than the normal requirement and this restricts the development of tea cultivation, its growth and quality as shown in Table 11.

Table 11. Water Regime of Tea Gardens in the Himalayas

Location	Elevation m	Annual rainfall mm	Relative moisture %	Aridity
Medong	1100	2357.6	80	-
Lower Zayu	1500	998.6	69	1.26
Yigong	2250	960.4	73	0.59
Dongjiu	2500	703.1	77	-
Zhamu	2750	935.8	69	0.56
Zayu	2327	764.7	67	0.84

Soil factors in the Himalayas are also favourable for the cultivation of tea. The yellow and reddish yellow soil is similar to that of sub-tropical evergreen broad-leaved forest and tropical evergreen rain forest at elevations lower than 1800m. The whole soil profile presents acid reaction; the pH value of the upper soil is 4-5, and deeper down it is 5.5-6.0. The humus layer is thick and the necessary plant nutrients are sufficiently available. This is the most suitable type of soil for tea cultivation. On the impoverished soil of coniferous forest, where the pH value is nearly 7, tea is not widely suitable, except for some areas with deep soil horizon and relatively high humic composition accompanied by acid fertilization. On the shaded slopes at an elevation of 1800m in the evergreen and deciduous broadleaved mixed forest, yellow-brown soil dominates, which should be selected for tea cultivation.

On the whole, in the Hengduan Mountains, tea can be planted at elevations of 800-1500m in the north-east, and at around 2000m in the south, while in the Himalayas, tea plantations are distributed at elevations 1000-2500m on the southern flanks.

Growth, Management, Production and Quality

Growth

Tea grown in the Himalayas has the following characteristics:

- Elevation is the most important decisive factor for tea growth. For example, tea can grow in one year, to 25 cms in height at an elevation of 1800m while it grows to 10 cm at 2500m.
- The area is not continuous or large instead, it is scattered as a result of the uneven landform and varied environment. Different distribution areas obviously differ.
- The number of terminal buds per unit area is 450-650 every square metre, far less than production in east China. However, the weight per shoot is rather high; according to research done in Dongjiu garden, the shoot of one terminal bud and one leaf weighs 0.387g, and that of one bud and three leaves 0.577g with the highest being 1.2g, which surpasses the level found in east China.
- Tea roots are distributed underground according to character. Nearly 80 per cent of the roots are distributed on the soil layer of the upper 30 cm, which indicates the focused part in fertilization.

The growing properties in different tea gardens are shown in Table 12.

Table 12. Inventory of Tea Growth in the Himalayas

Location	Eleva	Age	Plot	H	GD	LN	SL	LL	LW	LA	CD
Xinchun	1800	1	38x150	17	0.18	-	17	2.9	4.8	8.2	-
Dongjiu	2500	1	30x 50	9.9	0.08	4.6	9.9	2.7	4.6	7.4	-
Dongjiu	2500	2	30x150	10.3	0.27	10.8	6.5	2.7	4.9	7.8	15.2
Xinchun	1800	2	30x150	53.5	0.06	-	36.5	2.2	3.6	4.6	16.1
Dongjiu	2500	3	30x150	60.0	0.66	76.0	33.5	3.5	6.9	14.4	16.1
Dongjiu	2500	6	30x150	85.3	1.8	-	27.3	2.8	7.0	11.8	95.0
Dongjiu	2500	10	30x150	103.3	2.4	-	24.0	2.4	6.5	9.4	133.0

* Xinchun is in Zayu County, and Dongjiu is in Nyingchi County.

Plot: cm x cm

LN: leaf number

LW: leaf width (cm);

H: height (cm);

SL: shoot length (cm)

LA: leaf area, apu. (cm);

GD: ground diameter (cm)

LL: leaf length (cm)

CD: crown diameter (cm)

Management

In the Hengduan Mountains, tea gardens are well managed by a set of measures. In the Miaoxi tea garden, these measures include:

- Fertilizing system: Suitable proportions of different fertilizers have been recognized according to the soil condition, comprising 1500kg organic manure, 100kg oil residue, 5kg nitrogenous fertilizer and some phosphoric fertilizer. Organic manure has to be added in the spring, accompanied by small amounts of nitrogenous and phosphoric fertilizers.
- Plucking system: In the spring, the terminal bud and two or three leaves should be plucked leaving the stipules; in the summer, the terminal bud and two leaves should be plucked, leaving one leaf; in the autumn, the terminal bud and two leaves must be plucked leaving the stipules. Increasing leaf tenderness is the other part of the method which is done by starting to pluck early when only 10 per cent of the shoots are fit. Every year, after harvesting and pruning, there should be a thorough check of the productivity properties of the tea plants.
- Selection and cultivation of good varieties: Since 1983, eight varieties have been introduced, and three of them have been selected as productive and resistant to both cold and disease.

In the Himalayas, management is rather poor. Generally, tea leaves should be plucked about 25 times per year. But in the Himalayas, plucking is too light. In many gardens, tea leaves are plucked only 3-4 times. In Yigong area, as a result of labour shortage, plucking is done only 5-6 times. Even in the relatively well managed Dongfeng tea garden in Nyingchi County, plucking is done only 7-8 times: twice in the spring beginning from mid May at intervals of one month, 3-4 times in summer beginning in July at an interval of 10-15 days, and an autumn pruning of leaves for coarse tea. Too many leaves will have been left growing which is not good for production, e.g., the leaf area index is 6.6, 2.5 times higher than that of east China's Hangzhou tea gardens. The other problem of tea garden management in the Himalayas is the insufficiency of fertilization.

Production

In the Hengduan Mountains, relatively high production has been achieved and there is a long history of tea cultivation. In the north east, there are altogether 9440 ha. tea gardens, and the average production is 525kg/ha in the productive area. From Miaoxi tea gardens, fine processed tea leaves can yield as much as 1170kg/ha.

However, in the Himalayas, production is very low. On an average in the lower elevations, tea can be put into production within three years, while at higher altitudes it takes five to six years. But mismanagement hampers production. For example, in Yigong area, one of the advanced areas for tea introduction, only 315kg fine tea and 1125 kg coarse tea per ha. was produced in 1983. Even in the well-managed Dongfeng tea garden, the highest production recorded was only 375 kg fine tea and 1875 kg coarse tea per ha. Production is increasing very slowly, for instance, based on the total tea garden area of Tibet, the yield was 315 kg per ha from the total 45 ha. in 1981, and was only 375kg/ha. from the total 133 ha. in 1986.

Tea leaf quality

In the Hengduan Mountains, due to good management and high processing, good quality tea leaves have been produced. In Miaoxi tea garden, advanced processing methods were adopted for black tea, a promising tea product for export.

In the Himalayas, the tea processing techniques and mechanism are backward and do not produce quality tea. However, with good processing some good quality teas are now being produced. Maofeng tea and black tea made in Zayu were identified as possessing the properties of size, tenderness and aroma.

Because of the unique spectrum composition and intense radiation in mountain areas, in the Himalaya tea has plenty of water extracts and soluble tannic acid.

Diseases

The common diseases are given below:

Leaf-speck disease

Caused by *Phyllosticta theicola*, *Colletotrichum camelliae* and *Gloeosporium theaesinensis*, the tender leaves and new shoots are damaged, and white specks of about 0.1-0.2 mm size with brown edges appear.

Black blight

This disease occurs widely in the tea gardens of the Himalayas. In Yigong area black blight is so serious that it may last four to five years and cause production to decrease by one-third. The general causes are *Neocapnodium theae* and *Zukalia nanoensis*.

Nosophytes

In areas with rich precipitation or near forests, the environment is so humid that many lichens and mosses develop, attaching themselves to tea bushes slowing their growth, withering their shoots, and making their leaves small and withered and therefore, unfit for tea making.

To control leaf-speck and black blight, refer to the measures used to control leaf-speck disease. As for lichens and mosses, the best method may be removal of infected portions of the bush.