Cultivation of Japanese Green Tea

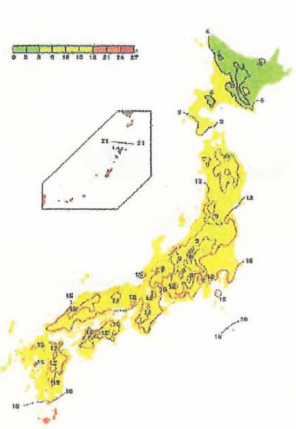
Outline

In Japan, the commercial tea cultivation is carried out in the south half side, where the average temperature is 11.5～18.0 ℃ and the average rainfall is 1,500～2,000 mm per year. Generally, the yield is higher in the areas where the average annual temperature is above 16 ℃. The quality of tea shows the reverse tends against high temperature that increases the yield.

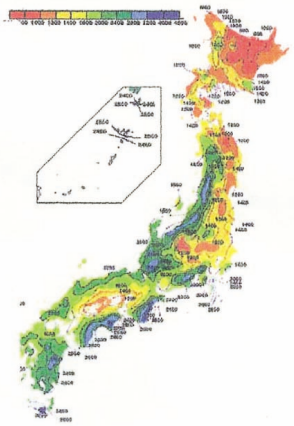
Tea plants grow from March to November and remain dormant for the rest of the year. Leaves are harvested 2～4 times in a year and each harvesting period is about 2 weeks. Tea production has been influenced by the agrotechnology, as well as by the sections of suitable land, tea cultivars, plucking methods, pest controls, climatic factors and unique trading system. The management cost in Japan is higher than that of other countries. High gross income allows a large investment into the use of expensive machines, fertilizers and chemicals.

Tea fields with clonal plants of superior cultivation, belong to *C. sinensis* var. *sinensis*, were accounted for about 46,000 ha (91 % of total production areas) in 2000. Among more than 80 cultivars, that are used for the production of various kinds of tea in Japan, 'Yabukita' occupies 86 % of the total of clonal areas, followed by 'Yutakamidori', 'Kanayamidori' 'Sayamakaori' and 'Okumidori' in much less extents.

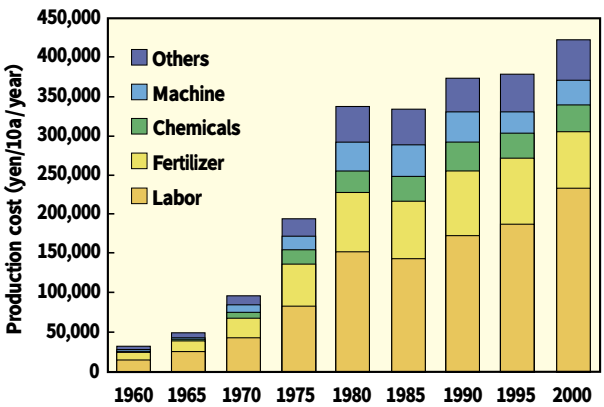
Average annual temperature(℃)



Annual rainfall (mm)



Changes in the cost of production of fresh leaves in Shizuoka Pref.



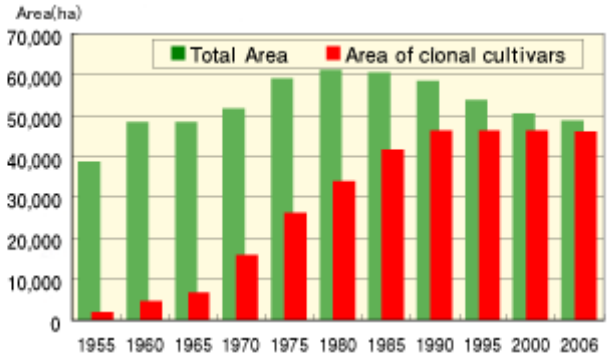
Five major cultivars in Japan

Yutakamidori　Sayamakaori　Yabukita　Kanayamidori　Okumidori

Tea Propagation

Until 50 years ago, tea seedlings planted in the fields. Since the Meiji era, however, progress in tea breeding was established by the introduction of technology from foreign countries. Cutting method for clonal propagation was established before World War II, in 1936, by Oshida. Thereafter, this method had been used for tea propagation and cuttings, superior to productivity and quality, were introduced to tea fields. At present, the most parts of tea fields are planted various clonal propagated cultivars, producing high quality of Japanese green tea.

Trend of tea production area



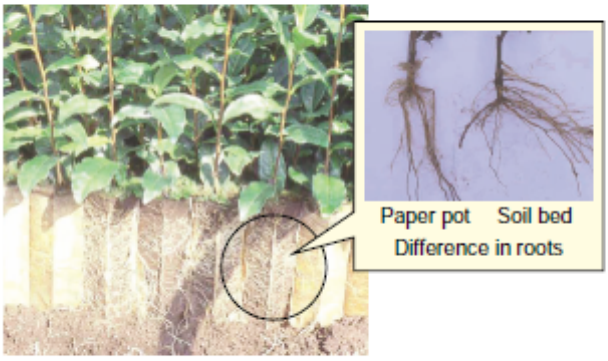
Clonal propagation

Cutting is favorable in June when the 1st flush of tea plant is matured and the color of its lower stem part is turned to yellow brown. Cuttings are prepared to cut mature flushes into 2 nodes, and are planted approximately 2 cm in depth (in the cutting bed). The suitable density of planting is 1 cutting per 4.5 cm. After planting, it is advisable to maintain the moisture of the air and soil.

Recently, direct introduction of cuttings through paper pots with unclosed bottom became popular. In this method, damage of vigorous root growth due to transplanting is lower than that of soil bed. The size of paper pot used for cutting depends on the size of plant at the time of transplanting. In Shizuoka, a convenient size for one-year-old cutting is 6 cm diameter and 15 cm in length. Even though the cutting grow than 30 cm in height, the paper pot can be moved from the nursery bed without any damage of roots.

Clonal propagation in the cutting bed

Cutting bed after one year of planting



Paper pot cutting

Cultivation of Japanese Green Tea

Planting

From March to April is the most suitable time for planting of cuttings to field. There are two types of planting, single-row hedge planting and zigzag (double-row hedge) planting. In both types, distance between two adjacent hedges is 180 cm.

In single-row planting, the distance between plants is 30～45 cm. In zigzag planting, the distances between plants and rows in a hedge are 60～90 cm and 30～60 cm, respectively.

Zigzag Planting of paper pot cuttings

Excision of shoot tips after planting

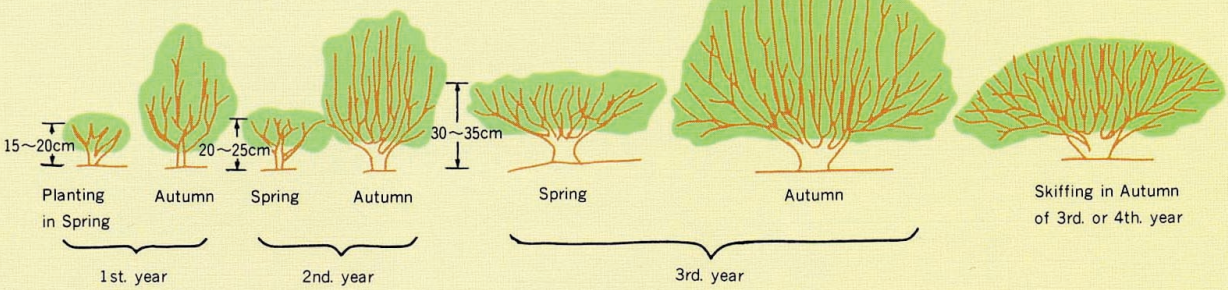
Frame Formation

The frame formation of tea plant is shown in the figure below. The tea plant is pruned every year in spring, and is skiffed in autumn of the third or fourth year after planting. These treatments increase the number of branches and plucking surface areas.

The first harvest can be done in the second year after planting but the yield is very low. Maximum productivity is reached by fifth or sixth year after planting. Under favorable conditions by the management (pruning) in Japan, the productivity remains 25～35 years.

Young tea field (First year after planting)

Method of frame formation of tea plant



Pruning

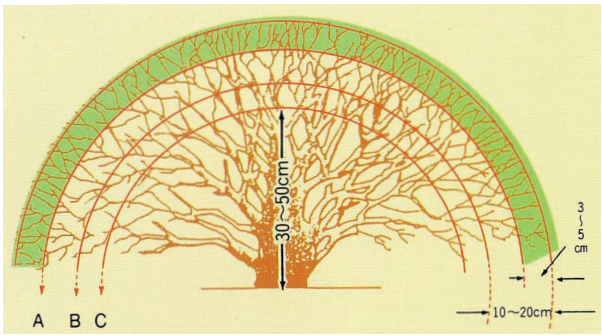
10 years later after planting, tea plants are subjected to trimming and pruning in order to get following aims.

1) To refresh the vigor of an old tea plant.
2) To keep the height of the plucking surface within the bounds of easy and efficient plucking.

Because of difference of effects between trimming and pruning, these treatments are done in different periods, the former every 2～3 years and the latter every 5 years.

Skiffing is done after every harvesting and in autumn to remove the late-emerging shoot and to keep the surface uniform for mechanical plucking.

Methods of trimming and pruning



A: light trimming of canopy
B: deep trimming of canopy
C: medium pruning

Growth and Harvest of Tea Shoots

Generally, from April to October, tea shoots grow and harvest 2～4 time, first crop in late April to mid May, second crop in late June, third crop in late July to early August and fourth crop in mid September in Shizuoka Pref. (see the figure on page 22). The average yield of tea field is 8,000 kg in the first harvest, 6,000 kg in the second harvest and 4,000 kg per hectare in the third harvest. First crop posses the highest quality and the highest price. The area where the third and fourth crop harvested is decreasing because of the low price.

Riding pruning machine

Portable pruning machine

Tea field after pruning

Cultivation of Japanese Green Tea

Plucking

Tea flushes are plucked either by hand (hand and hand-shear plucking) or mechanically. There are three types of tea plucking machines; portable machines (for one-and two-persons-type), self-propelled machines (riding-type and walking- type), and rail-tracking machines. Portable machine for two persons and riding-type plucking machines are most widely used in Shizuoka Pref. and Kagoshima Pref., respectively. Tea flushes for Tencha are plucked only by hand.

The amount of new shoots harvested by one person increases as following, hand plucking < hand-shear plucking < portable plucking machines for two persons < riding-type plucking machines.

Generally, tea flushes harvested by hand have high quality and make up for high grade Sencha or Gyokuro.

Hand plucking

Hand-shear plucking

Plucking efficiency

Methods	The amount of new shoots per day per person
Hand plucking	
Hand plucking	10 ～ 15kg
Hand-shear plucking	100 ～ 200
Mechanical plucking	
Portable machine for two persons	700 ～ 1,000
Riding machine	4,000 ～ 5,000
Self-rail-tracking machine	2,000 ～ 3,000

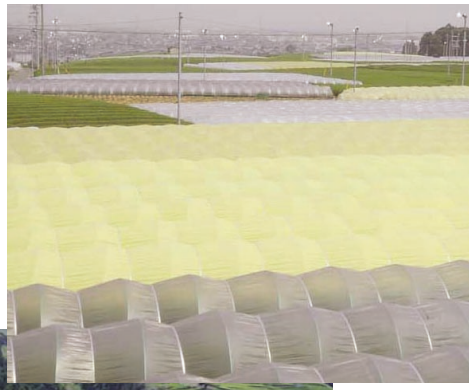
Portable machine for two persons

Rail-tracking plucking machine

Riding-type plucking machine

Covering Culture

The shading are classified to three types, ceiling-shelf covering, simple tunnel shading and direct covering and are used to protect the new shoots against frost, to prolong the plucking time and to produce high-grade tea. Gyokuro and Tencha, which are known as the finest tea in Japan, are made from the leaves grown under the ceiling-shelf covering.



Simple tunnel covering

Ceiling-shelf covering

Direct covering

Frost Protection

Frost falls in early spring damages the shoot tips of the first crop, and subsequently causes the maximum loss of farmers 'income. There are three methods for protection against frost: covering method (above photo), air stirring method (anti-frost fan) and freezing method (sprinkler).

Damaged buds

First crop injured by frost

Anti-frost fan

These fans, which are put in 6-8 m altitudes, prevent frosting by blowing stirring warm air to the tea field. They are used in more than 8,000 hectares of tea fields in Shizuoka Prefecture.

Freezing method

Sprinkler

Sprinklers are use not only for protection of the frost, but also for irrigation and for spraying of agricultural chemicals.

Cultivation of Japanese Green Tea

Major Pests and Diseases and Their Control

There are many pest insects and diseases attack to tea mature or new leaves, twigs or roots. Pests are most notorious because they cause damages directly on the shoots. To protect tea plants from these pests and diseases, agricultural chemicals are used under very strict rules and conditions.

Tea green leafhopper (*Empoasca onukii*)

This pest has 5 to 8 generations a year. This species pass the winters as adult in tea bushes. Damage is outstanding in budding leaves in the second plucking season and after that.

Tea leaf roller (*Caloptilia theivora*)

New leaves are attacked prior to the second plucking in June. Feces are accumulated in a bundles of leaves rolled triangularly by larvae.

Smaller tea tortrix (*Adoxophes honmai*)

This pest has 4 generations a year and overwinters as larva. Infestation is conspicuous in second and third plucking seasons. It usually comes just after the plucking.

Oriental tea tortrix (*Homona magnanima*)

This species has 4 generations a year and overwinters as larva. A sporadic occurrence of it on tea crop is diagnostic. Infestation is conspicuous in the third and fourth plucking seasons.

Mugwort looper (*Ascotis selenaria*)

This pest has 3 generations a year, and its overwintering is at pupal stage. The most prominent " Patchy " infections are in August and September.

Kanzawa spider mite (*Tetranychus kanzawai*)

This pest has two peaks of infestation, observed in June and in September to October. The population of this mite is suppressed spontaneous by its predator " Amblyseius ".

Mulberry scale (*Pseudaulacaspis pentagona*)

There are 2 or 3 generations a year and females are capable of overwintering. Hatchings (crawlers) are highly sensitive to insecticides, so are the targets of chemical controls.

Yellowish elongate chefer (*Heptophylla picea*)

Univoltine beetle. Larvae devour tea roots, which causes poor growth of the 1st flush. Most males have no muscle for flying.

Anthracnose (*Colletotricum theae-sinensis*)

This is one of the most important diseases in Japan.

The disease breaks out usually between May and October and its incubation period ranges from 14 to 20 days.

Gray blight (*Pestalotiopsis longiseta*)

The fungi invade a plant through wounds in young leaves or stems.

Especially when a plucking machine is used, it resulted in many cut or wounded leaves which invite more infection.

Blister blight (*Exobasidium vexans*)

This disease is most notorious in India and Sri Lanka. In Japan, its damage is not so pronounced. The disease affects tea fields in mountain areas with insufficient sunlight and under the shade of other trees.

Bacterial shoot blight (*Pseudomonas syringae pv. theae*)

This disease kills leaves and end of stems in autumn and early spring when tea plants are rather dormant. Serious damage is seen mostly in young tea plant fields and in windy fields.

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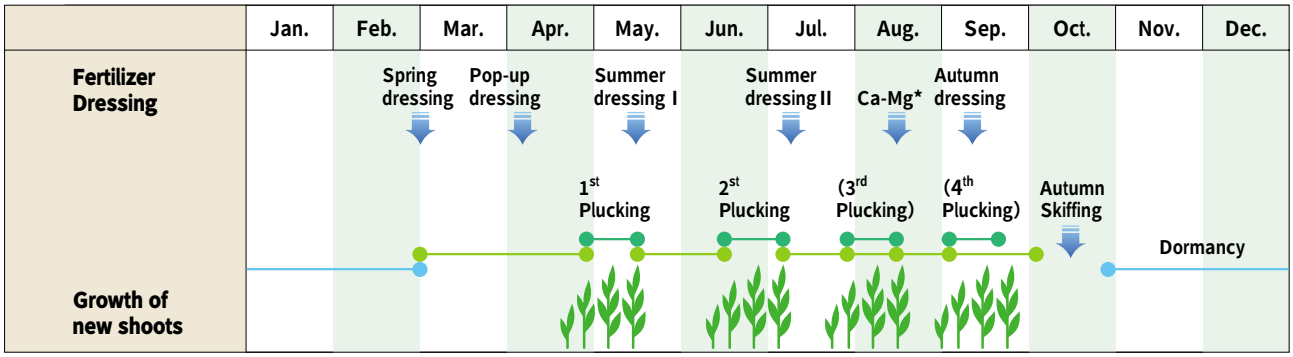
Fertilizer Application

Plucking is generally done 2 or 3 times a year. 18,000 kg/ha green leaf (fresh weight) is harvested annually, containing approximately 225 kg N, 36 kg P_2O_5 and 135 kg K_2O. The absorption rates for nitrogen, phosphorus and potassium by tea plants are estimated to be 40～50 %, 20 % and 45 %, respectively. Generally, the standard amount of fertilizer is determined according to the total amount of tea flushes annually harvested and their contents of elements that is equal to 540 kg N, 180 kg P_2O_5 and 270 kg K_2O per hectare.

Time of fertilizer application



(edited Standard application rate of fertilizer in Shizuoka Prefecture) ∗:Lime-magnesium

Standard application rate of fertilizer (Annual harvest : 18,000 kg FW. per hectare)

Fertilizer	Nutrients		
	Nitrogen (N)	Phosphate (P_2O_5)	Potassium (K_2O)
Spring dressing	100	90	130
Pop-up dressing	60		
Summer dressing I	110		
Summer dressing II	110		
Autumn dressing	160	90	140
Sum	**540**	**180**	**270**

Riding-type fertilizer-plower
(Fertilizer application with deep plowing)

Plowing

Shallow tillage and inter tillage (5－15 cm in depth), after each fertilizer application, are carried out to mix the soil, fertilizer and weed together. Deep plowing are done once a year in August in order to promote new rooting, to mix organic matters and soil and to improve the physical and chemical properties of soil after application of organic matters and soil conditioner (lime-magnesium) in August.

Fertilizer application

Deep plow subsailer

Low Input Sustainable Cultivation in Tea Fields

Using of agricultural materials is increased within several last decades in order to get maximum productivity. But it is clear that the excess dose of materials bring the environmental pollutions.

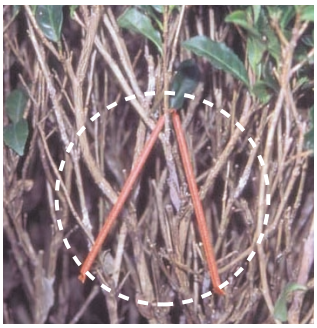
Now, the area of organic cultivation is increasing and new techniques are developing to reduce the amount of the agricultural chemicals and fertilizers. For instance, the cultivar with high resistance against pest and/or with high nitrogen uptake effeciency are selected for breeding.

Organic cultivation field

Reduce of Pesticides Spraying

Coming to this purpose, light traps (in determined optimum spraying date for lepidopterans), sex pheromone dispensers disruption of communication, mild pesticides (conserving spontaneous natural enemies) and so on are recommended to use.


Light trap


Dispenser releasing sex pheromone

Mild insecticides (IGRs, BTs) and Natural enemies


Amblyseius: mite predator

Scale parasitoides

Reduce of Fertilizer Application

Japanese green tea of high quality is containing the large amount of nitrogen. For the purpose of harvesting tea flushes containing high nitrogen content, application of nitrogen fertilizer increased and eventually caused pollution of both ponds and ground waters. To reduce the amount of fertilizer and to increase its efficiency, the controlled release fertilizers and new management systems are used in tea fields, based on determination of nutrient status of soil by the electric conductivity (EC) sensors.


EC Sensor


Check of nutrient status in tea fields with the EC sensor