Subsoil Improvement and Irrigation of Tea Gardens

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As tea plants are known to require a good drainage, growth of the plants is greatly influenced by physical properties of soils. However, many of tea gardens, including newly developed ones, have poor physical conditions of soils, often causing damage by impeded drainage. Therefore, physical ocnditions of soils, ranging to deep soil layers, must be improved in order to promote plant growth and sustain long-lasting productivity of tea gardens.

In practice the subsoil improvement can most effectively be done at the time of new planting or replanting, i.e., before planting of tea gardens. Furthermore, it is desirable to have cultural management adapted to the improved fields.

From this point of view, the present study was carried out in the replanted garden of this Institute to determine the effects of subsoil improvement, practiced by layer-mixing plowing, and cultural management such as irrigation, fertilizer application, supply of organic matter etc. on the plant growth at an initial stage.

Effect of subsoil improvement and irrigation on growth

In 1969 spring, a traditional tea garden on Red-yellow Soil of diluvium covered by the deposit of Kuroboku (Ando) Soil was cleared up, and experimental plots shown in Table 1 were designed. Subsoil improvement was made by thoroughly mixing soil layers to a depth of 70–80 cm by the use of a trencher. The design of 2^5 type multi-factors was established by including plots of irrigation, fertilizer application, and organic matter supply.

Table 1. Design of experimental plots

Factors	Levels	Treatments
Block	Eastern : Western	Eastern half of the field covered with 70~80 cm of Ando Soil, while western half with 40~50 cm of Ando Soil. Therefore, soil property was different between them even after subsoil improvement
Subsoil improvement	Treated : Untreated	Treated by trencher down to 70~80 cm of depth with thorough mixing of soil layers
Irrigation	Treated : Untreated	Irrigated at 20 mm by small nozzles when pF reached 2.3
Fertilizer	Standard rate : Double rate	Standard rate: 50 kg N, 20 kg P, and 20 kg K per 10a
Organic manure	Applied : Not applied	Compost at 3 ton/10a applied after subsoil improvement, and 1 ton/10a every year at time of autumn deep plowing. Mixed with soil thoroughly

Table 2. Effect of subsoil improvement and irrigation on shoot growth and yield

Factors	Levels	No. of shoots	Weight of shoots (g)	Weight of 100 shoots (g)	No. of new leaves	Length of shoots (cm)	Yield (kg/plot)	Quality
Block	East	164	58.2	38.7	3.1	7.9	7.18	33.5
	West	169	57.6	36.4	3.0	7.9	7.55	33.3
Subsoil	Untreated	167	61.1	38.6	3.1	8.0	7.86	33.7
improvement	Treated	165	54.7	35.4	3.0	7.7	6.86	33.1
Irrigation	Untreated	164	56.1	36.3	3.0	7.8	7.05	33.7
	Treated	168	59.6	37.7	3.1	7.6	7.67	33.1
Fertilizer	Standard rate	166	56.9	36.5	3.1	7.8	7.16	33.0
	Double rate	166	58.9	37.5	3.0	7.9	7.57	33.9
Organic	Not applied	162	56.7	37.0	3.1	7.8	7.06	33.3
manure	Applied	170	59.0	37.0	3.0	7.9	7.66	33.5

Note: Average of all plucking seasons with 5~6 years old trees.

After planting in June 1969, growth of shoots, yields and quality of tea were examined over a period of 6 years until 1974. Growth of plants of 5–6 years of age, with which plucking by shears became possible, is shown in Table 2. Effects of each treatment are given below briefly.

1) Depth of Ando Soil deposit

Depth of the Ando Soil covering was different between eastern and western blocks of the experimental field. During a period of 3 years after planting, the eastern blocks which had been covered with thicker deposit of the Ando Soil gave better growth in plant height and number of leaves produced as compared to the western block. However, no definite difference in yields was observed in later years.

2) Subsoil improvement

During a period of 3 years after planting, subsoil improvement resulted in the poor growth in plant height, number of leaves produced and in branching as compared to the control. Amount of branches pruned for training was also less in many cases in the subsoil improvement plot. Yields of shears-plucking at the first to third harvestings were also less in many cases. No clear trend was shown with the quality.

3) Irrigation

No clear effect of irrigation was observed in 3 years at the training stage, but since the harvesting began the irrigation gave more yields with increased number and weight of plucked shoots than un-irrigated control. However, the quality varied by years and harvesting seasons, giving no definite trend.

4) Fertilizer application

During a period of 3 years after planting, heavy application of fertilizer resulted in a decreased number of leaves and poor branching, probably due to the damage caused by heavy fertilization, although no visible symptom appeared. Since the shears-plucking began after 4 years of age, heavy application gave increased yields in many cases, and more or less better quality.

5) Compost application

During a whole period of 6 years, covering the training stage and plucking stage, the favorable effect of compost application on growth and yields was apparently recognized. Effect on the quality, however, varied by years and plucking seasons without a definite trend.

Effect of subsoil improvement and irrigation on root system

Effect of the various treatments on root

Table 3. Root system development as effected by subsoil improvement and irrigation (6 year old plants)

Factor	Block				Subsoil improvement				Irrigation				Fertilizer				Organic manure			
Level	East		West		Untreated		Treated		Untreated		Treated		Standard		Double		Not applied		Applied	
Item	Root Wt (g)	%	Root Wt (g)	%	Root Wt (g)	%	Root Wt (g)	%	Root Wt (g)	%	Root Wt (g)	%	Root Wt (g)	%	Root Wt (g)	%	Root Wt (g)	%	Root Wt (g)	%
Soil depth																				
0— 15	191.4	47.5	237.0	53.1	227.9	54.7	203.5	47.5	175.9	47.8	241.0	52.6	244.5	54.1	170.0	44.9	187.6	51.2	202.6	47.7
15— 30	104.0	25.8	95.3	21.4	99.4	23.9	96.6	22.5	81.6	22.2	111.5	24.3	121.2	26.8	75.3	19.9	83.0	22.7	90.2	21.2
30— 45	41.9	10.4	58.4	13.1	52.3	12.6	48.6	11.3	45.7	12.4	52.5	11.5	43.2	9.6	83.0	14.0	36.9	10.1	58.1	13.7
45— 60	33.5	8.3	32.3	7.2	27.9	6.7	37.4	8.7	36.8	10.0	32.3	7.0	27.3	6.0	43.1	11.4	26.0	7.1	44.2	10.4
60— 75	21.3	5.3	15.4	3.5	9.2	2.2	24.6	5.7	17.0	4.6	14.2	3.1	11.2	2.5	22.6	6.0	16.5	4.5	20.2	4.8
75— 90	9.7	2.4	7.8	1.7	—	—	16.6	3.9	9.9	2.7	6.5	1.4	4.2	0.9	13.1	3.5	14.5	4.0	8.9	2.1
90—105	1.4	0.3	—	—	—	—	1.2	0.3	1.4	0.4	0.2	0.1	—	—	1.8	0.4	1.8	0.5	0.3	0.1
Total	403.2	100	446.2	100	416.7	100	428.5	100	368.3	100	458.2	100	451.6	100	378.9	100	366.3	100	424.5	100

Note: Root Wt (weight) is shown in air-dried weight per plant.

systems of tea plants was examined. Although almost no difference was observed in the horizontal distribution of root systems, the vertical development of roots differed considerably by treatments, particularly subsoil improvement promoted the development of root system into deep soil layers. These results are shown in Table 3.

In the western block, root system was slightly shallower than that of eastern block, but weight of roots was a little heavier han the latter. Root systems reached 90–105 cm of depth by subsoil improvement, in contrast to only 60–70 cm of depth of the control plot. Improvement of physical property of soils caused by mixing soil layers was found to be beneficial for root system development.

Irrigation gave no effect on root distribution but increased the root weight. Fertilizer application gave no effect on root distribution, but the total root weight was heavy with standard rate of fertilizer application. Compost application showed a tendency to increase root weight, although no appreciable effect on root distribution was recognized.

In relation to the distribution of root system described above, water consumption pattern under different treatments are shown in Fig. 1. Subsoil improvement seems to have given no effect on water consumption pattern, but it is due to that the data of eastern and western blocks were combined. Actually, water consumption in the eastern block, which had previously a thick Ando Soil layer, was of "whole layer type" (water consumed uniformly from the entire soil layer), whereas that of the western block was of "surface layer type" (water consumed mainly from surface layer).

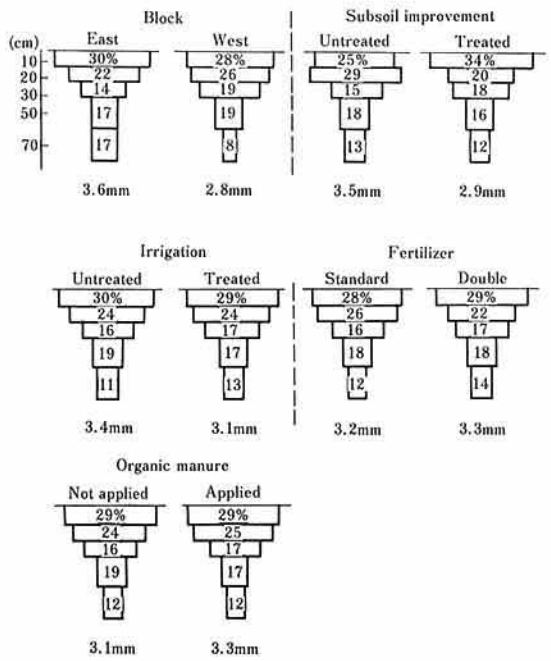

Fig. 1. Pattern of water consumption
Notes (1) % = Percentage of total water consumption
(2) mm = Evapotranspiration/day

Discussion and conclusion

Irrigation, compost application and heavy fertilizer application were found to be beneficial to plant growth, but subsoil improvement did not show beneficial effects, although it promoted the development of root system. The reason for that result may be as follows:

(1) Although physical property of soil was improved by subsoil improvement, there still remained an impermeable layer consisted of coagulated gravels in a deeper zone. It was found later that root development was further improved when this impermeable layer was broken.

(2) However, plant growth was not improved even when the impermeable layer was destructed. This is because that the chemical fertility of soil was decreased by being mixed with deep soil layer.

Therefore, the soil amendment measures must be applied in combination with the improvement of physical property of soil.

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