Effect of liquid fertilizer application under the canopy of Tencha tea garden.

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Summary
At present, the fertilizer placement in the tea garden is concentrated between hedges, therefore low efficiency and leaching of fertilizer are liable to cause water pollution. To reduce the application amount of fertilizer without degrading tea quality, it is necessary to improve the recovery rate of fertilizer by extending the dressing range to under the canopy. In this study, automatic drip fertigation system was installed in natural shape bush of Tencha tea garden. Compound liquid fertilizer in which urea was the main constituent was supplied under the canopy every day. The amounts of nitrogen application were 25g/m² and 50g/m² in the plots of liquid fertilizer, and it was 69g/m² in the plot of conventional application.

As the result, the growth of the first new shoot of liquid fertilizer treatment was superior to that of conventional treatment. The yield of plucked new shoot of liquid fertilizer treatment was increased more than 40% than that of conventional treatment, and the quality of crude tea of liquid fertilizer treatment was superior to that of conventional.

Keywords
Tencha, under the canopy, liquid fertilizer, drip fertigation

Introduction
Aichi Prefecture is a chief Tencha producing prefecture in Japan. As Tencha tea is the raw materials of Matcha, higher quality than Sencha is needed for Tencha. So, much fertilizer is usually applied in Tencha garden, it is the urgent problem to decrease the application amount of fertilizer in order to prevent water pollution.

At present, the fertilizer placement in the tea garden is concentrated between hedges, which causes the inefficiency of fertilizer. To reduce the application amount of fertilizer without degrading tea quality, it is necessary to improve the recovery rate of fertilizer by extending the dressing range to under the canopy. Using the conventional solid fertilizer was seemed to be ineffective, because of the difficulty of tillage and the shortage of the rainfall under the canopy.

Therefore, automatic drip fertigation system was installed in natural shape bush of Tencha tea garden. Compound liquid fertilizer having urea as the main constituent was supplied under the canopy every day. The growth of tea plant, the growth of first new shoot and the quality of crude tea of the liquid fertilizer treatment were compared with that of conventional fertilizer treatment.

Materials and Methods
A field experiment was conducted at Aichi-ken agricultural research center, Toyohashi research and extension station. The tea species tested was natural shape bush formation of
Tencha tea and the cultivar was 'Yabukiya'. The examination was begun in June in 2000.

1) The treatments of fertilizer

Three treatments were used as follows.

① 25gN/m² application as liquid fertilizer, ② 50gN/m² application as liquid fertilizer,
③ 69gN/m² application as conventional solid fertilizer

2) The method of fertilizer application

Drip irrigation (10cm of drop space) was set in 2 lines along the row under the canopy and the liquid fertilizer was supplied every day using the automatic drip fertigation system. Compound liquid fertilizer (12-5-7) having urea as the main constituent was diluted and supplied as figure 1. The concentration of liquid fertilizer during the growing period of first flush was 3 times as much as that of the other periods, and only water was supplied in winter. Amount of irrigation was 2L/m² in the plot of 25gN/m², and 4L/m² in the plot of 50gN/m², using the same concentration of liquid fertilizer. In the conventional fertilizer plot, solid fertilizer was applied at the rate of 69gN/m², 27gP/m², and 27gK/m².

3) The investigated items

The growth and the yield of the first crop of tea: The growth of new shoot was investigated by plucking each unit area (50cm × 50cm). The yield of new shoot was investigated by hand plucking (strip-off plucking) of 5.4 m²(3.0 × 1.8m). The investigation was done on May 15th, 2001 in the plots of liquid fertilizer, and on May 18th in the plot of conventional fertilizer.

The chemical composition of crop: Total nitrogen, total amino acids and tannin of new shoot of first crop were analyzed by the method of Ikegaya et al.1)

The quality of crude tea: It was evaluated by the method of sensory quality test.

Results and Discussion

(1) The growth and the yield of the first crop of tea

The growth state of new shoot was shown in Figure 2. It was clearly better in liquid fertilizer plot than in conventional fertilizer plot.

The first shoot growth investigated by plucking of unit area was shown in table 1. The lengths of new shoot in both liquid fertilizer plots were equal to or more than 5cm longer than that in conventional fertilizer plot. There were more numbers of opened leaves in liquid fertilizer plots than in conventional fertilizer plot by 1 sheet. And the weights of 100 new shoots in liquid fertilizer plots were equal to or more than 30g heavier than that in conventional fertilizer plot. There was no difference about the rate of banjhi shoot and the thickness of leaf.

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1) Nitrogen concentration of liquid fertilizer in different time
Left: 25gN/m² as liquid fertilizer
Center: 50gN/m² as liquid fertilizer
Right: Conventional fertilizer

Fig. 2 Difference of growth of new shoot (May 15th, 2001)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number of new shoot</th>
<th>Length of new shoot (cm)</th>
<th>Number of opened leaves</th>
<th>Weight of 100 new shoots (g)</th>
<th>Rate of banjhi shoot (%)</th>
<th>Thickness of leaf (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid 25-N</td>
<td>466</td>
<td>23.0</td>
<td>6.0</td>
<td>127.9</td>
<td>89.9</td>
<td>186.4</td>
</tr>
<tr>
<td>Liquid 50-N</td>
<td>572</td>
<td>21.3</td>
<td>6.1</td>
<td>131.1</td>
<td>89.9</td>
<td>190.2</td>
</tr>
<tr>
<td>Conventional</td>
<td>541</td>
<td>16.3</td>
<td>5.1</td>
<td>91.8</td>
<td>90.1</td>
<td>185.1</td>
</tr>
</tbody>
</table>

The yield of plucked new shoot in conventional fertilizer plot was 759g/m² (Figure 3). On the other hand, the yield was 1,074g/m² (142% to conventional) in the plot of 25gN/m² as liquid fertilizer, and was 1,215g/m² (160% to conventional) in the plot of 50gN/m².

As a result, it was found that the growth of tea tree and yield in liquid fertilizer plots were better than those in conventional fertilizer plot even in the plot of 25Ng/m². In 2000, the summer temperature was high, and the amount of rainfall was little. So, there was a tendency of drought. Moreover, the rainfall in spring of in 2001 was also little. Therefore, supplying liquid fertilizer under the canopy was effective not only because of its fertilizer effect but also of the moisture supply effect. These two effects caused such a big growth difference synergistically.

(2) The chemical composition of first new shoot and the quality of crude tea

The chemical composition of first new shoot was shown in table 2. There was not so much difference about total nitrogen content. The content of total amino acids was 4.0% in the plot of 25gN/m² as liquid fertilizer, and was 4.4% in the plot of 50gN/m², while it
was 3.1% in the plot of conventional fertilizer. The content of tannin was little in liquid fertilizer plots and much in conventional fertilizer plot.

The evaluated quality scores by the method of sensory test of crude tea are shown in Table 3. The total score of 25gN/m² as liquid fertilizer treat was 94.3 and that of 50Ng/m² treat was 94.8. The total score of these two liquid fertilizer treats were higher than that of conventional fertilizer treat. As to each quality item, the scores of aroma, taste and color of infused leaves of liquid fertilizer treats were higher than those of conventional fertilizer treat.

### Table 2 Chemical composition of first new shoot

| Treatment | Total nitrogen | Total amino acid | Tannin (d.b.%)
|-----------|---------------|-----------------|-----------
| Liquid 25-N | 6.2 | 4.0 | 8.5
| Liquid 50-N | 6.4 | 4.4 | 8.4
| Conventional | 6.1 | 3.1 | 10.5

### Table 3 Evaluated score by the method of sensory quality test of crude tea

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Appearance</th>
<th>Aroma</th>
<th>Color of Liquor</th>
<th>Taste</th>
<th>Color of infused leaves</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid 25-N</td>
<td>17.0</td>
<td>19.5</td>
<td>18.8</td>
<td>19.0</td>
<td>20.0</td>
<td>94.3</td>
</tr>
<tr>
<td>Liquid 50-N</td>
<td>19.5</td>
<td>19.3</td>
<td>17.3</td>
<td>18.8</td>
<td>20.0</td>
<td>94.8</td>
</tr>
<tr>
<td>Conventional</td>
<td>17.3</td>
<td>17.0</td>
<td>18.3</td>
<td>16.5</td>
<td>18.0</td>
<td>87.0</td>
</tr>
</tbody>
</table>

As a result, the liquid fertilizer application not only increase the yield of the first crop but also improve the quality of crude tea. The reasons of this results are (1) the synergy effect of fertilizer and water made tea plant vigor and the amount of nutrient accumulation in the tree became much, (2) the nutrients were sufficiently absorbed in the growing period of first flush. (3) the ammonium nitrogen which was more effective for the growth of tea plant was supplied smoothly by using the liquid fertilizer of urea form.

In conclusion, it can be said that liquid fertilizer supply under the canopy little by little to rhizosphere can suppress nitrogen leaching and promote the healthy growth of tea plant. It is also suggested that such a liquid fertilizer application method will become very effective in order to reduce the application amount of nitrogen fertilizer maintaining yield and quality of tea.

**Literature Cited**