Comparison between Ammonium-Nitrogen and Nitrate-Nitrogen on the Effect of Tea Plant Growth

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The principal chemical sources of nitrogen which can be utilized by crop plants are ammonium-nitrogen (NH_4-N) and nitrate-nitrogen (NO_3-N). As to the comparative studies on the absorption and utilization of the nitrogen of these two sources, many investigations have been carried out with various crop plants.

The author et al. had also made a preliminary comparative study of these two sources of nitrogen with some young tea plants by the sand culture test[1].

As the result, NH_4-N gave better growth than NO_3-N, and the growth was affected by the pH of media; that is, at the range of pH from 3 to 6.5, NH_4-N gave better growth when the pH of medium was higher, while NO_3-N showed no difference in any value of pH.

The author had also carried out a comparative fertilizer response test with ammonium-nitrogen fertilizer (ammonium sulphate) and nitrate-nitrogen fertilizer (calcium nitrate)[2] by the soil culture test, and as a result, ammonium-nitrogen fertilizer rendered better growth.

Since nitrogen is the most important component among the nutritive elements for tea plant, the chemical source of nitrogen must be examined fundamentally in detail. Though it is necessary to carry out the examination under the most possible conditions, the effects of the concentrations of nitrogen, phosphorus and potassium were examined by the sand culture test with the Wagner pot of a/2000 this time.

Effect of nitrogen concentration[3]

The chemical sources of nitrogen in culture solution were NH_4-N and NO_3-N, and their concentrations were set to be 0 (for contrast), 25, 50 and 100 ppm respectively. The concentrations of phosphorus and potassium were set to be 25 ppm, and the compositions of other elements were set to the constant as described in the former report[1]. The pH of culture solution was adjusted to be 5.

The culture was carried out from May 1963 to September 1964, and growth, assimilation, respiration, enzyme activities and leaf analysis were investigated. The amounts of the inorganic components of each organ of the examined tea plant were investigated when the experiment was finished.

1) Growth

As Fig. 1 shows, the growth of the plant

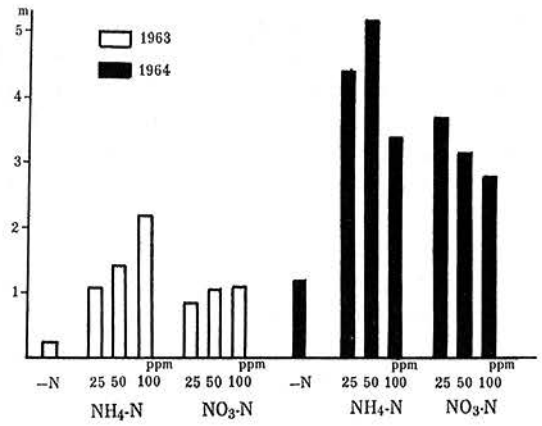

Fig. 1. Growth amount (total length of branches)

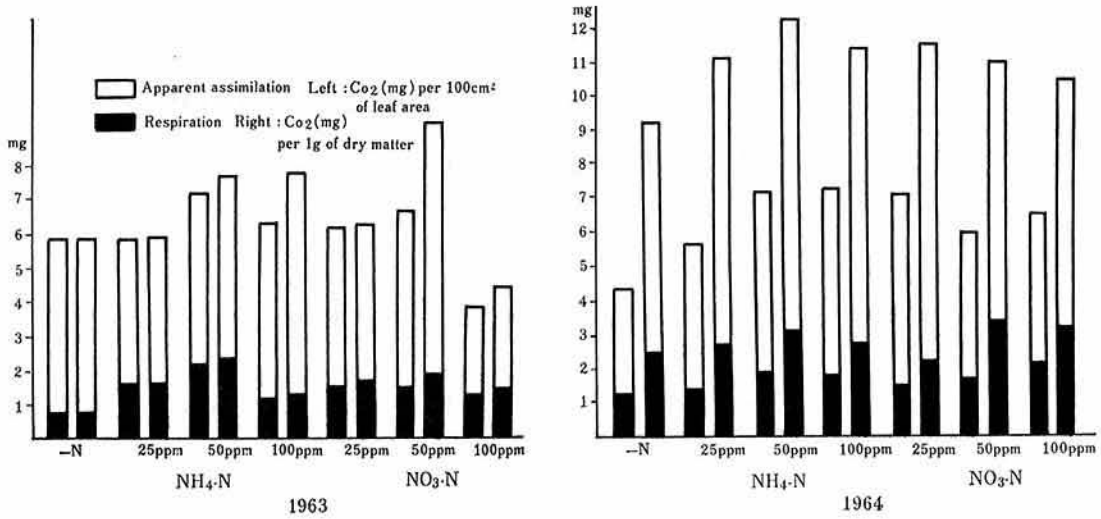

Fig. 2. Net assimilation

applied with no nitrogen was very bad, and chlorosis appeared on the plant. The growth of the plant applied with NH_4-N was better than that applied with NO_3-N. In the first year of the experiment, growth became better according to the increase of nitrogen concentration without any difference between both chemical sources, but in the second year, the growth of the plant applied with high concentration nitrogen of both sources declined.

2) Amounts of assimilation and respiration

Fig. 2 shows the amounts of assimilation and respiration determined with an infrared gas analyzing apparatus; namely, even the plant applied with no nitrogen carried out assimilation but its respiration amount was little. In the comparison of both chemical sources of nitrogen, the amounts of assimilation and respiration of the plant applied with NH_4-N were generally more than that applied with NO_3-N. This is the same trend as the growth.

3) Enzyme activities

The polyphenol-oxidase activities of copper enzyme and the catalase activities of iron enzyme, which are presumed to be easily affected by management practices, were determined for comparison. Both of the enzymes revealed higher activities in the plant applied with NH_4-N than that applied with NO_3-N.

But in respect of the nitrogen concentration, the activities increased according to the increase of nitrogen concentration in the plant applied with NO_3-N, and especially the increase of catalase activity was remarkable. On the contrary, the enzyme activities of the plant applied with NH_4-N declined at the excessive high concentration of nitrogen, and the catalase activity declined distinctiviely in such case.

4) Chemical components of tea leaf

The total nitrogen, chlorophyll, sugar (reducing sugar, non-reducing sugar), starch, tannin and inorganic component of the tea leaf were determined. In the tea plant leaf applied with NH_4-N, the total nitrogen was contained more abundantly and its increasing rate was also high in accordance with the increase of the concentration of the nitrogen applied.

The plant applied with NH_4-N contained more reducing sugar and that applied with NO_3-N contained more non-reducing sugar, while the content of starch showed no fixed tendency. Tannin was contained more in the plant applied with NH_4-N. Though in the plant applied with NH_4-N, tannin increased according to the increase of nitrogen concentration, it decreased reversely according to

the increase of nitrogen concentration in the plant applied with NO_3-N.

There were some inorganic components which revealed distinct different contents by the difference of the chemical source of the nitrogen applied, that is, manganese and aluminum were detected far more in the plant applied with NH_4-N. Potassium contents decreased according to the increase of the concentration of applied nitrogen, and this trend was recognized more remarkably in the plant applied with NH_4-N.

The calcium contents of the plant applied with NH_4-N decreased also according to the increase of nitrogen concentration. Magnesium contents decreased in accordance with the increase of nitrogen concentration in the plant applied with nitrogen of any source.

Effect of the concentrations of phosphorus and potassium[4]

Two chemical sources of nitrogen were used for the preparation of culture solution, NH_4-N and NO_3-N, and the nitrogen concentrations of solution were set to 50 ppm and 100 ppm in both sources. And the concentrations of phosphorus and potassium in the solution were determined to be 25 ppm and 50 ppm for comparison. The culture was carried out from May 1965 to September 1966, and the growth and development of tea plant and its chemical components were investigated.

1) Growth investigation

The growth of the plant applied with NH_4-N was better than that applied with NO_3-N, and all the plants applied with NO_3-N showed chlorosis as shown in Fig. 3.

As to the relation between nitrogen sources and the concentrations of phosphorus and potassium, the growth of the plant applied with NH_4-N was slightly better when the concentrations of phosphorus and potassium were 25 ppm, but when these concentrations were 50 ppm, the growth of the plant applied with NH_4-N of 100 ppm was remarkably better than that of 50 ppm.

On the contrary, the growth of the plant applied with NO_3-N of 100 ppm was inferior to that of 50 ppm, and the increased concentrations of phosphorus and potassium rendered no influence on the growth.

2) Chemical components

The chlorophyll, sugar (reducing sugar, non-reducing sugar) total nitrogen and inorganic component of the tea leaf (adult one) were determined.

As for the plant applied with NH_4-N, leaf contained more chlorophyll, and the higher the nitrogen concentration, the more the chlorophyll contents. But the chlorophyll contents of the plant applied with NO_3-N showed a

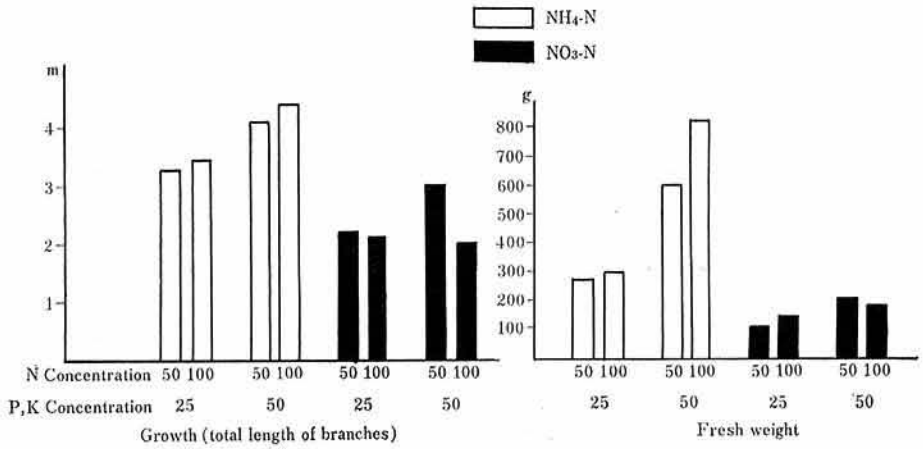

Fig. 3. Growth investigation

trend to decrease according to the increase of nitrogen concentration. Sugar contents showed a tendency to increase according to the increase of the concentration of nitrogen of both sources, and this tendency was recognized very distinctively on the non-reducing sugar of the plant applied with NO_3-N.

in the aerial part than the subterranean one of the plant applied with NH_4-N, while it was higher in the subterranean part than the aerial one in the case of NO_3-N.

The iron content was more abundant, especially in the root, in the case of NH_4-N than that of NO_3-N, and the aluminum content was

Table 1. Inorganic components (dry matter %) of tea leaf (adult)

Plot No.	Source of nitrogen	Concentration (ppm) N	P	K	Total nitrogen	Phosphorus acid	Potassium	Calcium	Magnesium	Manganese	Iron	Aluminum
					%	%	%	%	%	%	%	%
1	NH_4-N	50	25	25	2.47	0.95	1.27	0.77	0.59	0.175	0.020	1.12
2		100	25	25	3.60	1.05	1.08	0.58	0.66	0.198	0.029	1.30
3		50	50	50	2.88	1.90	1.84	0.62	0.39	0.249	0.027	1.16
4		100	50	50	3.21	1.83	1.61	0.66	0.35	0.148	0.035	1.07
5	NO_3-H	50	25	25	1.92	2.00	1.64	1.44	0.68	0.063	0.014	0.17
6		100	25	25	2.66	1.02	1.53	1.56	0.57	0.053	0.015	0.12
7		50	50	50	2.28	2.30	1.94	1.60	0.36	0.097	0.016	0.15
8		100	50	50	2.42	1.60	1.89	1.65	0.46	0.105	0.021	0.13

Table 2. Inorganic components (dry matter %) of root

Plot No.	Source of nitrogen	Concentration (ppm) N	P	K	Total nitrogen	Phosphorus acid	Potassium	Calcium	Magnesium	Manganese	Iron	Aluminum
					%	%	%	%	%	%	%	%
1	NH_4-N	50	25	25	1.52	0.66	2.66	0.07	1.66	0.048	1.094	1.78
2		100	25	25	1.68	0.68	2.21	0.09	1.56	0.035	1.630	2.10
3		50	50	50	1.68	0.88	2.67	0.07	1.38	0.033	1.129	1.25
4		100	50	50	1.72	0.89	2.53	0.09	1.26	0.028	1.323	1.82
5	NO_3-N	50	25	25	1.52	1.00	2.09	0.20	1.63	0.095	0.183	0.89
6		100	25	25	1.65	1.00	2.18	0.37	1.52	0.086	0.239	0.78
7		50	50	50	1.50	1.02	2.39	0.20	1.47	0.059	0.217	0.35
8		100	50	50	1.58	1.05	2.47	0.28	1.28	0.083	0.217	0.32

Table 1 (adult leaf) and Table 2 (root) show the total nitrogen and inorganic components contained in each organ of the tea plant.

The amount of total nitrogen was more abundant in the aerial and subterranean parts of the plant applied with NH_4-N, and it increased according to the increase of nitrogen concentration. And this increasing rate was higher in the case of NH_4-N than that of NO_3-N. The manganese content was higher

more abundant in the aerial and subterranean parts of the plant applied with NH_4-N than the case of NO_3-N.

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