STUDIES ON THE SOILS OF APPLE ORCHARDS IN JAPAN. III

ON THE PROPERTIES OF SOILS UNDER GRASS SOD

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In Japan most of orchards have been so far cultivated under the clean tillage system. Orchard soils have always been kept in a bare state, and grasses, not to mention weeds, have been considered undesirable. For this reason it may be concluded that farm cultivation in Japan is mainly that of rice culture and upland crops, in a limited area with a lot of manual labour. The same is true of fruit culture. It may be noticed, too, that Japanese farmers are fastidious in land cultivation.

Recently much importance has been attached to culture system under sod. The sod plot of the Aomori Apple Experiment Station is a case in point. It has been under grass sod for a decade or more. The yield of the plot has been better than any other experimental plot.

Japan is a narrow island with mountains rising one above the other. Its land pattern is commonly hilly and mountainous with large numbers of steep slopes upon which fruit trees are grown. Moreover, Japan is a very rainy country and large areas are susceptible to soil erosion by rain. These are reasons why constant watch must be taken for soil erosion. For the purpose of controlling such soil erosion, grass sod again is very significant.

As mentioned above, grass sod is beneficial in the control of soil erosion and in the promotion of soil productivity. The purpose of the present study is to obtain some information on the increase of soil productivity by sod. Soil conservation has not been taken into consideration.

Experimental Procedure

The soil samples used in this study were obtained from the experimental plots of the Aomori Apple Experiment Station. They are the surface soil and subsoil of the sod plot in which red clover was grown and the soils of a ordinary plot which was left in a bare state. The soils may be classified in ando soils.

Analyses on the physical and chemical properties in general were conducted in accord with the ordinary procedure adopted in Japan.

For ammonification experiment 1% peptone solution was used as a culture medium. 100 cc. of the solution were taken into 300 cc. ERLNMFYER flasks and sterilized. Control experiment was carried out

in this and in the following three microbial experiments. 3 gm. of soil sample were put in the flasks and kept at 30°C. After a week the ammoniacal nitrogen content was determined. The ammoniacal nitrogen formed was obtained by subtracting the ammoniacal nitrogen in the control culture from that of the nitrogen in the incubated one.

The composition of the medium used for the nitrification experiment was:

Ammonium sulphate 3 gm. Potassium biphosphate 2 gm. Water 1L.

40 cc. of the medium was put in a 300 cc. ERLNMEYER flask and sterilized. 3 gm. of soils were added to it. It was kept at 30°C for 3 weeks. Then, the nitrate formed was determined. By subtracting the nitrate nitrogen of the control culture from that of the nitrogen of incubated one, the nitrified nitrogen content was calculated.

For the experiment of free nitrogen fixation ASHBV's medium was used. Its composition is as follows:

Mannit	15 gm.
Potassium biphosphate	0.2 gm.
Magnesium sulphate	0.2 gm.
Sodium chloride	0.2 gm.
Calcium sulphate	0.1 gm.
Calcium carbonate	5 gm.
Water	1 L.

100 cc. aliquots of this liquid media were placed in 500 cc. ERLNMEYER flasks and sterilized. 3 gm. of soils were put into the flasks and incubated at 30°C for 3 week. At the end of the term the total nitrogen was determined. The fixed nitrogen was obtained by subtracting the nitrogen of the control culture from the nitrogen of the incubated one.

The liquid medium used for cellulose decomposition was:

Potassium biphosphate	1 gm.
Magnesium sulphate	1 gm.
Sodium carbonate, anhydrous	1 gm.
Ammonium sulphate	2 gm.
Calcium carbonate	2 gm.
Tap water	1 L.

One sheet of No. 3 filter paper made by Tokyo Roshi Company was placed in each of the 300 cc. ERLNMEYER flasks and 100 cc. of the above solution were placed in it, and then sterilized. 3 gm. of

soil were put into the flasks and kept at 30°C for 3 weeks. At the end of the term the contents were taken out and centrifuged. The precipitate was treated with SCHWEIZER's reagent, and the cellulose dissolved. Then, the solution was centrifuged. A certain portion of the supernatant solution was acidified with sulphuric acid, and cellulose reprecipitated. The precipitated cellulose was separated by filtration, dried, and weighed. The discrepancy between the weight of cellulose obtained in the control culture and the weight of the cellulose in

the incubated one shows the amount of decomposed cellulose.

All the above microbial experiments were carried out in triplicate ways and the mean values obtained are shown in the table.

The aggregate analysis was conducted by YORDER's method⁽¹⁾ revised by the Institute of Agricultural Chemistry of Kyoto University.

Results and Discussion

The data obtained in the general physical and

Table 1. General Physical and Chemical Properties of Soils

		pH	Organic	Humus	N	C:N	1/5 N HCl soluble		Base Exchange
			C				P ₂ O ₅	K ₂ O	Capacity
			%	%	%		%	%	m. e. /100 gm.
Sod Plot {	Surface soil	4.90	5.93	10.22	0.466	12.72	0.0105	0.028	43.85
	Subsoil	4.95	2.94	5.06	0.362	8.12	0.0030	0.095	25.44
Ordinary Plot {	Surface soil	5.22	5.24	9.04	0.491	10.66	0.0151	0.074	30.89
	Subsoil	5.74	1.65	2.85	0.223	7.39	0.0020	0.027	16.93

chemical analyses are shown in Table 1.

The pH values are lower in the sod plots soils than in the ordinary plot soils, and lower in surface soils than in the subsoils of both plots.

Organic carbon—the humus contents are generally large in amount. The humus contents of the two soils of the sod plot are higher than the content of corresponding soils of the ordinary plot. In both plots, the nitrogen content of the surface soil is richer than that of subsoils.

As to available phosphorus, no distinct difference

is found between the surface soils of both plots, and the same true of the subsoils. As to available potash, the contents in the surface soils are larger in amount in the ordinary plot than in the sod plot. In subsoil the contents are reversed.

The difference in exchange capacity may be possibly due to the difference in humus contents.

As mentioned above, the contents of nitrogen, phosphorus and potash are, in some cases, rather less in the sod plot than in the ordinary plot. From these results the beneficial effect of sod can not be

Table 2. Microbial Actions of the Soils

		Ammonification	Nitrification	Nitrogen Fixation	Cellulose Decom-
		NH ₃ -N	NO ₃ -N	Fixed N	position, Cellulose Decomposed
Sod Plot {	Surface soil	88.48 mg	0.142 mg	6.12 mg	338.1 mg
	Subsoil	75.86	0.137	4.04	193.1
Ordinary Plot {	Surface soil	80.43	0.043	5.24	310.5
	Subsoil	64.74	0	2.34	55.0

explained.

The data from the microbial experiments are given in Table 2.

Microbial action is more active in the surface soil than in the subsoil.

Ammonification in the surface soil and subsoil of the sod plot is found in a higher degree than in the corresponding soils of the ordinary plot. Nitrification in the surface soil of sod plot is about three times higher in degree than that of the ordinary plot. The subsoil of the ordinary plot shows even zero value. Fixed nitrogen of sod plot soils is larger in amount than that of the corresponding ordinary plot soils. Similarly, cellulose is found more decom-

posed in the soils of sod plot than in the soils of the ordinary plot.

As stated above, the microbial properties of sod plot soils are superior to those of the ordinary plot soils, and nitrification is most noticeable among these four microbial actions. Formerly the author studied some microbial action—ammonification, nitrification, and nitrogen fixation—on Japanese soils and Manchurian soils, found Manchurian soils to be superior to Japanese soils, and concluded that the difference might be attributed to soil reaction.⁽²⁾ In the present study a more acidic reaction is found in the sod plot soils than in the ordinary plot soils. It may be concluded that the action by grass roots

has made the soil conditions favourable to the microbial activity.

The data from the aggregate analyses are shown in Table 3.

Table 3. Result of Aggregate Analyses of Soils

	Aggregation Coefficient
Sod Plot { Surface soil	43.7%
{ Subsoil	39.9
Ordinary { Surface soil	21.0
Plot { Subsoil	37.6

From the result shown in Table 3, grass roots gave good effect on soil texture and soil particles are favourably aggregated. Many studies have been carried out on the increase of soil aggregate by sod. Aggregates correlate with the time of sod and humus contents. The results will be favourable on soil erosion control, too.

In conclusion, clover sod may give some good soil conditions to the root growth of fruit trees.

Summary

For the apple orchards in Aomori Prefecture, clover sod has been extensively used recently. The culture system is beneficial not only to the yield and the quality of the fruit, but also to the protection of soil erosion. The experimental results conducted on the soils of grass sod and ordinary plot

may be summarized as follows:

The humus content and base exchange capacity are little higher in the sod plot soils than in the ordinary plot soils. But soil reaction is more acidic in the sod soils than in the ordinary plot soils, and on nitrogen, available phosphorus and potash contents no significant difference is found between the two soils.

On the microbial action studied, ammonification, nitrification, nitrogen fixation and cellulose decomposition in the sod plot soils are distinctly superior to those in the ordinary plot soils. Nitrification is the most distinct of the four.

On aggregate analysis the higher degree of aggregation is found in the sod plot soils than the ordinary plot soils.

The favourable effect of clover sod will be partly attributed to the above results.

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