

Soil Management through Green Manure Crop Cultivation Prior to Tea Plantation

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Abstract

*This study was performed to analyze the improvement of soil physical property and soil biota characteristics through cultivation of green manure crops for a one-year period before creation of a tea plantation as follows. The study revealed that the contents of available phosphate tended to decrease after sod-culture by green manure cultivation and open-pollination, when compared to the level before cultivation. The ratio soil porosity increased by approximately 30% when *Crotalaria juncea* and *Sorghum bicolor* L. Moench were cultivated, while the soil bacteria and fungi also increased. In a research on microfauna using a pit fall trap, the population number of the microfauna was 174 of 27 species in the plot of open-pollinated sod-culture and no organic matter application, and 268 of 26 species in the plot of *Sorghum bicolor* L. Moench. Consequently, the culturing tool of *Crotalaria juncea* recorded the highest level of species diversity at 2.5, the evenness index at 3.7 and richness at 4.6, with the lowest level of a dominance index. The ecological quotient of microfauna was 0.76 in the plot of *Sorghum bicolor* L. Moench, and 0.63 in the plot of *Crotalaria juncea*.*

Introduction

Camellia sinensis L. is a perennial heavy fertilizing crop, and requires well-managed soil physical property, such as soil fertility, air-permeability in the root zone, and good drainage for environmentally friendly organic cultivation. This study was performed with the aim at improving the soil physicochemical property, microorganisms, and soil biota by applying green manure crops and organic compost before planting *Camellia sinensis* L. for organic cultivation.

Materials and methods

Organic matter input and green manure crop cultivation

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The study was performed in 2010 at field of Tea Research Institute Jeollanamdo Agricultural Research and Extension Services, situated in south-western Korea. A field where crops had not been cultivated for two years was used as an experimental plot, and the experiment was performed on 6a of land in a single block design. The plot size was 7 m x 30 m. The green manure crops of *Crotalaria juncea* and *Sorghum bicolor* L. were harvested, and organic matter was applied to be ploughed into the soil.

Tab. 1: Input of organic matter and cultivation of green manure crops

Treatment	Green manure crop	Organic matter (kg/10a)	Others
T1	<i>Crotalaria juncea</i> + <i>Vicia Villosa</i>	Organic Matter 2,000	- Green manure seeding rates (kg/10a)
T2	<i>Sorghum bicolor</i> L. +Rye	Organic Matter 2,000	<i>Crotalaria Juncea</i> 8, <i>Vicia Villosa</i> 5, <i>Sorghum bicolor</i> L. 5, Rye 12
T3	Open-pollinated sod culture	No-application	

* Green manure seeding date: *Crotalaria juncea* and *Sorghum bicolor* L. on June 1, 2010; *Vicia Villosa*, and rye on Oct. 13, 2010.

* Green manure harvest date: *Crotalaria juncea* and *Sorghum bicolor* L. on Sept. 24, 2010.

* Date of organic matter application and green manure input: Oct. 12, 2010.

Soil physicochemical property analysis

In order to analyze the soil physicochemical property, the top soil and subsoil of each plot were collected before and after green manure crops were planted. The ratio soil porosity and soil chemical property were analyzed from the soil samples.

Soil microbial analysis

Soils were collected before green manure crops were planted (on Apr. 27) and after green manure crops cultivated and harvested for application (on Sept. 30). The soil samples were analyzed for the density of bacteria, actinomycetes and fungi.

Biodiversity of soil micro organism

Microorganism was captured twice a month (From June to September) by using a pit fall trap of a 10cm diameter, and was examined to find out the species diversity.

Results

Soil physicochemical property

The soil physical property improved after green manure cultivation and sod-culture. In particular, the ratio soil porosity rose by 30% from the cultivation of *Crotalaria juncea* and *Sorghum bicolor* L. Moench (Fig. 2). With regard to the soil chemical property, the total contents of nitrogen increased after cultivating green manure crops, while available phosphate decreased. In addition, the exchangeable K dropped, whereas exchangeable Ca and Mg increased. At 60cm-deep subsoil, the level of exchangeable cation was the highest in the *Crotalaria juncea* culturing tool (Tab. 4).

Changes in soil microorganism

After cultivating green manure crops, the number of soil bacteria as well as fungi increased. The B/F rate also went up in the plot of *Sorghum bicolor* L., from 4% to 67%. The ecological quotient of soil microfauna was 0.76 in the plot of *Sorghum bicolor* L., and 0.63 in the plot of *Crotalaria juncea*. The outcome of soil microfauna capture using a pit fall trap is described in Tab. 6, which shows a high level of species diversity and evenness index in the green manure nurturing tool.

Tab. 2: Soil physical property of experimental field before and after planting green manure crops

Treatment	Sampling depth	Bulk density (g/cm ³)	Three phases of soil (%)			Porosity (%)	Porosity Increase (%)
			Solid phase	Liquid phase	Gaseous phase		
Crotalaria Juncea	before	top soil	1.50	57.7	22.5	19.8	42.3
	after	top soil	1.20	45.1	47.6	7.31	54.9
	after	60 cm	1.48	55.9	25.5	18.5	44.1
Sorghum bicolor L.	before	top soil	1.50	56.4	22.9	20.7	43.6
	after	top soil	1.15	43.4	50.9	5.75	56.6
	after	60 cm	1.46	55.1	31.7	13.2	44.9
Open-pollinated	before	top soil	1.40	54.4	18.8	26.7	45.6
	after	top soil	1.30	49.2	45.3	5.46	50.9
	after	60 cm	1.51	57.0	33.1	9.90	43.0

Tab. 3: Soil chemical property before planting green manure (top soil)

Treat.	T-N (%)	pH (1:5)	OM (g/kg)	Av.P ₂ O ₅ (mg/kg)	Exchangeable cation (cmol ⁺ /kg)			CEC (cmol ⁺ /kg)	EC (dS/m)
					K	Ca	Mg		
T2	0.080	6.79	19.0	233	1.70	0.93	1.41	5.87	0.175
T3	0.060	6.61	13.7	262	1.97	1.08	1.39	5.33	0.147

Tab. 4: Soil chemical property after planting green manure (top soil)

Treat.	T-N (%)	pH (1:5)	OM (g/kg)	Av.P ₂ O ₅ (mg/kg)	Exchangeable cation (cmol ⁺ /kg)			CEC (cmol ⁺ /kg)	EC (dS/m)
					K	Ca	Mg		
T2	0.077	6.85	23.0	175.0	0.43	4.66	1.81	9.38	0.235
T3	0.070	6.82	20.0	192.3	0.36	4.23	1.34	8.14	0.208

Tab. 5: Outcome of soil microbial analysis before and after green manure crops treatment

Treat.		No. of Microorganisms (CFU/g dry soil)			B/F (%)
		Bacteria(B) ($\times 10^7$)	Fungi(F) ($\times 10^4$)	Actinomyces(A) ($\times 10^6$)	
T1	Before	1.36	0.25	6.7	550
	After	13.52	2.61	8.8	519
T2	Before	0.07	2.02	5.9	4
	After	2.60	3.89	6.8	67
T3	Before	0.60	3.90	7.7	15
	After	3.23	4.18	10.2	77

* Date of soil capture: On Apr. 27 before treatment and on Sept. 30 after treatment.

Tab. 6: Biodiversity of soil micro organism in a pit fall trap

Treat.	Species number	Population number	Species diversity	Evenness index	Richness index	Dominance index
T1	26	223	2.518	3.741	4.623	0.390
T2	26	268	2.459	3.529	4.471	0.433
T3	27	174	2.447	3.450	5.040	0.414

Tab. 7: Weeds and dominance species in soil

Green manure crops	Number of weeds species	Dominance species
<i>Crotalaria Juncea</i>	7	<i>Digitaria ciliaris</i> (Retz.) <i>Setaria viridis</i> (L.) <i>Justica procumbens</i> L.
<i>Sorghum bicolor</i> L	8	<i>Digitaria ciliaris</i> (Retz.) <i>Echinohloa crus-galli</i> (L.) <i>Setaria viridis</i> (L.)
Open-pollinated	13	<i>Digitaria ciliaris</i> (Retz.) <i>Setaria viridis</i> (L.) <i>Commelina connunis</i> L. <i>Acalypha australis</i> L.

Discussion

The research will continue to be performed to keep track of the changes in the improvement of soil physicochemical property on an annual basis through a cultivation of organic matter and green manure crops prior to the creation of a tea plantation.

Conclusions

As a result of the cultivation of green manure crops for one year prior to creation of a tea plantation, it was revealed that the contents of available phosphate tended to decrease after sod-culture by green manure cultivation and open-pollination. The ratio soil porosity increased by approximately 30% when *Crotalaria juncea* and *Sorghum bicolor* L. were cultivated, while the soil bacteria and fungi also increased. In the examination on micro organism using a pit fall trap, the number of the species increased; and the species diversity was also high in the plot of *Crotalaria juncea*.

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