Physico-chemical properties between organic and conventional kiwifruit orchards in Korea

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Key words: organic, kiwifruit, soil, nutrient

Abstract

Organic kiwifruit orchard soils were compared with conventional ones in Korea. Soil structure of organic soil had higher gaseous and liquous phase as well as soil porosity in the surface soil. Although the nutritional level of each orchards were quite different among soils, the analysis of both system revealed that organic kiwifruit orchard soil had similar or even higher nutrient level (N and organic matter content in surface soil) compared to conventional ones. The organic matter content of deep soil also had the high tendency in deep soil of organic soil. Higher level of nitrogen in organic surface soil is presumably due to the excessive application of organic compost and liquid fertilizer rather than the contribution by grasses such as green manure. Available phosphorous level of organic system was quite high but similar in surface soil of both system, compared to the recommended level. Potassium, calcium and magnesium levels were also enough in organic kiwifruit orchard soils.

Introduction

One of the concerns in organic kiwifruit production will be soil fertility management as other organic crops (Hasey *et al.* 1995, Davis and Abbott 2006). In Korea, there are very small numbers of organic kiwifruit growers (about 24 vs. 2,500 conventional growers in total, unpublished survey data by Fruit Research Institute, 2010). So, most of organic growers did not receive much interest on soil management by research sector in Korea. As the yield of kiwifruit reaches 20 up to 30 tonnes per ha recently so the nutrient loss with fruits is expected to be high if there is enough input for the nutrient loss. Although the recommended standard fertilization amount of each nutrients application were well set out in conventional production system (Hasey *et al.* 1995, Song *et al.* 2008), the soil nutritional conditions under organic management was not investigated in Korea. This survey was carried out to diagnose current soil nutritional conditions of organic kiwifruit orchards and support organic kiwifruit growers.

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Materials and methods

4 organically-certified and 5 conventional kiwifruit orchard soils were chosen to evaluate the physical properties and chemical characteristics. Most soil types were sandy loam or loam. All the orchards were at least 20-year old up to 32-year old. Among them, organic orchards were managed for 5 to 20 years organically. Generally organic soils were given organic compost in winter as basic fertilizer and some plant extracts formulas during growing season as additional fertilizer (Tab. 1). Both organic and conventional orchards returned the pruned shoots and branches into orchard soil by leaving them right after pruning. Organic orchards were separated by wind breaking nets (using less $2mm^2$ net, 5m high net wall sometimes roof covered), agricultural roads (3 to 3.5m wide) and trenches (1m wide and deep) around orchard block. Sampling was done on mid November 2010. Stainless cylindrical cores ($100cm^3$, 2 inches in diameter) were used for sampling and soils were measured according to ASTM procedure (ASTM 2010). Soil hardness on surface soil was measured by Yamanaka soil hardness tester. For the analysis of soil chemicals, surface (between 0 and 15cm under soil surface) and deep (between 15 and 30cm) soils were collected, aerated for 1 week in room temperature and analyzed by the soil chemical analysis manual of RDA (RDA 1988), which included CN-analyzer (Vario Max) for organic matter and total nitrogen, Lancaster method for available phosphate, UV-spectrophotometer (Perkin Elmer 7300 DV) for exchangeable cations.

Tab. 1: Comparative fertilization and soil management practices between organic and conventional kiwifruit orchard

Practices	Organic	Conventional
Main compost materials and composting procedure	Cow or pig manure mixed with rice straw and bran, composted with occasional aeration under cover for 6 to 7 months	Same as organic
Amount of applied fertilizer per ha	25 tonnes compost, liquid fertilizer extracted from wild herbs 10 to 15 times sprayed on vine per season	15 tonnes compost, 25kg NPK or NK applied 2 times
Soil surface management	Previously rye (*Secale cereal*) sown for 2-3 years, currently native herbs cut and mulched 2-3 times per year	Rye sown or herbicide sprayed 2 times per year

Results and Discussion

Organic soil showed lower solid phase, similar level of liquous phase and higher gaseous phase (Tab. 1). The ratio of soil porosity of organic soil was also higher than that of conventional. Surface soil hardness was not different between organic and conventional soil. This higher soil porosity of organic soil could be the results from more input of organic compost and no use of herbicides. More compost and no herbicide use would create better soil environment where microorganisms and small soil animals to be more prosperous, form eco-balance therefore increase small animal population to furrow soil, leading better soil structure than conventional ones (Mäder *et al.* 2002, Pulleman *et al.* 2003). Soil pH was similar in both systems even if there were 2 orchards to exceed pH 6.5 (recommended maximum) (Tab. 2). However, total-N and organic matter content was higher in organic soil than conventional in surface soil although there were no different between both system in deep soil. The organic matter content in deep organic soil seemed to be high but was not significant statistically.

Available P and exchangeable cations were similar level. The each nutrient levels of both system were above the recommended level in kiwifruit orchard in Korea (Song *et al.* 2008). The nutrients were distributed in more surface soil than deep soil. Overall, organic soils have not less nutrients than conventional under current production system. Most organic kiwifruit orchards have not used green manure currently but used to sow rye in autumn. These levels of soil nutrients in organic kiwifruit production system coincide with previous report in New Zealand soil (Carey *et al.* 2009). One possible reason would be more organic compost and frequent liquid plant extract spray than conventional (Tab. 1). There is a tendency of putting significant amount of other nutrient sources in Korean organic kiwifruit orchards as well (unpublished document). Especially available phosphorous was very high compared to the recommended level in both systems (Tab. 2), which would be also attributed to higher external input of phosphorous sources by compost and plant extracts in organic and chemical fertilizer in conventional (Tab. 1). However, overall the soil nutritional inputs of organic kiwifruit production system even tends to exceed the removals so soil nutritional balance does not become issue at the moment (Carey *et al.* 2009). This might be due to externally sourced fertilizers such as compost, plant extracts and some other sources like fish oil because Korean and New Zealand organic orchards actively apply those farming materials but rarely have green manure in the system (Personal communication with Zespri and organic farmers).

Tab. 2: Physical property of organic and conventional kiwifruit orchard soil

Farming system	Solid phase (%)	Liquous phase (%)	Gaseous phase (%)	Soil porosity (%)	Surface soil hardness[z] (mm)
Organic	31.8	35.8	32.4	68.2	14.2
Conventional	42.3	33.3	24.4	57.7	14.6
	*	n.s	*	*	n.s

[z]Measured by Yamanaka soil hardness tester. *Significant for $P<0.05$, n.s: none significant

Tab. 3: Chemical property of organic and conventional kiwifruit orchard soil depending on soil depth

(a) Surface soil (0-15 cm depth)

Farming system	Soil pH	Total nitrogen (%)	Org. matter (g/kg)	P_2O_5[z] (mg/kg)	Exchangeable cation ($cmol^+/kg$)		
					K	Ca	Mg
Org.	6.8	0.34	69.0	1,032	1.82	12.84	4.20
Con.	6.7	0.24	45.4	1,085	1.93	11.92	3.46
	n.s	*	*	n.s	n.s	n.s	n.s
Recommended	6.0-6.5	-	20-35	200-300	0.3-0.6	5.0-6.0	1.2-2.0

[z]Available phosphorous. *Significant for P<0.05, n.s: none significant. Org.; organic, con; conventional.

(b) Deep soil (16-30cm depth)

Farming system	Soil pH	Total nitrogen (%)	Org. matter (g/kg)	P_2O_5[z] (mg/kg)	Exchangeable cation ($cmol^+/kg$)		
					K	Ca	Mg
Org.	6.4	0.22	40.0	692	1.56	8.91	2.65
Con.	6.5	0.14	26.4	539	1.61	7.20	2.24
	n.s	n.s	n.s	n.s	n.s	n.s	n.s

[z]Available phosphorous. *Significant for P<0.05, n.s: none significant. Org.; organic, con; conventional.

Conclusions

The current cultural practices shows more input of organic compost and nutrients by frequent foliar spray of plant extracts thereby Korean soils of organic kiwifruit orchards are considered they have developed better soil structure and are keeping good nutritional level. Probably some orchards need to consider reducing the application level of organic fertilizers following proper soil analysis.

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