

ORIGINAL ARTICLE

Physicochemical Properties of Topsoil Used for River Improvement and Non-Improvement Areas

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Abstract

This study was carried out to evaluate the physicochemical properties and perform a feasibility analysis of planting material composed of topsoil from river improvement and non-improvement areas. The results showed that the physicochemical properties of topsoil from river improvement areas were on the average sandy loam~loamy sand in soil texture, 5.6~6.8 in pH, 0.01~0.06 dS/m in EC, 0.9~2.1% in OM, 0.02~0.12% in T-N, 8~14 cmol⁺/kg in CEC, 0.01~0.08 cmol⁺/kg in Ex. K⁺, 2.55~11.11 cmol⁺/kg in Ex. Ca²⁺, 0.34~2.06 cmol⁺/kg in Ex. Mg²⁺, and 3~396 mg/kg in Av. P₂O₅. And non-improvement areas showed on average sandy clay loam~sand in soil texture, 5.7~6.7 in pH, 0.02~0.08 dS/m in EC, 0.9~4.4% in OM, 0.02~0.23% in T-N, 7~18 cmol⁺/kg in CEC, 0.01~0.08 cmol⁺/kg in Ex. K⁺, 3.81~12.67 cmol⁺/kg in Ex. Ca²⁺, 0.60~1.95 cmol⁺/kg in Ex. Mg²⁺, and 3~171 mg/kg in Av. P₂O₅. Meanwhile, the results of an applied valuation of topsoil-based planting were as follows. Ex. K⁺ levels were low grade in all survey areas. OM was low grade in 12 improvement areas and 11 non-improvement areas. Av. P₂O₅ levels were low grade in 10 improvement areas and 10 non-improvement areas. T-N was low grade in six improvement areas and four non-improvement areas. Ex. Mg²⁺ levels were low grade in two improvement areas.

Key words : Topsoil, River improvement, Physicochemical properties, Planting base

1. Introduction

Soil is a natural body consisting of layers that are primarily composed of minerals, mixed with at least some organic matter. So, soil is used as a planting

base, where it serves as the anchor and primary nutrient base for plants (Yoo, 2000). Soil generally consists of visually and texturally distinct layers. The "A" horizon is the top layer of the soil horizons or topsoil. Topsoil is the upper, outermost layer of soil,

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usually the top 7 cm to 25 cm. It has the highest concentration of organic matter and microorganisms and is where most of the Earth's biological soil activity occurs (Yoo, 2000). In this case, the topsoil is regarded as a bio-mantle. Meanwhile, soil quality is also referred to as soil health. Many soil properties impact soil health, but organic matter deserves special attention. Because organic matter enhances water and nutrient holding capacity and improves soil structure, managing for soil carbon can enhance productivity and environmental quality, and can reduce the severity and costs of natural phenomena, such as drought, flood, and disease. In addition, increasing soil organic matter levels can reduce atmospheric CO₂ levels that contribute to climate change. Therefore, healthy soil gives us clean air and water, bountiful crops and forests, productive grazing lands, diverse wildlife, and beautiful landscapes (Park et al., 2008).

However, in our country, we waste most of the natural resources such as topsoil, which can be found in many construction works; in most cases, we dispose of it or use topsoil in the foundations of facilities and structures. For instance, it is easy to find workers neglecting the topsoil at many construction works. The buildings and facilities have been constructed without the collection and preservation of the topsoil layer, which is a valuable natural resource. Moreover, additional fertile soil was carried out in the vanished state, without reuse of renewable fine topsoil for reclamation of the planting base. Currently, focus is placed on the topsoil layer problem, which leaves considerable room for conflicting arguments on the final planting base stage. At issue is how to collect, preserve, and recycle this valuable natural resource. The reason behind this is that there are no clear laws for how to manage topsoil, and not many people know about the importance of topsoil management, and those who know have little authority in the construction process, and therefore they can't manage the topsoil in the process (Cho and Kim, 2000; Kim

et al., 2012).

To restore the topsoil damaged due to thoughtless actions or other reasons will take a long period of time, effort, and money. Therefore, in this research the goals are to establish the techniques for the recycling of planting base materials for the establishment of ecological restoration with neglected or wasted topsoil from stream improvement projects at disturbed sites.

2. Experimental

This research was made and entered into for a period beginning the 1st day of August 2011 and ending the 30th day of September 2011, consisting of 2 months. Table 1 describes the locations of the survey sites. The scope of the investigation areas included streams of the Chungcheong region and included the Kum River, depending on the stream improvement project supervised by the Ministry of Environment. The research looked at physicochemical properties and the availability of appropriately based planting of topsoil used for river improvement areas and non-improvement areas close to improvement area.

Table 1. List of survey sites

River name	Survey site	
	Improvement area	Non-improvement area
Musim River	128/2, Pyeongchon-dong, Sangdang-gu, Cheongju-si	
Daejeon River	304, Gudo-dong, Dong-gu, Daejeon	
Daecheon River	983/94, Dongdae-dong, Boryeong-si	
Wonseong River	285/7, Yuryang-dong, Cheonan-si	
Cheonan River	339/5, Yonggok-dong, Cheonan-si	
Yesan River	382/98, Yesan-ri, Yesan-eup, Yesan-gun	
Jeongji River	258/2, Seongnim-dong, Seosan-si	
Dangjin River	562/4, Udu-ri, Dangjin-eup, Dangjin-gun	
Onyang River	332/1, Sin-dong, Asan-si	
Wolha River	586/40, Seongje-ri, Seo-myeon, Yeongi-gun	
Nojang River	400/3, Nojang-ri, Jeondong-myeon, Yeongi-gun	
Pangyo River	326/30, Sagok-ri, Seocheon-eup, Seocheon-gun	

Table 2. Soil assessment guidelines for the planting base

Division	High grade	Middle grade	Low grade
soil acidity	6.0~6.5	5.5~6.0 6.5~7.0	4.5~5.5 7.0~8.0
electrical conductivity(dS/m)	below 0.2	0.2~1.0	1.0~1.5
organic matter(%)	over 5.0	3.0~5.0	below 3.0
total nitrogen(%)	over 0.12	0.06~0.12	below 0.06
cation exchange capacity(cmol ⁺ /kg)	over 20	6~20	below 6
K ⁺ (cmol ⁺ /kg)	over 3.0	0.6~3.0	below 0.6
Ca ²⁺ (cmol ⁺ /kg)	over 5.0	2.5~5.0	below 2.5
Mg ²⁺ (cmol ⁺ /kg)	over 3.0	0.6~3.0	below 0.6
available phosphate(mg/kg)	over 200	100~200	below 100

We investigated and analyzed topsoil physicochemical properties: soil texture, soil acidity(pH), electrical conductivity(EC), organic matter(OM), total nitrogen (T-N), cation exchange capacity(CEC), exchangeable cations(Ex. cations), and available phosphate(Av. P₂O₅). There were 72 samples from 36 sites representing 12 improvement areas and 36 sites representing 12 non-improvement areas based on soil and plant analysis methods (RDA, 2000).

Meanwhile, the composition of the topsoil planting base for utilization was assessed by the applicable landscape design standards (KILS, 2007).

3. Results and discussion

3.1. Physicochemical properties of topsoil

Table 3 describes the physicochemical properties of the survey sites. The results of physicochemical properties analysis of topsoils from river improvement areas were, on average, sandy loam~loamy sand in soil texture, 5.6~6.8 in pH, 0.01~0.06 dS/m in EC, 0.9~2.1% in OM, 0.02~0.12% in T-N, 8~14 cmol⁺/kg in CEC, 0.01~0.08 cmol⁺/kg in Ex. K⁺, 2.55~11.11 cmol⁺/kg in Ex. Ca²⁺, 0.34~2.06 cmol⁺/kg in Ex. Mg²⁺, and 3~396 mg/kg in Av. P₂O₅.

And the results of the physicochemical properties analysis of topsoils from river non-improvement

areas were, on average, sandy clay loam~sand in soil texture, 5.7~6.7 in pH, 0.02~0.08 dS/m in EC, 0.9~4.4% in OM, 0.02~0.23% in T-N, 7~18 cmol⁺/kg in CEC, 0.01~0.08 cmol⁺/kg in Ex. K⁺, 3.81~12.67 cmol⁺/kg in Ex. Ca²⁺, 0.60~1.95 cmol⁺/kg in Ex. Mg²⁺, and 3~171 mg/kg in Av. P₂O₅.

As discussed above, the physicochemical properties of topsoil on river improvement areas and non-improvement areas tended to have some similarities, however for those two sites the soil quality was very poor. Therefore, our study supports the need for improvement of soil quality.

3.2 Evaluation for the use of topsoil as a planting base

The classifications of soil assessments for river improvement areas were evaluated under landscape design standards (KILA, 2007). As for the Musim River, pH, EC, and Ex. Ca²⁺ were high grade, CEC was middle grade, and the others were low grade. In the Daejeon River, pH, and EC were high grade, CEC, and Ex. Ca²⁺ were middle grade, and the others were low grade. In the Daecheon River, pH, and EC were high grade, CEC, Ex. Ca²⁺, and Ex. Mg²⁺ were middle grade, and the others were low grade. In the Wonseong River, EC, Ex. and Ca²⁺ were high grade, pH, T-N, CEC, and Ex. Mg²⁺ were middle grade, and the

Table 3. Physicochemical properties of survey sites

Division		soil texture	pH (1:5)	EC (dS/m)	OM (%)	T-N (%)	CEC (cmol ⁺ /kg)	Ex. Cations (cmol ⁺ /kg)			Av. P ₂ O ₅ (mg/kg)
								K ⁺	Ca ²⁺	Mg ²⁺	
Improvement area	Musim River	loamy sand	6.3	0.03	1.0	0.05	8	0.01	6.51	0.34	21
	Daejeon River	loamy sand	6.1	0.01	0.9	0.03	8	0.00	4.81	0.80	7
	Daecheon River	sandy loam	6.2	0.01	0.9	0.02	10	0.02	3.57	1.79	7
	Wonseong River	sandy loam	6.8	0.06	1.4	0.07	11	0.04	11.11	2.05	19
	Cheonan River	sandy loam	6.4	0.02	1.0	0.03	10	0.01	6.57	0.98	49
	Yesan River	sandy loam	6.0	0.04	1.5	0.06	11	0.06	4.65	0.82	157
	Jeongji River	sandy loam	5.7	0.02	1.3	0.06	10	0.02	2.55	0.92	3
	Dangjin River	loamy sand	6.5	0.05	1.0	0.03	9	0.01	7.81	0.67	33
	Onyang River	sandy loam	6.7	0.03	1.8	0.12	14	0.08	10.47	2.06	396
	Wolha River	sandy loam	5.6	0.01	1.0	0.04	10	0.01	3.95	1.33	10
	Nojang River	sandy loam	5.8	0.03	2.1	0.12	13	0.04	7.07	1.42	61
	Pangyo River	sandy loam	5.9	0.04	1.6	0.06	12	0.04	5.13	1.37	69
Non-improvement area	Musim River	sandy loam	6.1	0.02	1.3	0.06	11	0.02	5.36	0.94	27
	Daejeon River	loamy sand	6.0	0.03	1.5	0.06	12	0.04	6.31	1.75	10
	Daecheon River	sandy loam	5.8	0.04	2.0	0.10	12	0.03	4.60	1.12	39
	Wonseong River	sand	6.7	0.03	1.4	0.05	9	0.02	4.30	0.69	89
	Cheonan River	sandy loam	6.5	0.02	1.1	0.03	7	0.01	4.86	0.60	62
	Yesan River	sandy loam	6.2	0.04	1.4	0.05	11	0.03	3.81	0.81	112
	Jeongji River	sandy clay loam	5.9	0.03	1.4	0.06	11	0.05	4.40	0.90	34
	Dangjin River	sandy loam	6.4	0.08	2.8	0.11	17	0.05	12.67	1.68	93
	Onyang River	sandy clay loam	6.3	0.04	4.4	0.23	18	0.07	11.18	1.93	171
	Wolha River	loamy sand	5.9	0.03	0.9	0.02	8	0.02	4.98	0.77	3
	Nojang River	loamy sand	5.7	0.03	2.0	0.12	11	0.02	6.06	1.12	32
	Pangyo River	sandy loam	5.7	0.05	2.3	0.14	15	0.08	7.66	1.95	61

others were low grade. In the Cheonan River, pH, EC, and Ex. Ca^{2+} were high grade, CEC, Ex. and Mg^{2+} were middle grade, and the others were low grade. In the Yesan River, pH, and EC were high grade, T-N, CEC, Ex. Ca^{2+} , Ex. Mg^{2+} , and Av. P_2O_5 were middle grade, and the others were low grade. In the Jeongji River, EC was high grade, pH, T-N, CEC, Ex. Ca^{2+} , and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Dangjin River, pH, EC, Ex. and Ca^{2+} were high grade, CEC, and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Onyang River, EC, T-N, Ex. Ca^{2+} , and Av. P_2O_5 were high grade, pH, CEC, and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Wolha River, EC was high grade, pH, CEC, Ex. Ca^{2+} , and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Nojang River, EC, T-N, and Ex. Ca^{2+} were high grade, pH, CEC, and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Pangyo River, EC, and Ex. Ca^{2+} were high grade, pH, T-N, CEC, and Ex. Mg^{2+} were middle grade, and the others were low grade.

In addition, the classifications of soil assessments of non-improvement areas were as follows: As for the Musim River, pH, EC, and Ex. Ca^{2+} were high grade, T-N, CEC, and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Daejeon River, pH, EC, and Ex. Ca^{2+} were high grade, T-N, CEC, and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Daecheon River, EC was high grade, pH, T-N, CEC, Ex. Ca^{2+} , and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Wonseong River, EC was high grade, pH, CEC, Ex. Ca^{2+} , and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Cheonan River, pH, and EC were high grade, CEC, Ex. Ca^{2+} , and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Yesan River, pH, and EC were high grade, CEC, Ex. Ca^{2+} , Ex. Mg^{2+} , and Av. P_2O_5 were middle grade, and the others were low grade. In the Jeongji River, EC

was high grade, pH, T-N, CEC, Ex. Ca^{2+} , and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Dangjin River, pH, EC, and Ex. Ca^{2+} were high grade, T-N, CEC, and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Onyang River, pH, EC, T-N, and Ex. Ca^{2+} were high grade, OM, CEC, Ex. Mg^{2+} , and Av. P_2O_5 were middle grade, and the others were low grade. In the Wolha River, EC was high grade, pH, CEC, Ex. Ca^{2+} , and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Nojang River, EC, T-N, and Ex. Ca^{2+} were high grade, pH, CEC, and Ex. Mg^{2+} were middle grade, and the others were low grade. In the Pangyo River, EC, T-N, and Ex. Ca^{2+} were high grade, pH, CEC, and Ex. Mg^{2+} were middle grade, and the others were low grade.

Meanwhile, the results of applied valuations of topsoil-based plantings are described next. Ex. K^+ was low grade in all survey areas. OM was low grade in 12 improvement areas and 11 non-improvement areas. Av. P_2O_5 was low grade in 10 improvement areas and 10 non-improvement areas. T-N was low grade in six improvement areas and four non-improvement areas. Ex. Mg^{2+} was low grade in two improvement areas. In this regard, there is a need for improved levels of these items for the purpose of laying the foundation for planting. However, improvement with chemical fertilizer needs to be carefully considered due to worries about water pollution because the area was a stream improvement project region.

4. Conclusions

These results evaluated the physicochemical properties and performed a feasibility analysis of topsoil based planting for the establishment of rehabilitation techniques and ecological restoration of neglected and wasted topsoil by stream improvement projects at disturbed sites.

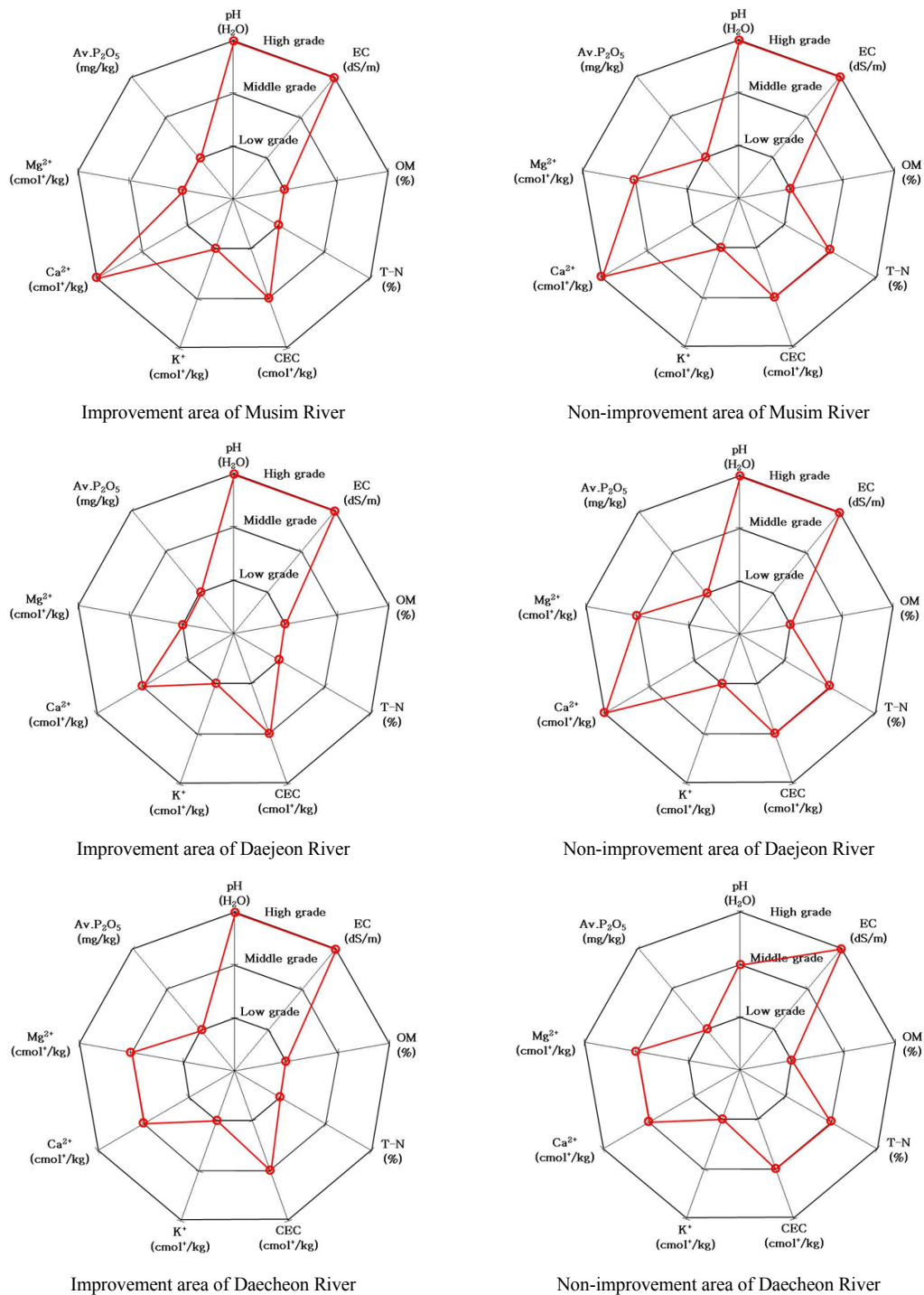


Fig. 1. Planting grades of the survey areas in this study.

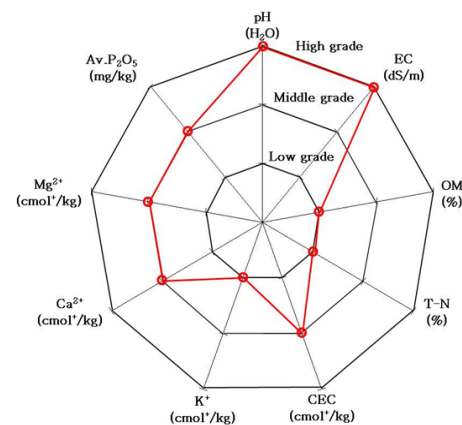
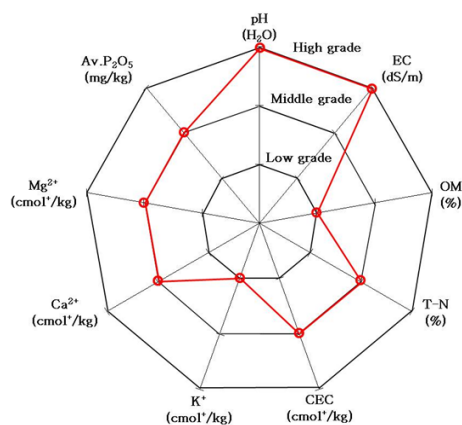
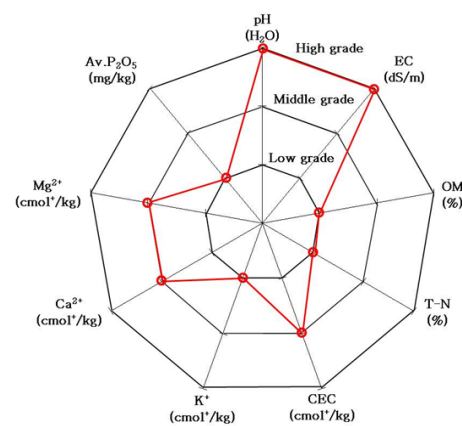
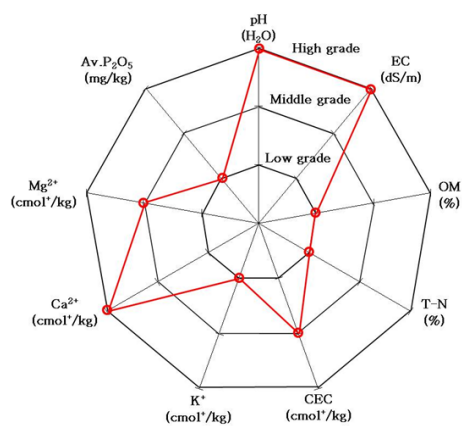
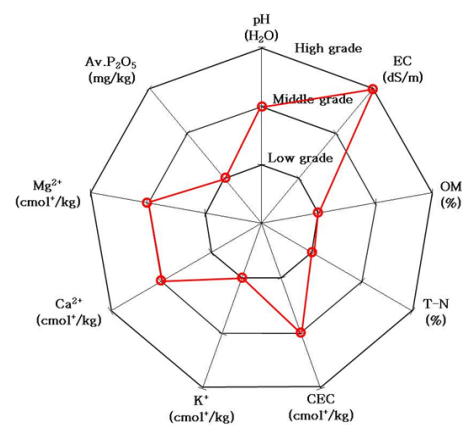
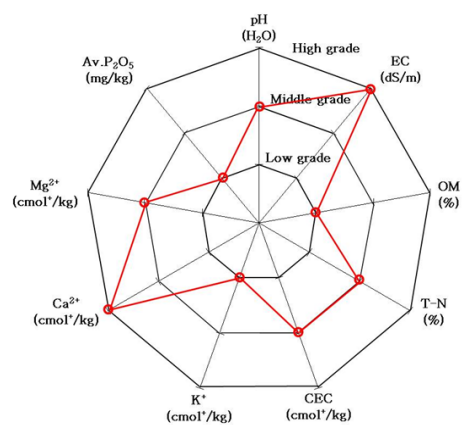
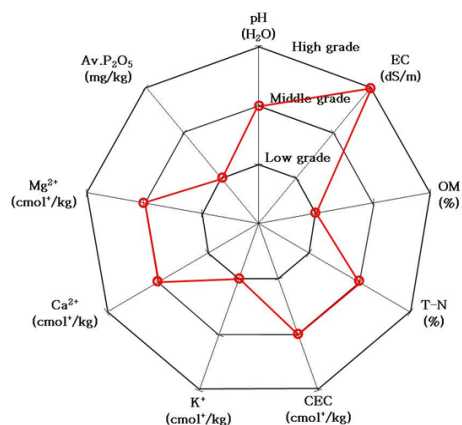
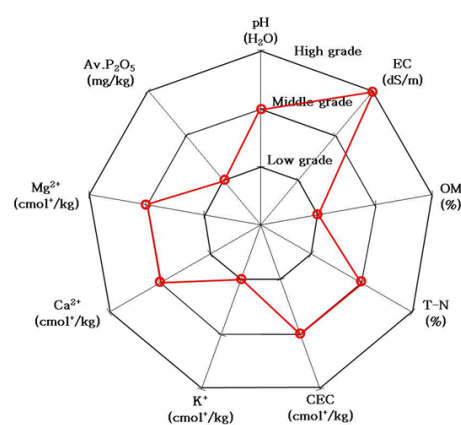


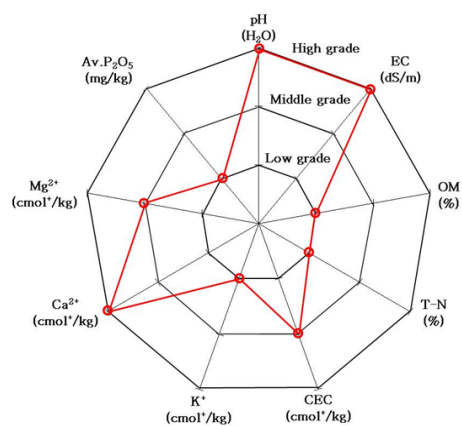
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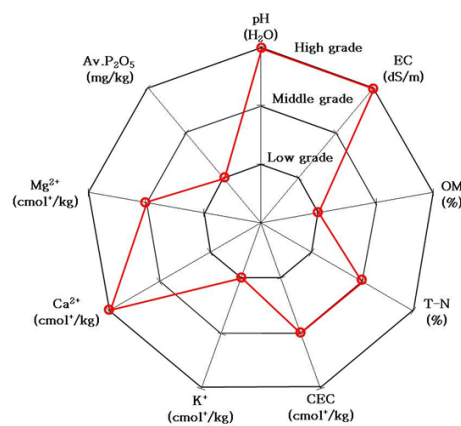
Improvement area of Jeongji River



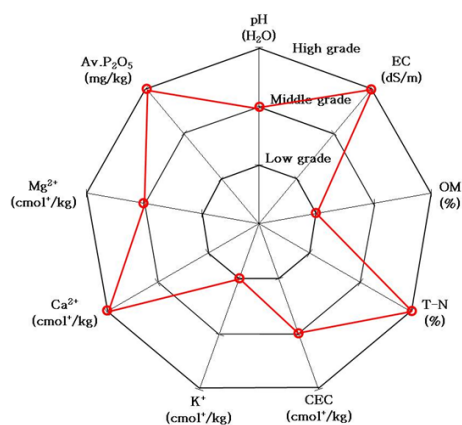
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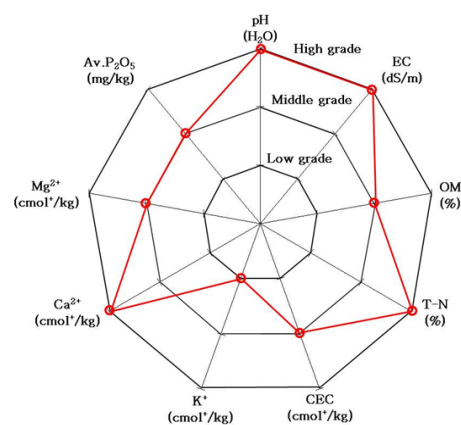
Improvement area of Dangjin River



Non-improvement area of Dangjin River

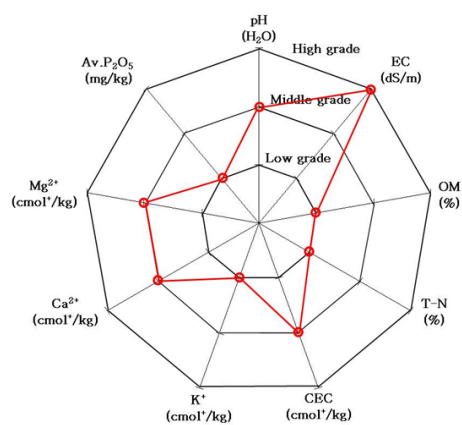


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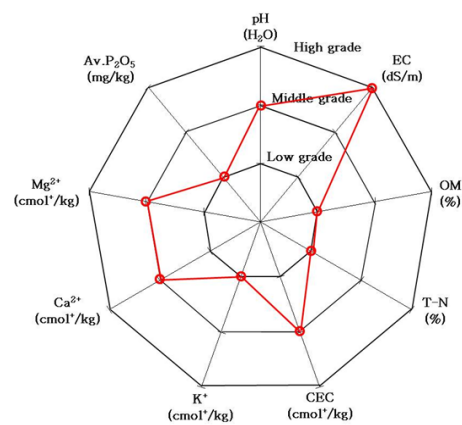


Non-improvement area of Onyang River

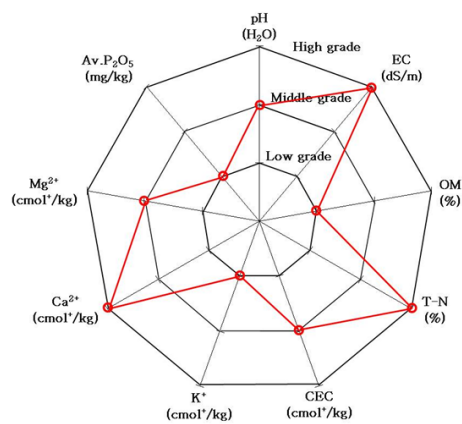
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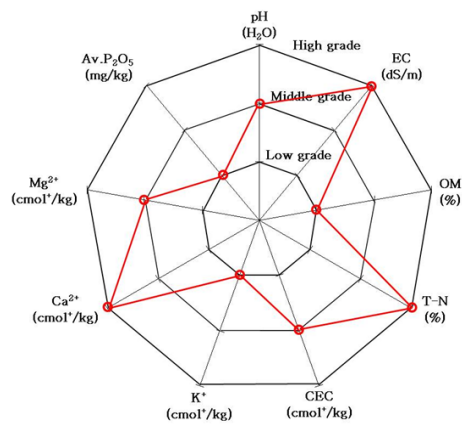
Improvement area of Wolha River



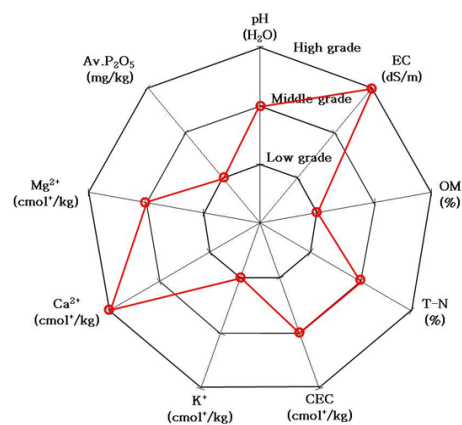
Non-improvement area of Wolha River



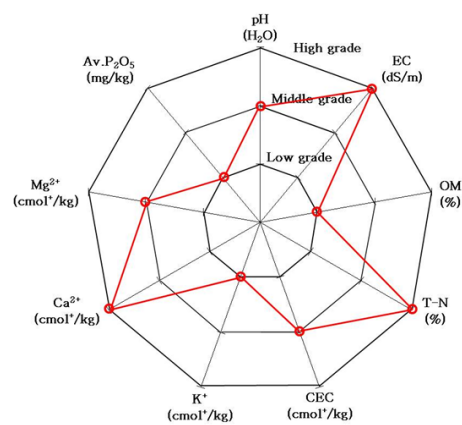
Improvement area of Nojang River



Non-improvement area of Nojang River



Improvement area of Pangyo River



Non-improvement area of Pangyo River

Fig. 1. Continue

The results of physicochemical properties analyses of topsoils from river improvement areas, on average, sandy loam~loamy sand in soil texture, 5.6~6.8 in pH, 0.01~0.06 dS/m in EC, 0.9~2.1% in OM, 0.02~0.12% in T-N, 8~14 cmol⁺/kg in CEC, 0.01~0.08 cmol⁺/kg in Ex. K⁺, 2.55~11.11 cmol⁺/kg in Ex. Ca²⁺, 0.34~2.06 cmol⁺/kg in Ex. Mg²⁺, and 3~396 mg/kg in Av. P₂O₅. And the results of physicochemical properties analyses of topsoils from river non-improvement areas were, on average, sandy clay loam~sand in soil texture, 5.7~6.7 in pH, 0.02~0.08 dS/m in EC, 0.9~4.4% in OM, 0.02~0.23% in T-N, 7~18 cmol⁺/kg in CEC, 0.01~0.08 cmol⁺/kg in Ex. K⁺, 3.81~12.67 cmol⁺/kg in Ex. Ca²⁺, 0.60~1.95 cmol⁺/kg in Ex. Mg²⁺, and 3~171 mg/kg in Av. P₂O₅.

These results of applied valuation of topsoil-based planting were obtained: Ex. K⁺ was low grade in all survey areas. OM was low grade in 12 improvement areas and 11 non-improvement areas. Av. P₂O₅ was low grade in 10 improvement areas and 10 non-improvement areas. T-N was low grade in six improvement areas and four non-improvement areas. Ex. Mg²⁺ was low grade in two improvement areas. In this regard, there is a need for improved measures for the purpose of laying the foundation for planting. However, the improvement of soils with chemical fertilizer needs to be carefully considered due to worries about water pollution because the area was a stream improvement project region.

Our study clearly shows that there is a need to measure physicochemical properties of topsoils and to verify the improvement effect based on the evaluation of whether to use or not use materials of topsoil-based planting in improvement areas.

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