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Soil Characterization of the Field where Rice has been Cultivated during Five Years

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최근 5년간 벼농사 논의 토양 특성 연구

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ABSTRACT

The study for soil has been conducted separately by several areas such as soil mechanics and soil chemistry. Soil is important in terms of prediction of how the plant grow with nutrient requirement. Also, soil is important for machines to work on to solve labor shortage and save farmers from harsh environment during farm work. To meet diverse needs related to soil in agriculture, the soil related study needs to be conducted synthetically. Thus, we tried to obtain the data related to soil chemistry including pH and Electrical Conductivity (EC) with data related to soil mechanics including Cone Index (CI), moisture content, soil classification. Specifically, the condition of the field was set to be cultivated at least for five years continuously at a first step. The soil was taken from 30 sites. CI was obtained using the soil penetrometer and soil classification was conducted using sieve analysis with eight kinds of sieve. The soil was taken on December when is during winter in Korea. There was variation of data including moisture content and CI.

Key Words : Cone Index(관입 지수), Electrical Conductivity(전기 전도도), Moisture Content(함수율), pH(수소 이온 농도 지수), Soil Classification(토양 조성)

1. Introduction

Agriculture is regarded to be a main reason that transform the soil although agriculture is the essential for mankind to survive and thrive.

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Among the soil properties, the physiochemical properties such as pH, EC (Electrical Conductivity) are meaningful to improve crop cultivation and pest control in agriculture[1].

Also, the mechanization for agriculture has been main issue to improve the productivity in the environment which labor is harsh along with the social condition which labor shortage has been enlarged since the 1970 in South Korea. Thus, Cone Index (CI), moisture content and soil classification related to the interaction between soil and machinery has been studied.

And then the physical properties such as Cone Index (CI), moisture content, soil classification are meaningful for agricultural machinery such as agricultural tractors and rice transplanters to work on the field. Intrinsically, the field related to soil is so large including soil physics, chemistry and biology that the soil related research is likely to be limited to the specific scope such as soil physics or soil chemistry[2]. However, agriculture is related to interdisciplinary scope.

Status of soil is important for plants including crops including rices to grow well and have nutritive substance.[3-7] There is a few study which report chemical, physical, and biological attributes of soil.[8-9] Thus, we decided to characterize the paddy field in Chungbuk National University where rice has been cropped at least for five years as shown in figure 1.

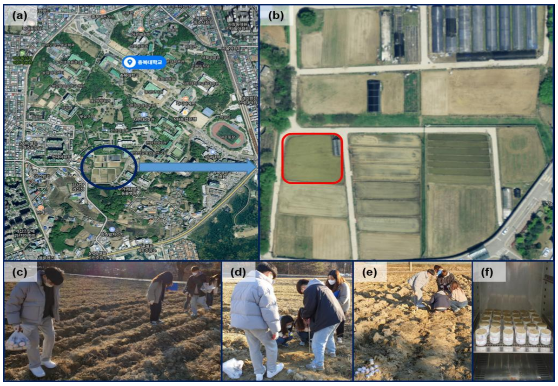

Fig. 1 Paddy Fields for obtaining data such as pH, Electical Conductivity (EC) , moisture content, Cone Index (CI) and soil classification; (a) map of the site where paddy field is located; (b) paddy field where soil is taken in Chungbuk National University; (c) soil compaction by men; (d) measuring CI; (e) obtaining soil samples at 30 points; (f) drying moisture of the sampled soil in the oven

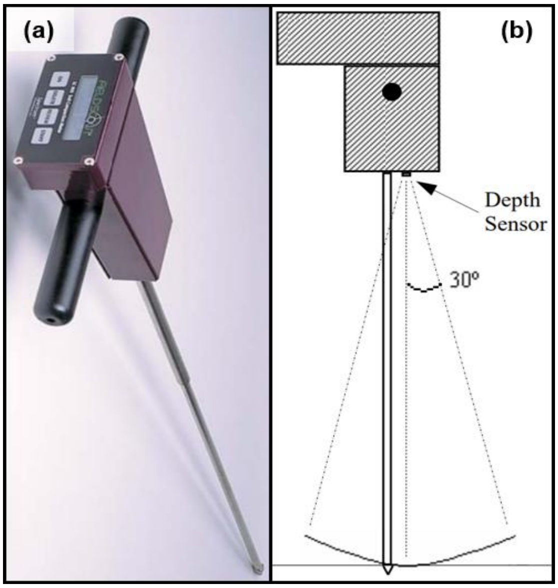

Fig. 2 Soil penetrometer which can measure Cone Index (CI); (a) picture of Soil penetrometer (SC900, Spectrum Technologies, Inc.); (b) Schematic diagram that elucidate the principle to measure CI (Extracted from User's Manual of Spectrum Technologies)

2. Materials and Methods

2.1 EC and pH

Electrical Conductivity (EC) which is the reciprocal of the electrical resistance is high in metals such as silver, copper, gold, aluminum, zinc, nickel, and brass in general. Via soil pH, we can decide the type of plants fit for any field because it can be a rough indicator of the plant availability of nutrients in the soil.

2.2 Cone Index

Cone Index can be obtained using the soil penetrometer as shown in figure 2(a). Cone Index value can be measured by a load cell sensor inside the soil penetrometer while soil depth reading is done by a sonic depth sensor as shown in figure 2(b).

2.3 Moisture Content

Moisture content can be obtained by comparing the weight before and after drying in the oven at 105℃ for 24 hours. Moisture Content (MC) from 30 soil samples were obtained by

$$MC = \frac{M_2 - M_3}{M_3 - M_1} \times 100$$

where,

$M_1 = the\ weight\ of\ soil\ can\ without\ soil$

$M_2 = the\ weight\ of\ soil\ can\ with\ soil$

$M_3 = the\ weight\ of\ soil\ can\ with\ dried\ soil$

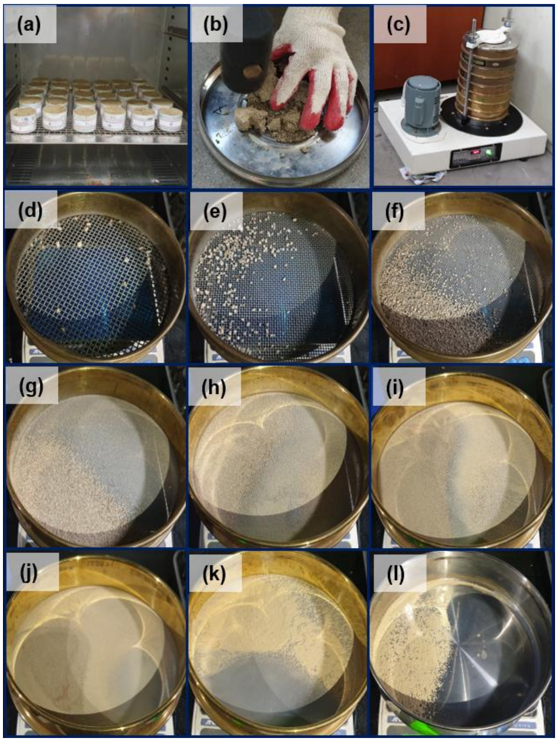

Fig. 3 Soil classification; (a) dried soil in the oven; (b) pulverized soil before shaking; (c) sieve shaker; (d)~(l) sieves (4mm, 2mm, 1mm, 0.5mm, 0.25mm, 0.106mm, 0.053mm, 0.02mm) and pan with soil after shaking for 2 hours.

2.4 Soil Classification

Soil was classified using sieve analysis with a sieve shaker as shown in figure 3(c) and 8 kinds of sieves as shown in figure 3(d) through 3(f).

3. Results and Discussion

3.1 EC and pH

EC and pH data were obtained 2 times as shown in table 1.

3.2 Cone Index

Cone Index (CI) data were obtained in 30 sites as shown in table 1 through 10. CI has trend that it is the smallest in topsoil and grows as depth becomes deeper. Cone penetrometer is defined to be a 30° circular stainless steel cone with driving shaft[10]. Also, Cone Index (CI) wad defined to be the force required to push the penetrometer through a specified small increment of soil[10]. The CI obtained from 30 sites ranged between 207kPa and 3208kPa and the reason of the variation is likely to be resulted from the difference of the soil compaction degree. The measured CI is shown in table 2 through 11.

Table 1 Electrical Conductivity (EC) and pH of 2 points of sites in the paddy field

Site No.	EC, us/cm	pH
1	48.29	7.60
2	47.76	7.58
Average	48.03	7.59

Table 2 CI measured at sites 1, 2, and 3

Site No.	Site 1	Site 2	Site 3
Point, cm	CI, kPa	CI, kPa	CI, kPa
5	1138	931	379
10	1345	1483	1345
15	1449	1690	1483
20	1449	1414	1621
25	1932	1104	2001

Table 3 CI measured at sites 4, 5, and 6

Site No.	Site 4	Site 5	Site 6
Point, inch	CI, kPa	CI, kPa	CI, kPa
5	931	207	1345
10	1621	1794	2242
15	1414	2277	2208
20	1242	1828	2173
25	1483	1656	2587

Table 4 CI measured at sites 7, 8, and 9

Site No.	Site 7	Site 8	Site 9
Point, inch	CI, kPa	CI, kPa	CI, kPa
5	1932	862	931
10	2173	1207	759
15	2035	1656	966
20	2139	1311	897
25	2553	1242	862

Table 5 CI measured at sites 10, 11, and 12

Site No.	Site 10	Site 11	Site 12
Point, inch	CI, kPa	CI, kPa	CI, kPa
5	621	690	724
10	1621	1414	1690
15	1207	1345	1828
20	1138	1345	1173
25	1242	1863	655

Table 6 CI measured at sites 13, 14, and 15

Site No.	Site 13	Site 14	Site 15
Point, inch	CI, kPa	CI, kPa	CI, kPa
5	621	586	345
10	1069	1828	862
15	1000	1897	1725
20	1345	1794	1621
25	1725	1414	1587

Table 7 CI measured at sites 16, 17, and 18

Site No.	Site 16	Site 17	Site 18
Point, inch	CI, kPa	CI, kPa	CI, kPa
5	724	931	690
10	966	379	1173
15	1276	1587	931
20	1759	1380	1311
25	1656	1414	1242

Table 8 CI measured at sites 19, 20, and 21

Site No.	Site 19	Site 20	Site 21
Point, inch	CI, kPa	CI, kPa	CI, kPa
5	1000	1380	1449
10	793	897	483
15	1138	1104	1207
20	1207	1173	1207
25	1276	3208	1311

Table 9 CI measured at sites 22, 23, and 24

Site No.	Site 22	Site 23	Site 24
Point, inch	CI, kPa	CI, kPa	CI, kPa
5	1138	931	1621
10	2311	1276	1242
15	1966	1587	1483
20	2070	1725	1621
25	2725	2484	2484

Table 10 CI measured at sites 25, 26, and 27

Site No.	Site 25	Site 26	Site 27
Point, inch	CI, kPa	CI, kPa	CI, kPa
5	655	793	931
10	1587	1483	1932
15	1483	1828	1656
20	1656	1483	1069
25	1345	2656	2035

Table 11 CI measured at sites 28, 29, and 30

Site No.	Site 28	Site 29	Site 30
Point, inch	CI, kPa	CI, kPa	CI, kPa
5	241	1069	1621
10	621	759	1069
15	690	1242	862
20	1138	1414	69
25	1414	2932	1725

Table 12 moisture content at sites 1 through 30

Site No.	M.C. %	Site No.	M.C. %
1	17.3	16	11.1
2	21.9	17	19.8
3	15.8	18	12.6
4	15.0	19	19.5
5	19.4	20	23
6	13.9	21	18.5
7	11.8	22	21.7
8	16.6	23	21.0
9	13.0	24	22.6
10	16.0	25	16.6
11	19.5	26	19.5
12	14.3	27	18.3
13	11.2	28	17.6
14	11.5	29	23.4
15	13.9	30	16.6

3.3 Moisture Content

Moisture content in the soil taken from site 1 through 30 is shown in table 12.

3.4 Soil Classification

Among 30 soil samples, one soil sample was spilled from the soil sieve while sieving. Also, the data was not reasonable for one soil sample because the weight after removing one of the sieve was below zero. Thus, the number of final soil samples used for soil classification was not 30 but 28. Soil was classified according to USDA criterion as shown in figure 4. The percentages of gravel, sand, and clay were each 13.4%, 56.5%, and 30.1%.

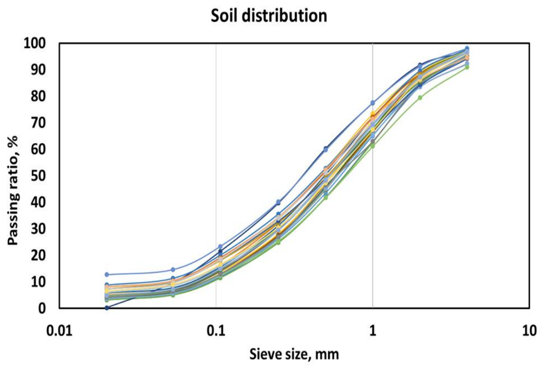

Fig. 4 Size distribution of soil classified by test sieve shaker with standard sieve

The passing ratio was similar among soil sampled on the 28 spots. In average, the ratio of the gravel was 13.4%, sand 56.5%, clay 30.1%. Thus, the soil can be classified into the loam soil because the ratio of clay is between 25% and 37.5% (USDA crieterion).

4. Conclusion

We obtained the data in terms of soil chemistry and soil mechanics synthetically from the soil of 30 sites in Chungbuk National University. Details of this study are as below

1. The Cone Index and Moisture Content was obtained for 30 soil samples and soil was classified into loam after sieving the 28 soil samples of the field where rice has been cropped for recent 5 years.
2. The Cone Index and Moisture Content was obtained for 30 soil samples and soil was classified into loam after sieving the 28 soil samples of the field where rice has been cropped for recent 5 years.
3. The soil data related to soil chemistry and soil mechanics was obtained synthetically so that it can be used as basic information to improve cultivation, pest control and machine interaction.
4. It is expected that we can get the relationship between the soil chemistry and mechanics data on the field after growing specific grain.

후 기

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