沖縄島の土壌管理のための肥沃度グループ設定について(農芸化学科)

Grouping of Okinawa Island Soils for Fertility Management

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Introduction

Okinawa Island soils have been classified to eighteen soil series by Matsuzaka et al.[4] Fertility of these soils is studied to some extent[1] but not comprehensively. The authors believe that proper management of the soils is essential to promote soil's capacity of production under intensifing agriculture.

The objectives of the present paper are (i) to characterize the soils of Okinawa Island by determining some chemical properties, and (ii) to make a tentative grouping of the soils for fertility management.

Material and Methods

Soil samples of surface layer (0 to 20 cm) were collected from cultivated land of randomly selected sites in each of eighteen soil series, which were identified refering to the soil maps and descriptions by Matsuzaka et al.[3] Air-dried soil samples were sieved through 2 mm wire cloth and determinations were carried out as follows:

1. pH was measured with a glass electrode pH meter on 1:2 soil-water suspension.
2. CEC (cation exchange capacity) was determined by summing up exchangeable bases, as determined by using neutral normal ammonium acetate solution, and titrable hydrogen ion for non-calcareous soils, but for calcareous soils by titrating ammonium distilled and caught in boric acid solution after saturation and displacement procedures with neutral normal ammonium acetate and potassium chloride solutions.
3. Exchangeable bases were determined in neutral normal acetate extractant with a flame photometer for K and by atomic absorption technique for Ca and Mg.
4. Available P was extracted with Bray and Kurtz No. 1 solution and determined colorimetrically.
5. And suluble Mn, Fe and Cu were extracted with 0.1 N HCl and determined by atomic absorption technique.

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Analytical Results

The results of analysis were shown in Table 1, where indicated were the means and standard deviations of analyzed samples, or the ranges of obtained value when only two samples were analyzed, and the number of analyzed sample was denoted by n.

Table 1. pH, CEC and contents of some nutrient elements of Okinawa Island soils*

Soil series	pH (H_2O)	CEC	Exchangeable base			Available	Soluble microelement		
			Ca	Mg	K	P	Mn	Fe	Cu
		me/100g	kg/ha			kg/ha	ppm		
1. Oku	5.5 ± 0.7 (n = 6)	9 ± 2 (n = 6)	451 ± 206 (n = 6)	427 ± 23 (n = 4)	139 ± 124 (n = 6)	61 ± 44 (n = 6)	4.5 ± 6.6 (n = 6)	28 ± 4 (n = 6)	3.9 ± 1.8 (n = 6)
2. Nago	5.4 ± 0.7 (n = 35)	12 ± 5 (n = 35)	1,611 ± 1,385 (n = 35)	794 ± 486 (n = 35)	157 ± 136 (n = 35)	64 ± 51 (n = 35)	4.1 ± 6.2 (n = 35)	78 ± 116 (n = 35)	8.1 ± 8.7 (n = 35)
3. Shikiya	8.0 ± 0.4 (n = 6)	9 ～ 12 (n = 2)	4,536 ± 1,973 (n = 6)	461 ± 222 (n = 6)	136 ± 79 (n = 6)	31 ± 23 (n = 6)	8.9 ± 15.7 (n = 6)	106 ± 147 (n = 6)	2.4 ± 2.0 (n = 6)
4. Higashi	5.1 ～ 5.2 (n = 2)	5 ～ 6 (n = 2)	737 ～ 737 (n = 2)	410 ～ 557 (n = 2)	45 ～ 54 (n = 2)	0 ～ 17 (n = 2)	0.4 ～ 18.0 (n = 2)	0 ～ 32 (n = 2)	3.2 ～ 13.2 (n = 2)
6. Yabu	8.3 ± 0.2 (n = 7)	6 ± 2 (n = 5)	5,387 ± 1,563 (n = 7)	769 ± 438 (n = 7)	149 ± 93 (n = 7)	65 ± 80 (n = 7)	1.6 ± 2.1 (n = 7)	17 ± 22 (n = 7)	5.8 ± 9.4 (n = 7)
7. Ageda	7.9 ± 0.4 (n = 9)	20 ± 2 (n = 4)	7,632 ± 2,648 (n = 9)	1,876 ± 435 (n = 9)	352 ± 128 (n = 9)	23 ± 16 (n = 9)	1.8 ± 1.2 (n = 9)	6 ± 11 (n = 9)	5.9 ± 3.6 (n = 9)
8. Onaha	7.8 ± 0.2 (n = 6)	14 ～ 18 (n = 2)	7,299 ± 1,445 (n = 6)	1,733 ± 347 (n = 6)	486 ± 148 (n = 6)	65 ± 61 (n = 6)	4.2 ± 2.3 (n = 6)	16 ± 10 (n = 6)	5.0 ± 3.5 (n = 6)
9. Ada	4.7 ± 0.6 (n = 8)	18 ± 6 (n = 8)	1,852 ± 2,247 (n = 8)	364 ± 143 (n = 8)	142 ± 92 (n = 8)	6 ± 6 (n = 8)	1.6 ± 3.1 (n = 8)	33 ± 24 (n = 8)	1.2 ± 1.6 (n = 8)
10. Nakagawa	5.3 ± 0.6 (n = 22)	13 ± 6 (n = 21)	1,209 ± 948 (n = 22)	665 ± 516 (n = 22)	188 ± 146 (n = 22)	14 ±11 (n = 22)	1.1 ± 1.6 (n = 22)	13 ±10 (n = 22)	1.4 ± 1.6 (n = 22)
11. Itosu	7.1 ± 0.9 (n = 30)	15 ± 5 (n = 14)	4,423 ± 2,384 (n = 30)	1,289 ± 499 (n = 30)	306 ± 125 (n = 30)	26 ± 27 (n = 30)	4.1 ± 5.4 (n = 30)	12 ± 8 (n = 28)	2.4 ± 2.0 (n = 30)
12. Mabuni	7.1 ± 0.9 (n = 31)	15 ± 3 (n = 8)	4,891 ± 2,703 (n = 31)	1,643 ± 1,629 (n = 31)	390 ± 240 (n = 31)	22 ± 16 (n = 31)	6.3 ± 5.4 (n = 31)	23 ± 46 (n = 29)	3.9 ± 2.3 (n = 31)
13. Inamine	7.8 ± 0.5 (n = 20)	28 ± 4 (n = 9)	8,303 ± 1,429 (n = 20)	1,742 ± 335 (n = 20)	398 ± 87 (n = 20)	21 ± 12 (n = 20)	0.4 ± 0.6 (n = 20)	13 ± 8 (n = 20)	4.6 ± 1.8 (n = 20)
14. Iji	8.1 ± 0.2 (n = 7)	18 ～ 18 (n = 2)	8,307 ± 1,372 (n = 7)	1,641 ± 345 (n = 7)	342 ± 87 (n = 7)	26 ± 20 (n = 7)	3.7 ± 3.0 (n = 7)	9 ± 11 (n = 7)	3.3 ± 1.9 (n = 7)
15. Namisato B	6.1 ± 0.8 (n = 6)	13 ± 3 (n = 5)	1,542 ± 854 (n = 6)	1,085 ± 338 (n = 6)	385 ± 190 (n = 6)	18 ± 16 (n = 6)	27.2 ± 28.2 (n = 6)	23 ± 6 (n = 6)	5.1 ± 1.9 (n = 6)
16. Namisato A	6.0 ± 1.2 (n = 7)	11 ± 2 (n = 5)	1,614 ± 1,014 (n = 5)	486 ± 322 (n = 7)	155 ± 140 (n = 7)	20 ± 10 (n = 7)	4.9 ± 4.0 (n = 7)	42 ± 52 (n = 6)	5.1 ± 4.7 (n = 7)
17. Gushiken	4.9 ± 0.6 (n = 14)	12 ± 4 (n = 14)	808 ± 640 (n = 14)	369 ± 232 (n = 14)	152 ± 73 (n = 14)	28 ± 41 (n = 14)	1.0 ± 2.6 (n = 14)	31 ± 46 (n = 14)	1.5 ± 2.2 (n = 14)
18. Yanaza	5.0 ± 0.7 (n = 23)	16 ± 5 (n = 18)	831 ± 876 (n = 23)	458 ± 349 (n = 22)	152 ± 100 (n = 23)	17 ± 35 (n = 23)	2.3 ± 3.7 (n = 19)	16 ± 14 (n = 18)	1.2 ± 1.7 (n = 23)

* Values are the means and standard deviations (±) in the number of samples (n) analyzed. Ranges are shown where only two samples were analyzed. No samples were analyzed from Izumi soil series of unit no. 5.

The soils of Okinawa Island vary widely in pH. CECs are mostly less than 30 me/100g. Some soils are calcareous and show higher contents of exchangeable Ca and Mg as determined with neutral normal ammonium acetate solution which dissolves some portions of calcium carbonate. The contents of exchangeable K are closely related to occurrence of montmorillonite as reported by investigators[2,3,7]. Available phosphorus seems to be low in acid soils as well as in calcareous soils, of which available phosphorus was shown relatively high when determined with a different method by Miyagi et al[5]. A suitable method is still required to be developed for Okinawa Island soils.

It is generally understood that micro-elements such as Mn, Fe and Cu are more soluble in acid

soils than in alkaline soils. No such tendency, however, is obtained from the present determinations of Okinawa Island soils. This may be resulted from that the soils are derived from varieties of parent material and are exposed to divers degrees of soil forming process on the hilly geomorphology characteristic to Okinawa Island.

Rating

The authors chose pH, CEC, available P and exchangeable K for rating the soils among the measurements. Because they consider that the chemical properties of soil are intensively reflected by pH, physico-chemical properties occur as cation exchange capacity in the summing up of the quantity and quality of active fractions of soil, and probable nutrient status under the present management practices is represented by the contents of available phosphorus and exchangeable potassium.

Since the authors aim to make locally adaptable ratings, the analytical values of above mentioned measures were conveniently rated to L (low), M (medium), or H (high) except for soil pH which was categorized as below 5.4, between 5.5 and 6.4, between 6.5 and 7.4, and above 7.5 in accordance with that in soil chemistry. Ratings adapted here are as follows; for CEC, L: less than 10, M: 10 to 20, and H: more than 20 me/100g, for available P, L: less than 30, M: 30 to 60, and H: more than 60 kg/ha, and for exchangeable K, L: less than 200, M: 200 to 400, and H: more than 400 kg/ha, respectively.

Available phosphorus by Miyagi et al,[5], who covering all eighteen series soils determined it by extracting with 0.002 N H_2SO_4, was also considered in the present rating. The available P_2O_5 (mg/100g) in the data of Miyagi et al.was rated by the authors as follows; L: less than 12, M: 12 to 24, and H: more than 24. In addition, moisture conditions of the soils which were judged by the authors upon various information and the soil descriptions of Matsuzaka et al.[4] were taken into consideration. In the rating, "Good" denoted that the soils when planted to such a crop as sugarcane gave no severe damage by drought experienced in the recent years, "Poor" denoted that the soils gave severe damage to the crop, and "Fair" was of moisture conditions between the "Good" and "Poor".

Grouping of the Soils

According to the characteristics and raings, the soils with similarity were arrarged to form groups. Five management groups were established tentatively as shown in Table 2.

The numerical order of the management groups was arbitrarily given here. The soils of group I are regarded most fertile and productive of sugarcane among the five management groups under present cultivation practices as indicated by many experiments. The soils of group II are con-

Table 2. Grouping of Okinawa Island soils for fertility management

Soil characteristics					Soil series and approx. hectareage*		Management group (and relative hectareage)	
pH	CEC	Available P	Exchangeable K	Moist. cond. in drought				
<5.5	L	L	L	Good	Higshi	125		
					(Izumi)	374		
	M		L～M	Fair	Nakagawa	5,257	III (40%)	IV (7%)
		L～M	L		Ada	1,691		
					Guchiken	3,224		
					Yanaza	11,034		
	L～M	L～H		Good	Oku	444		
			L～M		Nago	2,956		
5.6～6.4	M	L～M	M～H	Poor to fair	Namisato B	443	II (19%)	
		L～H	L～M		Namisato A	709		
6.5～7.4		L～M	M～H		Mabuni	4,059		
			M		Itosu	4,648		
7.5<	L	L～H	L	Fair to good	Yabu	1,566	V (5%)	
	L～M	L～M		Good	Shikiya	816		
	M	L～H	M	Fair to good	Iju	4,339	I (29%)	
			H		Onaha	3,187		
	M～H	L～M	M～H		Ageda	752		
	H	L～H			Inamine	6,942		

* Approximate hectareage of each soil series was taken from K. Oya (1973).

sidered important because they are more or less intensively cultivated. The group III soils are regarded rather poor in fertility but occupy a large portion of the arable land. The soils of group IV are alluvial and too wet in places for ordinary crops except for rice. Although any determinations were carried out on Izumi series soil in the present study, Izumi series was tentatively included in group IV, because the descriptions of Izumi soils in the soil survey report[3]) resembled that of Higashi series except texture. The group V soils are also alluvial and much sandier in texture.

The authors believe that the grouping is suggestive enough how to manage the respective soils for better mangement. The validity of the proposed grouping must be confirmed in the future. The authors, however, are not reluctant to modify the grouping if necessary upon accumulating data on the soils of Okinawa Island.

Summary

Surface soil samples of all eighteen soil series of Okinawa Island except Izumi series were analyzed, and the respective soil series were characterized to some extent. The soils were rated in a locally adaptable way by their pH, CEC, exchangeable K, and available P among the measurements. Moisture conditions estimated from available informations were also included in the rating. The soils were suitably arranged to form groups according to the rating and five groups were tentatively proposed to be established for fertility management.

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204　沖縄島の土壌管理のための肥沃度グループ設定について

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要　　約

沖縄島土壌の肥沃度特性を把握し，肥沃度管理上の土壌グループ設定を行なうために実験を行なった。

沖縄島に設定されている18土壌統（うち伊豆味統を除く）の耕土のサンプルを多数採取し，そのpH CEC，置換性塩基（Ca，Mg，K）含量，可給態りん酸含量，および可溶性微量元素（Mn, Fe, Cu）などを分析測定したが，これらの測定項目のうちpH, CEC, 置換性カリ，可給態りん酸などを肥沃度指標として選び各土壌肥沃度の相対的等級付けを行なった。肥沃度等級付けには各土壌の水分状態も考慮に入れた

この等級付けに従い類似等級の土壌をまとめて肥沃度管理上の土壌グループとした。その結果沖縄島には5つの肥沃度グループを設定することが適当であると思料された。

すなわち肥沃度グループⅠに属するものには伊集統，小那覇統，安慶田統，稲嶺統土壌など，グループⅡには並里統B，糸洲統，摩文仁統，並里統A土壌などグループⅢには安田統，中川統，具志堅，屋名座統土壌など，グループⅣには東統，（伊豆味統），奥統，名護統土壌など，グループⅤには屋部統，志喜屋統土壌などである。

グループ番号は肥沃度の順位とは関係なく付けられたが，それぞれのグループの肥沃度特性に従い適当な施肥管理をすることが望まれる。