

## Modified Conway Method for soil available nitrogen testing

Yu Zengshou (于增寿)<sup>1</sup>, Huang Deming (黄德明)<sup>2</sup>

1. Institute of Soil and fertilizer, Hebei Academy of Agricultural and Forestry Sciences, Shijiazhuang 050051

2. Institute of Soil and Fertilizer, Beijing Academy of Agricultural and Forestry Sciences, Beijing

Received October 10, 1992

**Summary** The ideal reducing reagent in testing available nitrogen of soil by Conway Method is Devard's alloy. The optimum ratio of soil:Devard's alloy:1.0N NaOH solution is 5.0g:0.2g:5ml. When reaction goes on at 30°C for 4 hours, the rate of soil  $\text{NO}_3\text{-N}$  reduction is about 90%, and the recovery rate of soil  $\text{NH}_4\text{-N}$  is about 95%. Some organic nitrogen can be measured at the same time. This method is defined as the Modified Conway Method and the soil N-min is  $r = 0.982$  ( $n=10$ ). In predicting soil nitrogen supplying power, the Modified Conway Method takes only 1/6 of time needed by Conway Method. The Modified Conway Method can also be used for the measure of soil N-min.

**Key words** soil, available nitrogen, Conway Method, Devard's alloy, reaction

### Introduction

Soil available nitrogen testing with Conway Method was first recommended by Corfield in 1960. This method is easy to carry out and considered as a better way to test soil available nitrogen in China after soil scientists have made lots of research and improvement on the method (Nanjing Soil Research Institute, 1978). However, it had some shortcomings in practice which were showed in "Study on the Nutrient Index in China's Main Kinds of Soil" researched with Conway Method in 1981-1985. It was proved to be a better method of soil test in Southern and North East China, but not good enough in the Northern and North West China because soil mineral nitrogen there is mainly nitrate, so how to reduce nitrate was a chief problem. At present, reducing reagents used in soil available nitrogen testing vary greatly. In 1987, reducing effects of  $\text{FeSO}_4$ ,  $\text{TiSO}_4$ , zinc powder and Devard's alloy were researched (Fang Zhangfa), the reaction conditions were 10ml of 1.0N NaOH and 40°C constant temperature for 48 hours. The results showed that the Devard's alloy was the best powerful reducing reagent. But nitrogen that can be tested under this conditions is mostly made up of slow release and invalid constituents rather than the soil mineral nitrogen. So it is necessary to make research about reducing reagents and analyzing conditions in order to estimate amounts of soil nitrogen supply in Northern China by Conway Method.

### Materials and methods

Ten kinds of soil in different nitrogen levels were selected from Shunyi and Tongxian Counties in Beijing suburbs. First, the reducing rates of standard nitrate were tested by use of Devard's alloy, zinc powder and  $\text{FeSO}_4\text{-Ag}_2\text{SO}_4$ , which all were considered to be better reducing reagents, in order to choose the best reducing reagent. And then, a experiment was designed with the best reducing agent to find out the best conditions for analyzing alkali-hydrolyzable nitrogen. In the experiments, the classic starch-blue method to test  $\text{NH}_4^+$  and phenol disulfonic acid method to test  $\text{NO}_3^-$  were used for reference.

## Results

### *Comparison of recovery rates of standard nitrate with different reducing reagents*

The experiment was carried out under the conditions: 100 $\mu$ g of standard nitrate, 5ml of 1.0 N NaOH, 30°C constant temperature, reaction for 2 hours and 4 hours. The data in Table 1 illustrates that there exists obviously difference in nitrate reducing rates among three reducing reagents. Recovery rate of standard nitrate by Devard's alloy for 4 hours is a little more than 97%, but less than 50% by other two reducing reagents. It suggests that Devard's alloy is the ideal reagent for testing nitrate by Conway Method.

**Table 1.** Recovery rates of standard nitrate about reducing reagents (%)

Reducing reagents	Lasting time	
	2 hours	4 hours
0.2g Devard's alloy	88.9	97.6
1.0g zinc powder	22.3	49.3
FeSO <sub>4</sub> -Ag <sub>2</sub> SO <sub>4</sub>	20.2	33.7

### *Suitable amount of Devard's alloy*

Reducing effect of Devard's alloy is good in aqueous alkali, but it varies with different amounts of Devard's alloy used. Table 2 shows that, under the conditions: 100 $\mu$ g standard nitrate, 10ml of 1.0N NaOH and 30°C constant temperature for 4 hours, the

recovery rates increase with addition amounts of Devard's alloy. Moreover, the lye in the Conway dish would be splashed from the outer-ring into the inner-ring when the amount of Devard's alloy increased up to 0.4g, so the suitable amount of Devard's alloy used should be 0.2g.

**Table 2.** Recovery rates of standard NO<sub>3</sub><sup>-</sup>-N about amounts of Devard's alloy (%)

Amounts(g)	Recovery rates			Average	C. V.
	I	II	III		
0.1	74.4	70.1	72.8	72.4	2.2
0.2	85.6	81.5	86.4	84.5	3.1
0.3	87.3	90.7	78.8	85.6	7.2
0.4	—	90.4	70.2	—	—

### *Influence of different alkaline concentration and volume on reducing effect of Devard's alloy*

It was discovered that there was no difference between 1.0 N NaOH and 1.6 N NaOH solution in the reducing effect when lasting for 4 hours, but 0.5N NaOH solution might decrease obviously the reducing effect under the same conditions, so 1.0N NaOH is the ideal concentration selected. A different volumes of alkaline solution in the same concentration could influence reducing effect, 5ml of the alkaline solution got higher recovery rate than 10ml of the alkaline solution, which might result from increasing the concentration of all reaction materials (in Table 3).

**Table 3.** Nitrate recovery rates of NaOH concentration (%)\*

Reaction time (hours)	NaOH concentration (mol)		
	0.5	1.0	1.6
2	61.7	83.3	90.1
4	81.5	97.6	97.6
8	99.8	99.8	99.3

\* Conditions: 100 $\mu$ g NO<sub>3</sub><sup>-</sup>-N 0.2g Devard's alloy; 5ml NaOH; 30°C

### *Influence of ratio of soil sample, reducing agent and aqueous alkali on testing results of alkali-hydrolyzable nitrogen*

Only if ratio of soil, reducing agent and aqueous alkali is appropriate, we can get a steady outcome. The figures in Table 4 illustrate that ideal result can be gotten when

proportion of fresh soil to Devard's alloy to

1. 0N NaOH equals to 5g:0. 2g:5ml. One of the reasons is that the amount of soil sample used in this experiment is more than others. And more important reason is that the reaction is fully complete because the hydrogen produced in the process creates honeycomb-like thing in the soil sample. On the basis of this ratio of materials the reaction temperature is 30 °C, and lasting time is 4 hours. This method is defined as Modified Conway's Method.

**Table 4.** Results of alkali-hydrolyzable nitrogen under ratios of soil, Devard's alloy and NaOH\*

Soil	Devard's alloy	NaOH	Nitrogen (ppm)				Average (ppm)	C. V. (%)
			I	II	III	IV		
2g	0. 3g	10ml	45	47	43	45	45. 0	3. 6
5g	0. 2g	10ml	40	40	42	39	40. 3	3. 2
5g	0. 2g	5ml	50	48	49	49	49. 0	1. 7

\* Condition: 30°C for 4 hours

#### *Comparison between fresh soil and dried soil*

Usually, it is hard to analyze large numbers of fresh soil sample in time, moreover mineral nitrogen in fresh soil varies greatly during storage, while in dried soil it changes little if being stored appropriately. So it is most necessary to know if drying process can affect the test of alkali-hydrolyzable nitrogen. The data in Table 5 make it clear that no obvious changes are observed during drying process. The same result was also reported by other soil scientists.

**Table 5.** Comparison about alkali-hydrolyzable nitrogen (ppm)

Number	1	2	3
Fresh soil	13	84. 9	107. 4
Dry soil	14	83. 4	110. 9

#### *Relation between alkali-hydrolyzable nitrogen and mineral nitrogen*

Ten kinds of soils in Beijing suburbs were analyzed for mineral nitrogen by routine Method and alkali-hydrolyzable nitrogen by

Modified Conway Method. Comparing statistically these two groups of data (in Table 6), a closely correlation was observed between N<sub>mod</sub> and N<sub>min</sub> ( $r=0.982^{**}$ ). The regression equation is  $N(\text{modified}) = 4.73 + 0.893 N(\text{min})$ . The equation represents that nitrogen tested by Modified Conway Method consists mainly of inorganic nitrogen, a little amount of organic nitrogen and absorbed ammonium.

**Table 6.** Data of mineral nitrogen and alkali-hydrolyzable nitrogen (ppm)

Soil number	1	2	3	4	5	6	7	8	9	10
N modified	16. 0	21. 4	44. 7	29. 2	38. 3	27. 3	44. 9	22. 6	27. 3	19. 7
N mineral	13. 1	21. 2	40. 1	26. 3	40. 7	25. 0	45. 9	19. 7	26. 3	15. 2

#### **Conclusion**

It has been verified that culture method of mineralization is the best way for predicting soil nitrogen-supplying power, but it is a complicated process and time-consuming, and not suitable for applying to practice. Common Conway Method is easy to carry out for testing

alkali-hydrolyzable nitrogen, but not good enough in Northern China. Recently, the N<sup>-</sup>-min Method is very popular to use for predicting soil nitrogen supplying power in North America and western Europe, but it needs advanced equipments, so it is limited to some extent. Modified Conway Method can analyse alkali-hydrolyzable nitrogen which consists of mineral nitrogen. The analysis results can reflect the decomposable organic nitrogen and exchangeable ammonium and can predict more exactly soil nitrogen-supplying power, so it is easy to spread in basic units of our country.

## References

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