A New Application Field for Rare Earths – Agriculture*

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Up till present, rare earth elements (RE) have been widely applied in metallurgy, oil cracking, glass and ceramics, luminescence and magnetic materials etc. Before the 1970s, there were few reports on applications of RE in agriculture [1]. Chinese chemists, agronomists, pedologists and hygienists have been carrying out systematic research in this field for more than ten years. They have developed a new RE application field – agriculture.

1. Technique and Effect

Chinese agricultural specialists Ning Jiaben [2], Xie Huiguang *et al.* [3], Wang Guohong *et al.* [4], Lin Xijie *et al.* [5] have performed hundreds of experiments to compare cultivation with REs and control for various crops in different districts. The results indicate that REs help plants grow vigorously in certain conditions. The yield of crops was increased by 5–15% and also the quality of products was improved. The main technique applied is as follows:

(1) The amount of 'Nongle' applied is 400–700 g/ha (in the form of REO). 'Nongle' is a complex product with soluble RE nitrates or chlorides as the main components. If the amount applied is below or above the stipulated range, the effect would not be obvious or maybe even harmful to crop growth.

(2) The application methods used can be: seed dressing (soybean, peanut etc.), leaf spraying (flue-cured tobacco, watermelon etc.), root soaking (narcissus) or using a mixture of these methods. It must be noted that the time of leaf spraying is very important. It is best to use REs at the primary growth stage of crops.

(3) The experiments showed that 'Nongle' cannot replace common manure. It can enhance metabolism of crops and uptake of nutrient elements if common manure is sufficient.

Many years of experiments have shown that by applying RE to some plants, the output of crops increases steadily. Some results are listed in Table I.

TABLE I. Increase in Yield of some Crops Treated with 'Nongle'

Crops	Increase in yield (average)	
	(T/ha)	(%)
Rubber tree	0.10	8–15
Sugar cane	6.08	10–15
Chinese cabbage	8.00	10–20
Wheat	0.22	6–12
Flue-cured tobacco	0.20	8–10
Litchi		14–17
Beet	2.25	6–10
Rice	0.30	6–10
Watermelon	2.25	8–10
Apple	1.12	10–15
Peanut	0.18	8–12
Grape	1.00	8–12

One of the important advantages of using 'Nongle' is that it results in a more vigorous plant growth and better crop quality. With 'Nongle', the sugar content of beet, watermelon and sugar cane increased by 0.4%, 0.5–1.0% and 0.5%, respectively. The rate of growth of first class tobacco increased by 10–15% and the big bulb of narcissus increased by 25%.

China initiated the application of RE in agriculture and the RE consumption in agriculture ranks first in the world. The total area to which RE was applied was about one million ha in 1986 (Fig. 1).

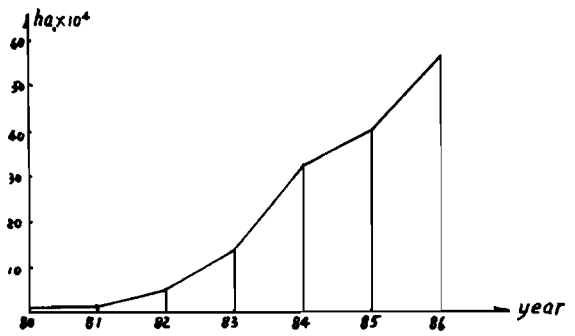

Fig. 1. The test areas for RE application in agriculture from 1980–1986.

2. The Main Factors of the Increasing Crop Output Caused by RE

RE can promote the metabolism and nutritious growing of crops. The main reasons are outlined as follows.

2.1. RE Promotes Rooting and Germination of Crops

Using solutions of different concentration RE for seed soaking, there are different degrees of promotion

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for germination of wheat, barley, radish, rape and cabbage. Table II shows the germination percentage increased by 8–19% for winter wheat treated with seed soaking [6]. For comparison, we tested the role of NH_4NO_3 in germination, and it was shown that NH_4NO_3 did not give any increase in germination percentage.

TABLE II. The Effect of RE–Nitrate on the Germination of Seeds of Winter Wheat

	Water (control)	$RE(NO_3)_3$ dose (ppm)				
		500	250	125	60	30
Germination percentage (%)	74.8	89.2	88.0	83.6	81.2	85.6
Germination increase (%)	0.0	19.2	17.6	11.7	8.5	14.4

Experiment results indicated that RE could stimulate rooting of plants. When the concentration of RE is in the range of 0.1–1.0 ppm, it promotes rooting of beans and cucumber; when the concentration of RE is 5 ppm it inhibits growth of bean root (Fig. 2).

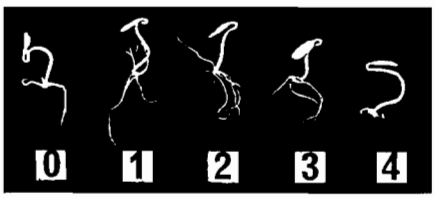

Fig. 2. The effect of promoting rooting for crops treated with RE.

2.2. REs Increase Chlorophyll Content of Crops

It has been proved by field experiments that the colour of crop leaves turns darker green by applying REs. Analytical data confirmed that the chlorophyll content increased by about 10%. The change of chlorophyll content for several crops is listed in Table III.

It is reported that REs can enhance crop uptake and transfer of phosphorus and also promote photosynthesis.

TABLE III. The Change in Chlorophyll Content of Crops by Applying RE

Crop	Treatment	Chlorophyll content	
		(mg/g fresh weight)	(%)
Peanut	control	3.718	100.0
	leaf spraying	3.981	107.0
Soybean	control	1.624	100.0
	leaf spraying	1.961	120.8
Rice	control	3.079	100.0
	leaf spraying	3.442	111.9

3. The Evaluation of Safety for Applying RE in Agriculture

The average RE_2O_3 contents in the crust and in soil are 0.015–0.02%. All plants contain RE, the average content in fresh weight is about 0.003%. Generally, RE is 0.1–0.5 ppm in grains and 0.8% in animal's ashes. REs participate in the cycle of biological food chains in nature.

According to Su Dexhao's determination, one human body in normal condition absorbs RE at about 2 mg/day from food and water.

The analysis of wheat treated with RE in the last four years indicated that, between the samples and the control, there is no evident change of the RE content.

Conclusion

Chinese experts have applied the physiological activity of RE to agricultural production and have achieved great economic benefits.

References

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