EFFECT OF AMINE–RARE EARTH ON TEA CULTIVATION IN BAT XAT, LAO CAI

Received: 21-05-2025

Pham Ngoc Chuc[1], Nguyen Trung Kien[1]*, Nguyen Thi Ha Chi[1], Nguyen Quang Bac[1], Phung Thuy Van[2], Dao Ngoc Nhiem[1]

[1]*Institute of Materials Science, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet Street, Cau Giay, Hanoi 100000, Vietnam*

[2] *Bat Xat Department of Agriculture and Environment, Bat Xat, Lao Cai 330000, Vietnam*

**E-mail: nguyentrungkien1009@gmail.com*

TÓM TẮT

ẢNH HƯỞNG CỦA PHÂN BÓN AMINE-ĐẤT HIẾM ĐẾN CANH TÁC CÂY CHÈ TẠI HUYỆN BÁT XÁT (LÀO CAI)

Trong nhiều năm trở lại đây, sản xuất chè hữu cơ để cung cấp các sản phẩm chè chất lượng cao thu hút được sự chú ý tại nhiều nơi. Chất lượng (cây) chè phụ thuộc vào nhiều yếu tố như là chất lượng đất, điều kiện thời tiết và điều kiện canh tác. Trong những yếu tố đó là việc sử dụng các loại phân bón vi lượng để tăng cường sinh trưởng năng suất và chất lượng chè. Phân bón lá đất hiếm được tổng hợp dưới dạng phức chất hữu cơ để tăng cường khả năng hấp thụ vi lượng đồng thời tăng cường tổng hợp dưỡng chất cho cây trồng. Nghiên cứu đánh giá ảnh hưởng của phân bón là amin-đất hiếm trong quá trình canh tác và phát triển của cay chè tại xã Mường Hum, huyện Bát Xát tỉnh Lào Cai. Việc sử dụng phân bón là amin-đất hiếm làm tăng tốc độ phát triển, độ dài búp và thành phần một số hoạt chất như tannin, caffeine và polyphenol của cây chè. Với lượng phun 300 mL phân bón amin-đất hiếm với mỗi hecta, sản lượng chè tăng 16,07%, hàm lượng caffein tăng 8,81% và polyphenol tăng 3,42% so với mẫu đối chứng.

Từ khoá: *chế phẩm amin-đất hiếm, phân bón vi lượng, lượng phun, chè Mường Hum.*

1. INTRODUCTION

Rare earth elements are progressively being studied and applied in the agricultural sector. The roles and impacts of rare earth elements on the growth and productivity of plants have been studied[1]. When using rare earth element fertilizers, plants increased growth ability, stimulated root development, increased chlorophyll content (thereby facilitating photosynthesis), and enhanced nutrient absorption. Consequently, the productivity and quality of certain cereal crops, fruit trees, and vegetables were increased. In addition, the dosage of foliar fertilizers containing rare earths affected the growth and development of plants. It stimulated growth at low concentrations and inhibited the development of roots and leaves at elevated concentrations[2]. Study on plants having developed root systems demonstrated that the suitable rare earth concentration for root growth and development was below 50 mg/L Ce and less than 200 mg/L La. Other work also indicated that the higher rare earth concentrations inhibited root growth and led to poor plant growth[3]. The presence of La in the form of $La(NO_3)_3$ at concentrations less than 150 mg/L could stimulate root growth, increase photosynthetic capacity, phosphorus utilization efficiency in phosphorus-deficient conditions, and the photosynthetic capacity of legumes[4]. A study on the effects of rare earth elements on tea plants showed that they enhanced the ability to stimulate shoot growth and increase the number of buds, and their concentration in tea leaves was very small after 25 days of spraying fertilizer[5]. Moreover, rare earth elements had the effect of inhibiting and restraining the continuous growth of fungi, consequently limiting the pathogens[6–8]. Rare earth element fertilizers were commonly used in tea production, and the accumulation of rare earth elements was mainly in the roots and stems of tea plants[9,10].

Rare earth elements were added to NPK and organic fertilizers to increase the quality and productivity of tea. Previous study showed that fertilizer containing rare earth elements helped plants to be healthy and increased productivity for tea plants from 22.87% to 24.39% and cabbage by 25%[11]. The presence of rare earth elements helped tea plants to increase the number of buds, reduce Mu Xeo disease, and increase productivity to 18.6%[12]. Mu Xeo disease happened in tea tops with two leaves without baby buds. In this study, the amine-rare earth product was tested on tea plants in Muong Hum Commune, Bat Xat District, Lao Cai province. Amine-rare earth product was an organic complex in a soluble form that could help plants absorb nutrients better.

2. EXPERIMENT AND RESEARCH METHOD

2.1. Object and research materials

The research object in this study was tea plants in Muong Hum (Bat Xat, Lao Cai, Vietnam). The amine-rare earth foliar fertilizer (AREFF) was prepared in the Inorganic Materials Laboratory of the Institute of Materials Science. The substituents of AREFF include organic compounds (5%), nitrogen (total nitrogen 7.5%), potassium (K: 23%), lanthanum (La: 0.2%), cerium (Ce: 0.25%), Praseodymium (Pr: 0.03%), Neodymium (Nd: 0.15%), and Gadolinium (Gd: 0.00045%).

2.2. Methodology

The experiment was applied with five spraying formulas and repeated three times. A control sample was sprayed with water. The experiments were performed on tea areas fertilized according to the technical process of intensive cultivation and sprayed with amine-rare earth foliar fertilizer. The area of each experimental plot was 1000 m^2, and the experiment was sprayed for five months (from February 2024 to June 2024). The amine-rare earth solution was mixed in a 16-L tank with water, shaken well, and sprayed on leaves after harvesting and cutting branches. Each experimental plot was sprayed with the following formulas:

- Formula 1 (CT1): Present fertilizer formula according to the cultivation process and sprayed with water;

- Formula 2 (CT2): Present fertilizer base formula according to cultivation and sprayed with 15 mL solution of AREFF/16-L tank/ spray;

- Formula 3 (CT3): Present fertilizer base formula according to cultivation and sprayed with 20 mL solution of AREFF/16-L tank/spray;

- Formula 4 (CT4): Present fertilizer base formula according to cultivation and sprayed with 25 mL solution of AREFF/16-L tank/spray;

- Formula 5 (CT5): Present fertilizer base formula according to cultivation and sprayed with 30 mL solution of AREFF/16-L tank/spray;

- Formula 6 (CT6): Present fertilizer base formula according to cultivation and sprayed with 40 mL solution of AREFF/16-L tank/spray.

2.3. Tea plant growth monitoring and analysis methods

The growth ability of each bud stage was screened for 10 days, 15 days, and 20 days, and the average length of buds was measured in each experimental plot. The average bud density and Mu Xeo disease of buds per m^2 were examined by counting the number of buds in a 25×25 cm^2 frame at 5 diagonal points of the experimental plot. Bud weight was determined by weighing the bud mass in each experimental plot. The appearance of tea samples was evaluated according to TCVN 3218:2012 and private standard 10TCN 745:2006. The soluble, tannin, polyphenol, and caffeine contents were determined by TCVN 9743:2013, $KMnO_4$ titration method (Leventhal method with coefficient k = 0.00582), TCVN 9745:2013, and TCVN 9744:2013, respectively. The rare earth trace elements and heavy metals in tea samples were finally analyzed using the inductively coupled plasma mass spectroscopy (ICP-MS) method at the Institute of Geography, Vietnam Academy of Science and Technology. A random pool of 100 samples was collected to examine those criteria.

3. RESULTS AND DISCUSSION

3.1. Effect of rare earth amine product on tea bud growth

Before spraying the amine-rare earth product on the experimental plots, the tea was pruned, fixed canopy, and fertilized through the cultivation process. Experimental plots were sprayed with fertilizer formulas, and monitored the growth of the tea buds was monitored. The experimental results of the effect of the amine-rare earth product on the growth of the tea buds were shown in Table 1 and Figure 1.

Table 1. Effect of AREFF on tea bud growth

Formula	The growth speed of the tea bud		
	10 days (cm)	15 days (cm)	20 days (cm)
CT1	6.74	12.33	15.41
CT2	7.92	13. 87	16.54
CT3	8.12	14.05	17.43
CT4	8.15	14.91	18.16
CT5	8.48	15.31	18.97
CT6	8,27	14,93	17,21

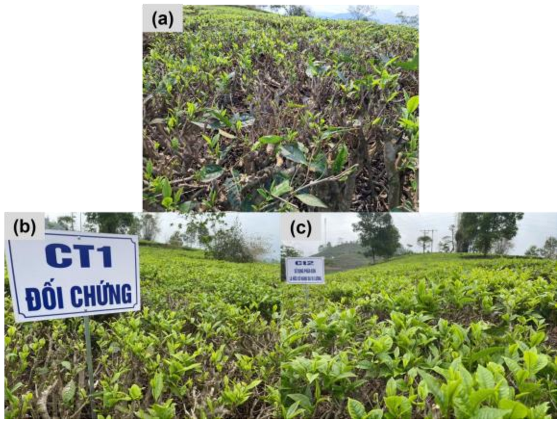

Figure 1. Tea samples (a) before and after spraying (b) without and (c) with AREFF for 20 days.

The survey results showed that the growth rate of tea buds when sprayed with amine-rare earth products was faster than the control sample in all formulas (CT2, CT3, CT4, CT5, and CT6). In particular, formula CT5 with a spraying dose of 30 mL solution of AREFF/16-L tank for 1000 m^2 (equivalent to 300 mL per hectare) gave the best results. Rare earth elements stimulated the growth of buds and increased chlorophyll content[13]. Thereby, they increased the ability of photosynthesis and the length of tea buds. In addition, when the concentration of rare earth elements is high, they could cause physiological inhibition, limit the ability to photosynthesis[14], and lead to the reduction of bud growth of tea plants.

3.2. Effects of AREFF on tea buds

Bud density, the ratio of Mu Xoe disease, and tea bud weight were monitored and counted in each experimental plot and calculated per 1 m^2. The results are presented in Table 2.

Table 2. Effects of AREFF on some indicators of tea buds

Spraying formula	Bud weight		Bud density		Ratio of Mu Xoe disease
	g/ bud	%	Bud/ m^2	%	%
CT1	0.56	100.00	126.70	100	10.08
CT2	0.59	105.35	134.40	106.08	9.20
CT3	0.60	107.14	141.60	111.76	8.90
CT4	0.63	112.50	147.90	116.73	8.50
CT5	0.65	116.07	157.01	123.91	8.20
CT6	0.62	110.71	148.50	117.20	8.40

Table 2 showed that the weight of tea buds was increased from 5.35% to 16.07%, bud density from 6.08 to 23.91%, and the rate of Mu Xoe disease was reduced from 10.08% to 8.2% when tea plants were sprayed with AREFF. The CT5 formula was given the best enhancement for tea buds. The bud weight and bud density increased by 16.07% and 23.91%, respectively, whereas the rate of Mu Xoe disease decreased by 8.2% as compared to those of the reference samples. AREFF improved the nutrient absorbability of plants through roots, stems, and leaves, stimulates growth ability, as well as increased productivity even under phosphorus-deficient conditions[4]. When the concentration of rare earth elements exceeded the limitation of plants' absorbance, it reduced photosynthesis and reduced the effectiveness of growth stimulation on plants[14].

Table 3. Analysis and evaluation results by sensory

Formula	Appearance		Color		Order		Taste		Total	
	Comment	*Point*	*Comment*	*Point*	*Comment*	*Point*	*Comment*	*Point*	*Comment*	*Point*
CT1	Bud twisted relatively evenly, wings slightly clumped	3.35	Leaves were light green-yellow	2.89	Fragrant	2.81	Astringent, slightly bitter	2.84	Meet requirement	12.89
CT2	Leaves were green, twisted, firm	3.62	Clear, bright yellow-green	3.45	Light fragrance, no strange taste	3.33	Gentle astringent	3.53	Meet requirement	13.93
CT3	Leaves were Green, twisted, slightly firm	3.71	Clear, green, dark yellow,	3.62	Light fragrance, no strange taste	3.58	Gentle astringency, harmonious flavor	3.61	Meet requirement	14.52

Formula	Appearance		Color		Order		Taste		Total	
	Comment	*Point*	*Comment*	*Point*	*Comment*	*Point*	*Comment*	*Point*	*Comment*	*Point*
CT4	Leaves were green, twisted, firm	3.85	Clear, green, dark yellow,	3.76	Light fragrance, no strange taste	3.60	Gentle astringency, harmonious flavor	3.67	Meet requirement	14.88
CT5	Leaves were green, twisted, firm	3.95	Clear, green, dark yellow,	3.83	Light fragrance, no strange taste	3.78	Gentle astringency, harmonious flavor	3.86	Meet requirement	15.42
CT6	Leaves were green, twisted, firm	3.86	Clear, green, dark yellow,	3.78	Light fragrance, no strange taste	3.62	Gentle astringency, harmonious flavor	3.72	Meet requirement	14.98

Table 4. Biochemical contents and rare earth residues of testing tea samples

Unit / CT	**Caffeine content** %	**Solute content** %	**Tannin content** %	**Polyphenol content** %	**Arsenic content** mg/kg	**Mercury content** mg/kg	**Lead content** mg/kg	**Cadmium content** mg/kg	**Rare earth content** mg/kg
CT1	4.14	40.9	25.1	21.33	0.350	0.01	0.338	0.01	Trace
CT2	4.39	41.4	27.7	21.74	0.256	0.01	0.331	0.01	Trace
CT3	4.42	41.5	28.3	21.86	0.251	0.01	0.330	0.01	Trace
CT4	4.46	41.6	28.9	21.98	0.247	0.01	0.329	0.01	Trace
CT5	4.54	41.8	29.1	22.06	0.247	0.01	0.325	0.01	Trace
CT6	4.48	41.6	28.8	21.93	0.247	0.01	0.328	0.01	Trace

3.3. Effect of AREFF on tea product quality

After being harvested from the experimental plots, tea leaves were processed to identical procedures, such as withering, rolling, and drying. The analyses and evaluation of tea quality by sensory were presented in Table 3.

The qualities of the tea samples after testing with the AREFF showed that all tea samples were of good quality and classified as meeting requirements. The tea samples made by the present process had a twisted appearance, firm wings, a unique green color of young tea, a gentle astringent of tea, and a bright yellow color of water without a strange smell. The highlight of the tea sample when sprayed with amine-rare earth product was that the tea water was clear, bright yellow, and had a mild aroma, and stimulated the taste of tea drinkers.

3.4. Effect of amine-rare earth product on biochemical composition of tea samples

Tea samples showed good results of sensory results. The biochemical contents were analyzed to assess tea quality. The results of the biochemical analyses of some Vietnamese standards were presented in Table 4. Among the biochemical compositions in tea, polyphenol and tannin compounds were two important compositions to assess the aroma and taste of the tea product. According to the obtained data in Table 4, the tea samples using AREFF exhibited an improvement in tannin and polyphenol contents of 1.22 – 2.20% and 1.92% – 3.42%, respectively, as compared with the reference samples. Therefore, the natural aroma and astringency of the tea sample using AREFF were more characteristic than the control sample. Otherwise, the caffeine content increased from 6.03% to 8.81% and was supported by better nerves. Rare earth elements helped tea plants increase photosynthetic ability. Therefore, mineral contents were increased by metabolism and synthesis of substances[15]. Metal contents were lower than those of the maximum allowable standards for tea products, while the rare-earth element contents in tea samples were traced and unaffected by tea quality and health[16]

4. CONCLUSION

The study of the effects of using amine-rare earth products on the cultivation of tea plants in Muong Hum Commune, Bat Xat District, Lao Cai (Vietnam), showed that tea yield was increased by 16.07%, whereas the contents of crucial compounds in tea products, including caffeine, tannin, and polyphenol, were remarkably enhanced by 8.81%, 2.20%, and 3.42%, respectively. On the other hand, the contents of heavy metals in tea samples were lower than the maximum allowable standards, and rare earth element contents were traced.

Acknowledgments: This study was funded by the project *"Experimental research on nano-organic foliar fertilizer with multiple micronutrients for some plants in Lao Cai province"* under contract No. 13/2023/HDKHCN of Lao Cai Department of Science and Technology, Lao Cai Province and Institute of Materials Science, Vietnam Academy of Science and Technology.

Declaration: This work is original and has not been submitted to any journal. The authors declare no conflict of interest.

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