

Research to Develop Integrated Solutions to Improve Environmental Soil of Tea in Tancuong Area Thainguyen Province Vietnam after 50 Years Exploitation and Using

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Abstract: This paper presents the results of research on integrated solutions to improve environmental soil of tea in Tancuong area, Thainguyen province, Vietnam. The study used organic fertilizer combined with mineral fertilizer and mulching solution. The study results showed mulching by *Gleicheniaceae* plays an important role in increasing the amount and quality of organic matter in the soil, and also improves some of the physical and chemical properties of the soil. The using of 3 types of micro bio organic fertilizer: Songgianh, Quelam 01 and Caudien fertilizer has affected bud density, bud weight, tannin content and solubility of the green tea business period. The 30% replacement of mineral fertilizer by Songgianh fertilizer is the best formula for both the productivity and quality of the tea product compared to other formulas.

Keywords: tea soil, soil improve, organic fertilizer, soil organic, *gleicheniaceae*

1. Introduction

Thainguyen province is the place suitable for developing of tea plants. Thainguyen Tancuong especially tea is long famous at home and abroad. Currently, the province's total tea area is 19,450 ha, including afforestation and rehabilitation of 6,000 ha. Production has reached 136,340 ton, the value averaged 2000 USD/ha.

Tancuong is a region of Thainguyen city that consists of 1/2 mountainous area. Mainly topography is hilly which slope from 7° to 20° and interspersed shallow valley deposition. It has an altitude of 40 m - 230 m compared to sea level.

The land in Tancuong has been exploited and used for cultivating tea plants for about 60 years. For tea groups which were planted about 10 years before the degradation of soil fertility and affecting to productivity and quality of tea have no obvious symptoms. But for tea groups which were planted over 40 years become seriously affected. The productivity of tea in 10 years has not increased, but tends to decline (about 10-15%). In this area, tea buds are hard so it creates many kinds of teas grade

B, and smell of tea flavor "nuggets" of tea Tancuong which created by phenol compounds and aromatic benzene ring's loss to 22-27%. The "after sweet" is also not good indicators as total sugar content was decreasing (Institute of Soils and Fertilizers, 2004-2007)... Notably tea cultivation area over 40 years is the largest area in the region and It is creating specialty tea brand Tancuong.

This study was carried out to contribute to restoring production capacity of land reducing soil fertility, improving soil environment, contributing to the safety of agricultural production thereby maintaining and sustaining brand tea Tancuong.

2. Material and methods

2.1. Materials research

- Tea soil in the area of research, fertilizer, tea tree, tea cultivation techniques..

- The study was conducted in the area tea cultivation at least 50 years old, where located in the geographical indication "Tancuong". The selected regions are declining yield and declining quality. Three communes are Tancuong, Phucxuan, Phuc triu in tea growing region of Tancuong, Thainguyen City, Thainguyen Province, Vietnam.

- Duration: From 1/2014 to 6/2016. Data were collected and refer to the period from 2000 to 2016.

2.2. Research Methods

To arrange experiments randomized complete block for tea cultivation is not high uniformity, in the form of big box, little box. These experiments are as follows:

Exp. 1: To impact using mulching material over time in some soil parameters.

Material for mulching is *Gleicheniaceae*. The tracking parameter is OM, humidity, pH ... during 4 years.

The treatments are as follows:

- Control: 270N +90 P₂O₅+90 K₂O.

- Treat: Control+20 tons *Gleicheniaceae* (dry).

Exp. 2: Assessing to use microbial fertilizers on soil properties.

Selecting micro bioorganic fertilizers: Songgianh fertilizer (humidity: 30%, Organic: 15%;

P₂O₅: 1.5%; Humic acid: 2.5%; Aspergillus sp: 1 x 10⁶ CFU/g; Azotobacter: 1x10⁶CFU/g; Bacillus: 1x10⁶ CFU/g; Quelam 01 fertilizer (humidity: 30%, Organic: 15%; P₂O₅: 1.5%; Aspergillus 1 x 10⁶ CFU/g; Azotobacter: 1x10⁶CFU/g; Bacillus: 1x10⁶ CFU/g); Caudien fertilizer (organic matter > 23%, N:P:K equal 2.5: 2.2: 3.3).

Care techniques according to 10TCN 446-2001 (Standard of Vietnam). Apply for 4 times in each period: Late February: 25% N + 60P₂O₅; early May: 30% N + 50K₂O; Early July: 30% N + 40P₂O₅ + 50K₂O; Early September: 15% N. Tea plant is business stage.

Control formula is common formula applying in Tancuong. We used 70% of N from the control formula add to 30% of N from micro bio organic fertilizers. Experimental formula:

Control: 270N +90 P₂O₅ + 90K₂O + 20 tons manure;

Treatment 1: 70% of control + 30% Songgiah;

Treatment 2: Control + 30% Songgiah fertilizer;

Treatment 3: 70% Control + 30% Quelam 01 fertilizer;

Treatment 4: Control + 30% Quelam 01 fertilizer;

Treatment 5: 70% Control + 30% Caudien fertilizer;

Treatment 6: Control + 30% Caudien fertilizer.

Dose application: Songgiah fertilizer: 1620kg/ha, 2 times/year; Quelam 01 fertilizer: 2700 kg, 2 times/year; Caudien fertilizer: 3240kg/ha, 2 times/year.

3. Results and discussion

3.1. Solution using cover material

Objectives: To improve organic content, enhance moisture retention, reduce soil erosion and leach.

Note 1: Do not mulch more than 3 years. It is necessary to delay at least 1 year.

The effectiveness of the solution is shown in Table 3.1.

Table 3.1. The characteristic of soil chemical and physical have been changed by mulching

| Mulching time | Start | | 1 year | | 2 years | | 3 years | | 4 years | |
|---------------------|---------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|-----------|
| | Control | Treatment |
| pH _{KCl} | 3.2 | 3.2 | 3.25 | 3.31 | 3.15 | 3.83 | 3.10 | 3.93 | 3.04 | 4.42 |
| W _{tp} (%) | 38.94 | 38.94 | 38.90 | 40.27 | 38.2 | 44.07 | 38.0 | 42.18 | 38.0 | 41.36 |
| OM (%) | 3.60 | 3.60 | 3.52 | 4.52 | 3.45 | 4.78 | 3.20 | 4.39 | 3.01 | 4.02 |

The results showed that the amount of organic matter accumulated in the soil is changed by the time of mulching. Total organic matter accumulation increased and concentrated mainly in the period from 1 to 2 year after mulching. The highest of organic content in soil is the second year after covered by Gleicheniaceae. After one year, organic matter content in the soil is increased rapidly. Before mulching, average value of OM is 3.60% but after mulching it is 4.02%.

This cause is due to slow decay of Gleicheniaceae. The content of hydrocarbons (lignin, cellulose and hemixenlulo) in Gleicheniaceae are high level, it is the main cause. Therefore, during the first 12 months, mulching Gleicheniaceae provided a very small amount of organic matter to the soil but it is essential for protection of soil fertility, erosion control, weeds and especially moisture retention. After 2 years, the rest of the Gleicheniaceae is difficult to decay. On the other hand the amount of Gleicheniaceae also reduces so the process of supplying organic matter to the soil also reduced. At this time organic matter mineralization increased while the humus decreased. After 3 years mulching by Gleicheniaceae, OM content is 4.39%, although it decreased 0.39% compared to the second year, but OM content is still quite good. In the fourth year,

OM content decreased but not much in comparison with the third year. It increased by 0.14% compared to the original time without mulching. After 3 years OM content in the soil not only increased but also decreased. Therefore, after 3-4 years, organic sources for soil should be added to soil.

After 1 year mulching pH_{KCl} is 3.31, It is not much increasing compared to the first time. However, the acidity is improved after 2 years mulching. pH_{KCl} is 3.83. After 3 years mulching it increased to 3.93 and in the 4th year pH_{KCl} is 4.42. The pH_{KCl} value of the control formulas gradually decreased from 3.2 to 3.04 after 4 years of cultivation.

Soil moisture increased in the first year mainly due to the role of organic matter formed and accumulated in the soil. However, in the first year the vegetation residue was not much decomposed. By the second and the third year, the soil moisture content significantly improved due to the more intensive organic decomposition and accumulation in the soil, the organic matter content in the soil is higher. However, in the third and fourth year, the moisture content decreased as tends of OM mineralization in the soil increased. Humus content and OM in the soil decreased. Conversely, the moisture values in the control formula were almost

unchanged or decreased slightly from 38.94 to 38.0 after 4 years of cultivation.

3.2. Solution using mineral fertilizers combined with micro bioorganic fertilizer

Objectives: To limit NO_3^- residues in fresh tea buds, restoration soil structures *Effectiveness of the solution applied to green tea production stage of business:*

Crop yield is the productive efficiency of the crop expressed by the number of products produced per unit of time. The yield of fresh tea buds consists of two main elements: bud density (bud/m²) and bud weight (gram/bud).

The results of the experiment (Table 3.2) show that the initial use of different micro bio organic fertilizers effected bud density, bud weight and fresh yield in treatment 6. Bud density in all treatment increased compared to control treatments without micro bioorganic fertilizer. There are differences, in the formula groups (treatment 1 & treatment 2; treatment 3 & treatment 4; treatment 5 & treatment 6). In most cases, when replacing 30%

Table 3.2. The effect of micro bioorganic fertilizer application on some of the constituents of fresh tea bud yield

| No | Treatment | bud density (bud/m ²) | bud weight (gram/bud) | Theoretical productivity (Tons of fresh bud / picking) | Real productivity (Tons of fresh bud / picking) |
|---------------------------|-------------|-----------------------------------|-----------------------|--|---|
| 1 | Control | 373 | 0.638 | 1.904 | 1.82 |
| 2 | Treatment 1 | 387 | 0.629 | 1.947 | 1.88 |
| 3 | Treatment 2 | 470 | 0.524 | 1.970 | 1.92 |
| 4 | Treatment 3 | 480 | 0.509 | 1.955 | 1.86 |
| 5 | Treatment 4 | 437 | 0.549 | 1.919 | 1.83 |
| 6 | Treatment 5 | 437 | 0.486 | 1.699 | 1.74 |
| 7 | Treatment 6 | 480 | 0.495 | 1.901 | 1.81 |
| LSD_{0,05} | | 41 | 0.013 | 0.127 | 0.09 |
| Cv(%) | | 8.76 | 8.05 | 7.99 | 8.31 |

The effectiveness of the solution affects the quality of dried tea buds in the business stage

Tannin is an important biochemical indicator of the quality of tea products. For black tea products, tannin is the principal substance for color and taste. The taste of green tea products will be better if the tannin content is suitable level. The high tannin content will make bitter tea not suitable for the consumer's market.

The analysis of tannin content in green tea buds of experimental and control formulas (Table 3.3) showed that tannin significantly reduced when we

of fertilizer by micro bio organic fertilizer, density increased except for Quelam 01 fertilizer in treatment 3 and treatment 4.

However, the results of the analysis on buds of weight showed that the weight of fresh tea buds reduced when we used three types of micro bio organic fertilizer compared to non-micro bio organic fertilizer at control. The addition of 30% of mineral fertilizers in the form of Songgiah and Caudien fertilizer respectively does not increase the weight of buds, and sometimes lead to the phenomenon of reducing fresh tea buds.

Analytical results showed that the yield of fresh buds increased compared to control when we used Songgiah fertilizer (Treatment 1 and Treatment 2). In treatment 3, when using Quelam 01 fertilizer, the yield was higher than control, but with treatment 4 the results showed no significant difference in productivity. In treatment 5 and treatment 6 when using Caudien fertilizer the results showed that if we reduce 30% of mineral fertilizers the yield will reduce compared to the control.

used compost compared to control using only mineral fertilizers. When we added 30% of the mineral fertilizers (for three types), the tannin content increased compared to replace 30% of mineral fertilizers by organic fertilizer. However, it should be emphasized that the tannin content of all 7 treatments were standard for exported green tea.

Table 3.3. Impact of microorganism fertilizers on biochemical parameters of tea product.

| No | Treatment | Tanin (%) | Solule (%) |
|----|-----------|-----------|------------|
| 1 | Control | 29.10 | 41.68 |

| | | | |
|---------------------------|-------------|-------|-------|
| 2 | Treatment 1 | 26.62 | 42.13 |
| 3 | Treatment 2 | 28.73 | 43.69 |
| 4 | Treatment 3 | 25.78 | 41.22 |
| 5 | Treatment 4 | 26.51 | 42.3 |
| 6 | Treatment 5 | 23.54 | 36.75 |
| 7 | Treatment 6 | 26.62 | 41.4 |
| LSD_{0.05} | | 0.70 | 1.32 |
| Cv(%) | | 8.18 | 7.89 |

The results of dissolved solids analysis (Table 3.4) showed that using Caudien fertilizer reduced the amount of dissolved matter compared to the control. The addition of 30% nutrients in the form of organic fertilizers also has different effects on the solubility in tea buds, which is higher than the control. Comparing to the export standards of green tea with dissolved solid, all 7 recipes were satisfactory (> 34% required).

Sensory analysis by scoring method is one of the important indicators for assessing the overall effect of basic factors: breed, care regime, raw material collection, technology and processing... to tea products.

According to Vietnamese standards (TCVN 3218 - 1993), most of the tea products in the treatment formulas (except treatment 3 and treatment 5) were evaluated satisfactorily, their composite scores compared to those of tea products the control is equal or higher. Treatment 1 (replacing 30% of mineral fertilizers with Songgiah) had the highest sensory score (17.10 point). Treatment 5 had the lowest score (12.10 point).

Conclusions

Mulching by Gleicheniaceae plays an important role in increasing the amount and quality of organic matter in the soil, and also improves some of the physical and chemical properties of the soil. The increase in organic matter accumulation occurred in the first and second year and then tends to decrease in subsequent years. Therefore, it is necessary to have a cover-up method after 2 years to stabilize soil organic matter. In order to achieve high efficiency, it is necessary to add a suitable amount of fertilizer and provide sufficient soil moisture to promote the decomposition and accumulation of organic matter in the soil.

The use of 3 types of micro bio organic fertilizer: Songgiah, Quelam 01 and Caudien fertilizer has affected bud density, bud weight, tannin content and solubility of the green tea business period. Replacing 30% of mineral fertilizer by micro bio organic fertilizer did not reduce the yield of fresh bud tea as well as the content of dissolved tea in bud tea compared to the control formula when using one

of two types of fertilizer: Songgiah or Quelam 01 fertilizer. The 30% replacement of mineral fertilizer by Songgiah fertilizer is the best formula for both the productivity and quality of the tea product compared to other formulas.

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