Effects of Applying Symbex on Tea Yield, Quality and Soil Fertility

Dongfeng Huang1,2*, Yu Li 1,2 and Xiaoxuan Qiu1,2
1Institute of Soil and Fertilizer, Fujian Academy of Agricultural Sciences, Fuzhou, China;
2Fujian Key Laboratory of Agro-products Quality & Safety, Fuzhou, China

*Corresponding author email: huangdongfeng@faas.cn

Abstract. Field plot experiments were conducted to study the effects of different doses of Symbex products (i.e., clear water, 50 times, 100 times, 150 times, 200 times and 250 times diluent) on tea yield, quality and soil fertility. The results showed that, compared with CK (clear water), applying different doses of Symbex diluent could increase the density of tea bud head by 2.7% ~ 25.3%, 100 bud weight by 3.6% ~ 21.1%, internode length by 5.3% ~ 21.1%, increase annual fresh tea yield by 7.6% ~ 37.9%, increase tea polyphenols by 9.4% ~ 41.4%, amino acids by 7.1% ~ 39.3%, soluble sugar by 9.4% ~ 41.4%, and water extract by 7.5%~43.9%. Results also showed that the soil organic matter, available nitrogen, available phosphorus and available potassium in the topsoil of tea garden increased by 2.4% ~ 29.8%, 13.7% ~ 98.1%, 26.2% ~ 98.0% and 24.4% ~ 102.2% respectively. Among them, T200 (Symbex 200 times diluent) and T250 (Symbex 250 times diluent) treatments had better effects on improving the morphological indexes and biochemical composition indexes of tea garden, increasing the yield of fresh tea leaves, and improving the basic available nutrient content in the topsoil of tea garden.

1. Introduction
Symbex, developed by the US company Agri-k, is specifically designed to improve crop yield and quality with minimal plant inputs and is a microbial enzyme and metabolic catalyst. When Symbex was applied to soil, the enzyme and micronutrient caused a 10~20 fold increase in the normal population levels of beneficial bacteria and fungi. This reaction resulted in the acceleration of soil nutrient cycling and mineralization, and the increase of plant available nutrients, especially phosphorus and potassium, in soil. Symbex acts as a catalyst, rapidly increasing the number of existing bacteria and fungi in the soil within 30 to 40 days. During this time, the total microbial population in a given soil type will reach 5-20 times the normal level. It was this large and transient increase in the soil microbial population that demonstrated the many benefits of Symbex[1].
Symbex is neither inoculum nor compost and it is free of humic and fulvic acids. Symbex naturally increased indigenous microbial populations in the soil, which stimulated the production of natural organic acids and led to an increase in nutrient mineralization. Symbex can improve the following soil functions: Promoting nutrient cycling of organic matter; increasing soil permeability and carbon dioxide production; improving soil water permeability and moisture retention; and improving the rhizosphere, increasing the total amount of roots and functional roots, and increasing the biodegradation of pesticides[1].
At present, there are few reports about the application of Symbex on crops in China, only Cai Yueqing[2] reported the effect of Symbex on vegetables. In order to further verify the application effect
of Symbex on tea, this experiment was carried out to provide scientific basis for promoting the application of Symbex in tea gardens in red-yellow soil region of south China.

2. Materials and Methods

2.1. Test Design

The test site is located in Fuzhou Beifeng tea base of Fujian Mantangxiang Tea Industry Co., Ltd. The soil type is red-yellow soil in mountainous area, and the basic fertility of soil is medium. The tea variety for test is Jin Guanyin, planted in 2009. Six treatments were designed: Treatment 1, CK, fresh water, 150 kg/ha; treatment 2, Symbex 50 times diluted solution, 150 kg/ha; treatment 3, Symbex 100 times diluted solution, 150 kg/ha; treatment 4, Symbex 150 times diluted solution, 150 kg/ha; treatment 5, Symbex 200 times diluted solution, 150 kg/ha; Treatment with 6, Symbex 250 times dilution, 150 kg/ha. The Symbex product being tested was developed and provided by Agri-k Inc. Different multiples of Symbex diluents dilute the original solution of Symbex products to the corresponding multiples with water. The application method is: before the test, the soil of the tilling layer between tea rows in each test area is turned loose and the soil is broken, and then the test solution of each treatment is uniformly poured into the soil of the tilling layer between tea rows in each test area according to the test design. Each process is set to repeat 3 times. Each experimental plot has an area of 20m² and is arranged in random blocks. The trial period was from March to October 2019. Water and Symbex diluent were poured on the 27th of every month during the experimental period.

During the trial period, record the output of tea green in each trial plot. The picking time of tea green was late April in spring, early July in summer and early October in autumn, which was divided into three times. The contents of biochemical components in tea were determined with the samples of Spring Tea Green. On October 22, soil samples of 0~20 cm above the surface of the tea garden were collected in various trial plots according to the "S" shape line, and 500 g soil samples were collected after being well mixed.

2.2. Survey Contents and Observation Methods

Observation method of morphological index of tea garden[3-6]: Before picking spring tea in late April, the morphological indexes of tea garden were observed in each experimental plot, and the density of bud head was observed at 3 points in each plot, the weight of 100 buds and the length of internodes were recorded at the stage of one bud and three leaves.

2.3. Method of Sample Test

The sample analysis methods[7] were as below: Tea Polyphenols content was determined by GB/T8313-2002, Amino acid GB/T 8314-2013, water extract GB/T8305-2002, soluble sugar GB/T8305-2002 and other national standard methods. Soil organic matter was determined by the potassium dichromate method; Alkali hydrolyzed nitrogen was determined by alkali hydrolysis diffusion method; The available phosphorus was extracted with 0.05 mol•L⁻¹ NaHCO₃ and determined by molybdenum blue colorimetry. The available potassium was determined by flame photometry.

2.4. Data Processing

Microsoft excel-2003 office software was used to process the experimental data, and SPSS10.0 statistical software was used for analysis of variance and significance test.

3. Results and Analysis

3.1. Effects of Different Doses of Symbex on Morphological Indexes of Tea Garden

The results (Table 1) showed that: compared with CK (clear water) treatment, different doses of symbex had a certain promotion effect on the bud head density, 100 bud weight and internode length of tea garden. The bud head density increased by 2.7% ~ 25.3%, the 100 bud weight increased by 3.6% ~ 21.1%, and the internode length increased by 5.3% ~ 21.1%. Among them, T200 treatment had
the best effect on improving the morphological indexes of tea garden. The results of variance analysis showed that: (1) T200 treatment was significantly ($P < 0.01$) better than CK treatment, and significantly ($P < 0.05$) better than T50 treatment; T250 and T150 treatment were significantly ($P < 0.05$) better than T50 and CK treatment; while T100, T50 and CK treatment had no significant difference ($P > 0.05$). (2) For the effect of increasing 100 bud weight and internode length of tea garden, T200 treatment was significantly ($P < 0.05$) better than T100, T50 and CK treatment, but there was no significant difference between T250 and T150 ($P > 0.05$); except for T200, there was no significant difference among other treatments ($P > 0.05$).

**Table 1.** Effects of different doses of symbex on morphological indexes of tea garden

| Treatment | Bud head density (number/m$^2$) | Hundred bud weight (g) | Internode length (cm) |
|-----------|---------------------------------|------------------------|-----------------------|
| CK        | 29.3Bb                          | 47.8b                  | 1.9 b                 |
| T50       | 30.1ABb                         | 49.5b                  | 2.0 b                 |
| T100      | 32.4ABab                        | 51.2b                  | 2.1 b                 |
| T150      | 33.7ABa                         | 53.7ab                 | 2.2 ab                |
| T200      | 36.7Aa                          | 57.9a                  | 2.3 a                 |
| T250      | 35.8ABa                         | 54.2ab                 | 2.2 ab                |

Note: Small and capital letters following the value indicate the difference is significant at 0.05 and 0.01 level, respectively (Inspect by LSD, following is the same).

3.2. Effects of Different Doses of Symbex on Morphological Indexes of Tea Garden

The results (Table 2) showed that: compared with CK (clear water) treatment, different doses of Symbex products had a certain increase effect on fresh tea yield, spring tea yield increased by 11.6% ~ 49.4%, summer tea yield increased by 1.4% ~ 7.6%, autumn tea yield increased by 8.6% ~ 51.6%, and annual fresh tea yield increased by 7.6% ~ 37.9%. Among them, T200 treatment had the best effect on improving the yield of fresh tea. The results of variance analysis showed that T200 and T250 treatments were significantly ($P < 0.01$) better than T50 and CK, and significantly ($P < 0.05$) better than T150 and T100; T150 and T100 were also significantly ($P < 0.05$) better than T50 and CK; there was no significant difference between T50 and CK ($P > 0.05$).

**Table 2.** Effects of different doses of Symbex on fresh tea yield

| Treatment | Spring tea(kg/ha) | Summer tea(kg/ha) | Autumn tea(kg/ha) | Annual tea(kg/ha) | Increasing rate(%) |
|-----------|-------------------|-------------------|-------------------|-------------------|-------------------|
| CK        | 11368             | 9023              | 10546             | 30937Bc          | \                |
| T50       | 12689             | 9145              | 11458             | 33292Bc          | 7.6               |
| T100      | 13987             | 9328              | 12357             | 35672ABb         | 15.3              |
| T150      | 14228             | 9549              | 14689             | 38466ABb         | 24.3              |
| T200      | 16987             | 9687              | 15987             | 42661Aa          | 37.9              |
| T250      | 15982             | 9706              | 15079             | 40767Aa          | 31.8              |

3.3. The Effects of Different Doses of Symbex on the Biochemical Indexes of Tea

Table 1 showed that compared with CK treatment, different doses of Symbex could improve the biochemical indexes of tea, the contents of polyphenol, amino acid, soluble sugar and water extract of spring tea increased by 9.4% ~ 41.4%, 7.1% ~ 39.3%, 8.7% ~ 65.2% and 7.5% ~ 43.9% respectively. Among them, T200 and T250 treatments had the best effect on improving the biochemical index of tea. The results of variance analysis showed that: (1) T200 treatment was significantly ($P < 0.01$) better than T100, T50 and CK, and significantly ($P < 0.05$) better than T250 and T150; T250 and T150 were significantly ($P < 0.05$) better than T100, T50 and CK; T100 was significantly ($P < 0.01$) better than T50 and CK; there was no difference between T50 and CK Significant ($P ≥ 0.05$). (2) The results showed that T250 and T200 treatments were significantly ($P < 0.01$) better than T100, T50 and CK,
and significantly \((P< 0.05)\) better than T150; T150 treatment was significantly \((P< 0.01)\) better than T50 and CK treatment, but there was no significant difference between T100 \((P> 0.05)\); T100 treatment was also significantly \((P < 0.01)\) better than T50 and CK treatment; and there was no significant difference \((P > 0.05)\) between T50 and CK treatment. (3) To improve the soluble sugar content of spring tea, T250 and T200 treatments were significantly \((P < 0.01)\) better than T100, T50 and CK, and significantly \((P< 0.05)\) better than T150 treatment; T150 treatment was significantly better \((P< 0.01)\) than T100, T50 and CK treatment; T100 treatment was also significantly \((P< 0.01)\) better than T50 and CK treatment; while there was no significant difference between T50 and CK treatment \((P> 0.05)\). (4) The results showed that T250 and T200 treatments were significantly \((P< 0.01)\) better than T100, T50 and CK treatments, and significantly \((P< 0.05)\) better than T150; T150 treatment was significantly \((P< 0.01)\) better than T50 and CK treatment, and significantly \((P< 0.05)\) better than T100 treatment; T100 treatment was also significantly better \((P< 0.01)\) than T50 and CK treatment; there was no significant difference between T50 and CK treatment \((P> 0.05)\).

### Table 3. Effects of different doses of Symbex on biochemical indexes in tea

| Treatment | Tea Polyphenols Content (%) | Amino acid Content (%) | Soluble sugar Content (%) | Water extract Content (%) |
|-----------|-----------------------------|------------------------|----------------------------|---------------------------|
|           | Increase rate (%)           | Increase rate (%)      | Increase rate (%)          | Increase rate (%)         |
| CK        | 20.3Cd                      | 2.8 Cc                 | 2.3Cd                      | 30.5Cd                    |
| T50       | 22.2Cd                      | 3.0 Cc                 | 2.5Cd                      | 8.7                       | 32.8Cd  | 7.5 |
| T100      | 24.8Bc                      | 3.3 Bb                 | 2.8Bc                      | 21.7                      | 35.8Bc  | 17.4 |
| T150      | 25.9AB b                    | 3.5 ABb                | 3.3Ab                      | 43.5                      | 39.4AB b| 29.2 |
| T200      | 28.7Aa b                    | 3.8 Aa                 | 3.8Aa                      | 65.2                      | 43.9Aa  | 43.9 |
| T250      | 26.8AB b                    | 3.9 Aa                 | 3.6Aa                      | 56.5                      | 42.7Aa  | 40.0 |

3.4. **The Effect of Symbex on the Content of Basic Available Nutrients in the Topsoil of Tea Garden**

The results (Table 4) showed that compared with CK (clear water) treatment, the application of symbex at different doses had a certain promoting effect on improving the content of basic available nutrients in the topsoil of tea garden. The contents of soil organic matter, available nitrogen, available phosphorus and available potassium increased by 2.4%~29.8%, 13.7%~98.1%, 26.2%~98.0% and 24.4%~102.2%, respectively. Among them, T200 and T250 treatments had the best effect on improving soil available nutrient content of tea garden. The results of analysis of variance showed that:

(1) the effects of T200 and T250 on improving soil organic matter content in tea garden were significantly \((P< 0.01)\) better than T100, T50 and CK, and significantly \((P< 0.05)\) better than T150; T150 was also significantly \((P< 0.05)\) better than T50 and CK, but there was no significant difference between T100 and T150 \((P> 0.05)\); T100 was significantly better than T50 and CK \((P< 0.05)\) handle.

(2) The results showed that T200 treatment was significantly \((P< 0.01)\) better than T100, T50 and CK, and significantly \((P< 0.05)\) better than T150 and T250; T150 and T250 were also significantly \((P< 0.01)\) better than T100, T50 and CK; T100 was significantly \((P< 0.01)\) better than T50 and CK; T50 was significantly \((P< 0.05)\) better than CK. (3) The results showed that T200 treatment was significantly \((P< 0.01)\) better than other treatments; T250 treatment was also significantly \((P< 0.01)\) better than T150, T100, T50 and CK treatment; T150 treatment was also significantly \((P< 0.01)\) better than T100, T50 and CK treatment; T100 treatment was significantly \((P< 0.01)\) better than CK treatment, and significantly \((P< 0.05)\) better than CK treatment; T50 treatment was significantly better than CK treatment \((P< 0.01)\).
Table 4. Effect of Symbex on the content of basic available nutrients in tea garden topsoil

| Treatment | Organic matter (Content %) | Increasing rate(%) | Available nitrogen (Content %) | Increasing rate(%) | Available phosphorus (Content %) | Increasing rate(%) | Available potassium (Content %) | Increasing rate(%) |
|-----------|-----------------------------|-------------------|--------------------------------|-------------------|---------------------------------|-------------------|---------------------------------|-------------------|
| CK        | 16.8Bc                      | \                | 57.8 Ce                        | \                | 55.3De                         | \                | 53.7Ef                          | \                |
| T50       | 17.2Bc                      | 2.4              | 65.7 Cd                        | 13.7             | 69.8Cd                         | 26.2             | 66.8De                          | 24.4             |
| T100      | 18.8Bb                      | 11.9             | 85.4 Bc                        | 47.8             | 80.9Bc                         | 46.3             | 74.9Dd                          | 39.5             |
| T150      | 19.2AB                      | 14.3             | 107.9 Ab                       | 86.7             | 98.4Ab                         | 77.9             | 88.9Cc                          | 65.5             |
| T200      | 21.8Aa                      | 29.8             | 114.5 Aa                       | 98.1             | 109.5Aa                        | 98.0             | 108.6Aa                         | 102.2             |
| T250      | 20.4ABa                     | 21.4             | 103.9 Ab                       | 79.8             | 102.6Aa                        | 85.5             | 99.7Bb                          | 85.7             |

4. Discussion

Symbex is a microbial enzyme and metabolic catalyst. When it is applied to soil, the enzyme and biological micronutrient cause a rapid increase of beneficial bacteria and fungi (10~20 times normal population level). This reaction results in the acceleration of soil nutrient cycling and mineralization, and the increase of plant available nutrients (especially P and K) in soil[1]. As the results of this study show, the content of organic matter, available N, available P and available K in topsoil (0~20 cm) increased by 2.4%~29.8%, 13.7%~98.1%, 26.2%~98.0% and 24.4%~102.2% respectively when Symbex was applied with different doses (50~250 times dilution). It is the obvious increase of soil available nutrient that promotes the increase of tea yield and increases the content of biochemical components in tea so as to increase the yield and quality of tea. However, this study was only conducted on tea plantations in the red soil region of southern China, and further research is needed on the application effect of tea plantations in non-red soil region and in red soil region under different site conditions such as different elevation and location.

5. Conclusion

The results showed that: compared with CK (clear water) treatment, different doses of Symbex could increase the shoot head density of tea garden by 2.7% ~ 25.3%, 100 bud weight by 3.6% ~ 21.1%, internode length by 5.3% ~ 21.1%, annual fresh tea yield by 7.6% ~ 37.9%, tea polyphenols 9.4% ~ 41.4%, amino acids 7.1% ~ 39.3%, soluble sugar 8.7% ~ 65.2% and water extract 7.5% ~ 43.9% in tea garden, and increase the yield of tea green tea by 7.6% ~ 37.9%, tea polyphenols 9.4% ~ 41.4%, amino acids 7.1% ~ 39.3%, soluble sugar 8.7% ~ 65.2% and water extract 7.5% ~ 43.9; and improve soil organic matter by 2.4%~29.8%, available nitrogen by 13.7% ~ 98.1%, available phosphorus by 26.2% ~ 98.0% and available potassium by 24.4% ~102.2% of. Among them, T200 and T250 treatments had better effects on improving the morphological indexes and biochemical composition indexes of tea garden, increasing the yield of fresh tea leaves, and improving the basic available nutrient content in the topsoil of tea garden.

Acknowledgments

This work was supported by several projects, which included Fuzhou Science and Technology Project(2018-G-65), Fujian Provincial Public Welfare Research Institute Basic Research Project(2018R1022-4), and Fujian Provincial Academy of Agricultural Sciences Science and Technology Innovation Team Project(STIT2017-2-10).

References

[1] Agro-Hytec. Products. SYMBEX [EB/OL]. http://www.agrohytec.co.za/products.php.
[2] Cai Yueqing. Preliminary report on the application effect of symbex products on vegetables [J]. *Journal of Minxi Vocational and Technical College*, 2019, 21 (3): 109 ~ 111

[3] Chen Liang, Yang Yajun, Yu Fulian, et al. Description and data standard of tea germplasm resources [M]. Beijing: China Agricultural Press, 2005

[4] Zhang Yingjie, Zhang Yaohua, Tang qianyong. The application effect of foliar fertilizer on tea [J]. *Hubei Agricultural Science*, 2014, 53 (6): 1298 ~ 1300

[5] Kang Yankai, Huang Jing, Luo Yi, et al. Effects of two foliar fertilizers on the growth and quality of tea [J]. *Tea News*, 2019, 46 (3): 298 ~ 301

[6] Peng Jing, Han Nan, Chen Pengsheng, et al. Preliminary study on the influence of "spray Shibao" tea special fertilizer on Tieguanyin tea garden [J]. *Southern Agriculture*, 2016, 10 (25): 85 ~ 88

[7] Chinese soil society. Analytical methods of soil agrochemistry [M]. Beijing: China Agricultural Science and Technology Press, 2000