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Soil remediation fertilizers improve soil in tobacco production

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Abstract: The overall agricultural productivity of soil is decreasing because of soil acidification and consolidation. The single tobacco cultivation mode is usually executed in tobacco production, easily inducing degradation of soil productivity. The soil remediation fertilizers were often used to improve the quality and agricultural productivity of soil. Here, it was found that soil remediation fertilizers can increase invertase, phosphatase and urease activities in soil and improve the soil pH. The analysis of soil nutrient showed that the soil remediation fertilizers can significantly increase the organic matter content, the available p content, the available potassium content and the hydrolyable nitrogen content in soil. The invertase, phosphatase and urease activities in T3 are the highest in all treatments, therefore, the appropriate amount of soil remediation fertilizers should be used in tobacco production. These results are helpful for the popularization and application of soil remediation fertilizers in tobacco production.
[Yang LJ, Xu XJ, Yu BC, Lu YW, Song YC, Yang YY, Liu WQ, Jin WH, Guo HX. **Soil remediation fertilizers improve soil in tobacco production.** *Life Sci J* 2019;16(10):107-111]. ISSN: 1097-8135 (Print) / ISSN: 2372-613X (Online). http://www.lifesciencesite.com. 12. doi:10.7537/marslsj161019.12.

Keywords: soil remediation fertilizers, soil enzymes, soil productivity, tobacco production

1. Introduction

In recent years, the arable land area is decreasing year by year, and the overall agricultural productivity is declining. In order to improve the overall agricultural productivity, a large amount of fertilizer is applied to the soil, which not only leads to soil acidification, soil consolidation, soil quality decline, soil nutrient loss, but also reduces the utilization rate of fertilizer, seriously affecting the quality of agricultural products [1]. Zhumadian city is one of the main areas of flue-cured tobacco production in Henan province of China. Long-term single tobacco cultivation mode will easily lead to degradation of soil quality, disruption of soil microbial flora balance, occurrence of crop diseases and insect pests caused by pathogenic bacteria, which will affect the normal growth and development of tobacco, and eventually reduce yield and quality [2]. Therefore, the study of soil improvement mechanism, exploration of comprehensive soil control measures, improvement of soil physical and chemical properties, enhancement of soil productivity, and construction of healthy and harmonious soil environment in tobacco fields are the ultimate way of sustainable development of tobacco production in Zhumadian city.

Biomass charcoal can not only reduce the soil bulk density, but also increase the soil pH, soil reunion and soil water-holding capacity. It is also used as natural nitrogen fertilizer relievers for slowing the release of fertilizer in soil and reducing the leaching loss of nutrient. A large number of studies have shown that the mixed application of biomass charcoal and fertilizer has positive effect on crop growth and yield [3-5]. Soil microorganism can drive the material cycle and nutrient transformation in the soil. The soil nutrient has obviously effect on soil microbial community, which in turn affects the use of soil nutrient and soil improvement. Soil enzymes play an important role in material circulation and energy flow in the soil ecological system. Their activities can represent the strength of soil material and energy metabolism, so they can be used as important biological indicator for evaluating soil fertility level and ecological environment.

To solve the soil problem in tobacco production, the dynamic change of soil microbial community, soil enzymes, soil nutrient, the growth and quality of tobacco were analyzed to evaluate the effect of soil remediation fertilizers. The mechanisms that soil remediation fertilizers improve soil and increase the yield and quality of tobacco leaf were also discussed. These results will provide a scientific basis for rational fertilization techniques and sustainable development of tobacco production.

2. Material and Methods

2.1 Plant material and treatment

The experiment was conducted in Zhumadian city with completely randomized block design. A total of five treatments include T0 (conventional fertilization), T1 (conventional fertilization–74.96 g N/100 m^2+soil remediation fertilizers 3748 g/100 m^2), T2 (conventional fertilization– 1 149.92 g N/100 m^2+soil remediation fertilizers 7496 g/100 m^2), T3 (conventional fertilization–149.92 g N/100 m^2+soil remediation fertilizers 7496 g/100 m^2+microbial bacterial fertilizer 2998 g/100 m^2), T4 (conventional fertilization–224.88 g N/100 m^2+repair soil remediation fertilizers 11244 g/100 m^2. The soil and tobacco plants were sampled at 30 d, 60 d and 90 d after transplanting. The rhizosphere soil and non-rhizosphere soil was randomly extracted from the root system of health tobacco plant according to the reported method [6]. These soil samples were used for the analysis of soil enzyme activity and soil nutrient.

2.2 The detection of soil enzyme activity and soil nutrient

The soil pH was determined with pH meter. The Soil organic matter content was detected with dichromate titration method. The activities of soil invertase, phosphatase and urease were determined with the methods reported by Guan [7]. The contents of available potassium, phosphorus and hydrolyable nitrogen were assayed with the methods [8-9].

3. Results

3.1 Soil enzymes activities at different growth stages of tobacco

Soil invertase plays an important role in soil carbon cycle and enriching soluble nutrients which can be easily used by plants and microorganisms. As shown in figure 1, the invertase activities had the same change rule that enzyme activity presented first reducing and then rising trend after tobacco transplanting. Compared with the control, the invertase enzymes were obviously increased in T3 treatment.

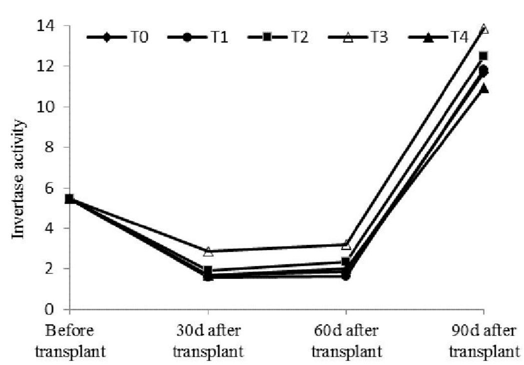

Figure 1 The invertase activity at the growth period of tobacco plant

The main effect of soil phosphatase is to make phosphorus compounds in soil to participate in soil phosphorus cycle. Its activity has a direct impact on the decomposition of organic phosphorus in the soil and biological availability. As shown in figure 2, the phosphatase activity had the same trend of change in the all treatments. The phosphatase activity were higher in T1, T2, T3 and T4 than T0, showing that soil remediation fertilizers can increase the phosphatase activity in soil. The phosphatase activities in T3 are the highest in all treatments.

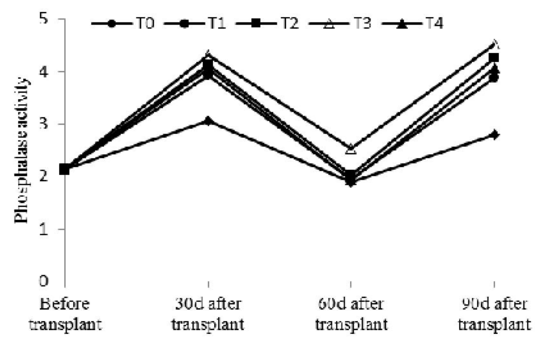

Figure 2 The phosphatase activity at the growth period of tobacco plant

Soil urease is the key enzyme to catalyze the hydrolysis of urea in soil to ammonia, and its activity is often used for characterization of soil nitrogen. As shown in figure 3, the enzyme activities gradually increased after tobacco transplanting, and the activities were higher in T1, T2, T3 and T4 than T0, showing that soil remediation fertilizers can increase the urease activity in soil. The urease activities in T3 are the highest in all treatments.

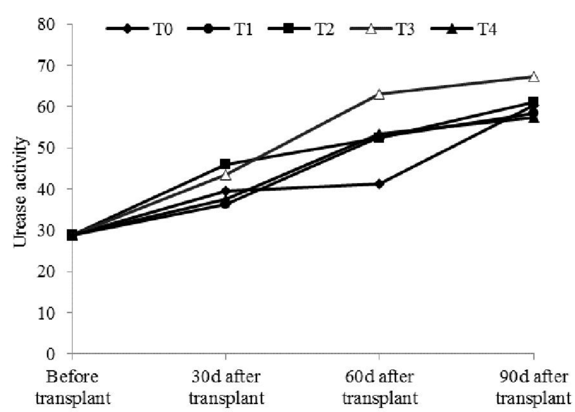

Figure 3 The urease activity at the growth period of tobacco plant

3.2 The soil pH at different growth stages of tobacco

The absorption of nutrients in tobacco plants can be affected by soil pH which has the indirect effect on the root cell surface charge and effective role in soil nutrient ions. Over the years, it has been considered that the optimum soil pH for the production of high quality tobacco is 5.5-7.0. As shown in table 1, soil pH in rhizosphere and non-rhizosphere first decreased and then increased at different periods after transplanting. The soil pH in rhizosphere was lower than non-rhizosphere, and pH range were from 5.14 to 6.33. In the same growth period, the soil pH in rhizosphere and non-rhizosphere gradually increased with the increase of soil remediation fertilizers. It was reported that the continuous cropping can induce the soil acidification, and the soil pH in rhizosphere and non-rhizosphere is lower than the optimum range after 6 years of continuous cropping. Here, soil remediation fertilizers can significantly improve the soil pH, so it can be used as conditioner for acidic soil to neutralize soil acidity.

3.3 The soil nutrient at different growth stages of tobacco

The level of soil fertility mainly depends on the organic matter content. As shown in table 2, with the growth of flue-cured tobacco, the organic matter content in rhizosphere soil gradually increased, and the organic matter content in non-rhizosphere soil first decreased and then increased. In all growth period of flue-cured tobacco, the organic matter content in rhizosphere soil is more than that in non-rhizosphere soil. In the same growth period, the organic matter content in rhizosphere and non-rhizosphere soil increased gradually with the increase of soil remediation fertilizers.

The soil available p is the indicator of p nutrient supply level in soil. As shown in table 3, the available p content in rhizosphere and non-rhizosphere soil gradually decreased with the growth of flue-cured tobacco, and the available p content in rhizosphere soil was higher than in the non-rhizosphere. In the same growth period, the available p content in rhizosphere and non-rhizosphere soil gradually increased with the increase of soil remediation fertilizers.

Potassium is referred to be the most important element related to the quality of the flue-cured tobacco. As shown in table 4, the available potassium content in rhizosphere and non-rhizosphere soil gradually decreased with the growth of flue-cured tobacco, and the available potassium content in rhizosphere soil was higher than in the non-rhizosphere. In the same growth period, the available potassium content in rhizosphere and non-rhizosphere soil gradually increased with the increase of soil remediation fertilizers.

As necessary nutrition element of flue-cured tobacco growth, the appropriate nitrogen supply is the base for the stable tobacco leaf production, high tobacco appearance quality and intrinsic quality. Generally, the suitable hydrolyable nitrogen content is 100-150 mg/kg for the flue-cured tobacco growth. As shown in table 5, the hydrolyable nitrogen content in rhizosphere and non-rhizosphere soil gradually decreased with the growth of flue-cured tobacco, and the hydrolyable nitrogen content in rhizosphere soil was higher than in the non-rhizosphere. In the same growth period, the hydrolyable nitrogen content in rhizosphere and non-rhizosphere soil gradually increased with the increase of soil remediation fertilizers.

Table 1 The pH in rhizosphere and non-rhizosphere soil

Time	T0		T1		T2		T3		T4	
	R	NR	R	NR	R	NR	R	NR	R	NR
30d	5.40±0.26	5.45±0.28	5.56±0.24	5.58±0.28	5.58±0.27	5.67±0.22	5.64±0.29	5.76±0.25	5.74±0.32	5.94±0.33
60d	5.14±0.24	5.37±0.25	5.46±0.31	5.49±0.32	5.58±0.29	5.59±0.31	5.72±0.26	5.61±0.27	5.76±0.29	5.87±0.26
90d	5.65±0.27	6.05±0.31	6.06±0.33	6.28±0.33	6.07±0.31	6.31±0.35	6.15±0.32	6.33±0.34	6.28±0.31	6.26±0.36

Table 2 The organic matter content in rhizosphere and non-rhizosphere soil

Time	T0		T1		T2		T3		T4	
	R	NR	R	NR	R	NR	R	NR	R	NR
30d	13.5±0.61	12.8±0.59	13.8±0.66	13.5±0.69	13.7±0.67	13.7±0.69	13.9±0.71	14.3±0.71	13.2±0.65	14.6±0.71
60d	14.6±0.68	11.4±0.58	14.7±0.71	11.8±0.54	14.8±0.76	12.2±0.61	15.5±0.78	12.8±0.66	15.4±0.75	13.3±0.68
90d	15.4±0.71	11.9±0.56	15.2±0.77	12.3±0.58	15.4±0.75	12.5±0.64	16.6±0.81	13.1±0.67	17.2±0.85	13.5±0.64

Note: R represents rhizosphere soil, and NR represents non-rhizosphere soil.

Table 3 The available p content in rhizosphere and non-rhizosphere soil

Time	T0		T1		T2		T3		T4	
	R	NR	R	NR	R	NR	R	NR	R	NR
30d	16.4±0.75	16.0±0.61	16.5±0.79	16.1±0.71	18.4±0.78	17.5±0.92	18.8±0.99	17.8±0.85	19.6±0.91	18.6±0.93
60d	12.6±0.58	11.9±0.52	13.1±0.58	12.6±0.43	13.5±0.65	12.8±0.76	14.5±0.73	13.6±0.69	15.2±0.77	14.8±0.71
90d	11.5±0.64	11.4±0.66	11.8±0.56	11.5±0.57	12.4±0.61	11.5±0.68	12.9±0.75	12.4±0.63	13.3±0.68	12.7±0.73

Note: R represents rhizosphere soil, and NR represents non-rhizosphere soil.

Table 4 The available potassium content in rhizosphere and non-rhizosphere soil

Time	T0		T1		T2		T3		T4	
	R	NR	R	NR	R	NR	R	NR	R	NR
30d	196±9.61	175±8.85	213±9.78	191±9.13	224±9.26	203±10.47	245±11.13	221±10.73	248±11.19	216±9.89
60d	182±8.79	116±5.49	193±9.45	125±6.38	206±9.61	147±7.83	223±10.92	149±7.28	225±10.72	156±7.64
90d	161±8.06	113±5.27	163±8.17	117±5.47	164±7.95	121±5.86	179±8.34	135±6.54	178±8.63	138±6.35

Note: R represents rhizosphere soil, and NR represents non-rhizosphere soil.

Table 5 The hydrolyable nitrogen content in rhizosphere and non-rhizosphere soil

Time	T0		T1		T2		T3		T4	
	R	NR	R	NR	R	NR	R	NR	R	NR
30d	132±6.31	123±6.57	134±6.54	127±6.17	136±6.82	130±6.45	143±6.96	136±7.02	146±7.16	139±6.91
60d	115±5.34	104±5.13	124±6.05	112±5.72	126±6.19	117±5.92	129±6.35	120±5.98	130±6.76	126±6.18
90d	89±4.62	85±4.53	93±4.26	89±4.31	96±4.65	90±4.97	98±4.82	93±4.85	100±4.99	97±4.73

Note: R represents rhizosphere soil, and NR represents non-rhizosphere soil.

4. Discussion

Soil enzyme is an important component of the soil biological activity, and it is one of the most active organic composition. These enzymes can catalyze the mineralization of soil organic matter to release inorganic nutrients, participating in the formation and decomposition of soil humus [10]. Therefore, soil enzyme can reflect the strength of different kinds of biochemical process in soil, and it is an important indicator of quality evaluation in recent years. Here, it was found that soil remediation fertilizers can increase invertase, phosphatase and urease activities in soil, showing that soil remediation fertilizers can improve the biochemical processes in soil. The analysis of soil nutrient showed that the soil remediation fertilizers can significantly improve the soil pH and increase the organic matter content, the available p content, the available potassium content and the hydrolyable nitrogen content in soil. The invertase, phosphatase and urease activities in T3 are the highest in all treatments, therefore, the appropriate amount of soil remediation fertilizers should be used in tobacco production.

Acknowledgements:

This work was supported by Science and technology project of Zhumadian Branch of Tobacco Company of Henan Province in China (201741170020121) and the opening laboratory project of undergraduate course teaching in Henan Agricultural University (18jx0101).

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References

1. Yang YG, Wang SL, Liu G, Qu PZ, Shi WH, Yang JY, Liu HB. Effects of bio-organic fertilizer on yield and quality of Flue-cured tobacco and soil improvement [J]. Chinese Tobacco Science, 2012, 33(4):70-74.
2. Zhang Y, Zhang CH, Wang ZM, Huang JG. The Effects of continuous cropping on the yields of Flue-cured tobacco and activities of main soil enzymes [J]. Chinese Agricultural Science Bulletin, 2007(23):211-215.
3. Kimetu JM, Lelnnann J, Ngoze SO, et a1. Reversibility of soil productivity decline with organic matter of differing quality along a

degradation gradient [J]. Ecosystems, 2008, 11(5): 726-739.
4. Gihnore AM. Mechanistic aspects of xanthopbyll cycle-dependent photoprotection in higher plant chloroplasts and leaves [J]. Physiologia Plantarum, 1997, 99(1): 197-209.
5. Hua L, Zhang C, Ma HR, Yu W. Environmental benefits of biochar made by agricultural straw when applied to soil [J]. Ecology and Environmental Sciences, 2010, 19(10):2489-2492.
6. Ren WD, Jia LJ, Wang LL, Li J and Yang XY. Seasonal dynamics of soil microbial biomass carbon and water soluble organic carbon in bulk and rhizospheric soils under long-term fertilization regimes in loess soil [J]. Acta Agriculturae Boreali-occidentalis Sinica, 2011, 20(12):145-151.
7. Guan SY. Soil enzyme and its methods [M]. Beijing: Agricultural press, 1986:3-25, 271-319.
8. Ma XM, Liu GS, Wang XC, Ni JH. The development of tobacco root system and its relation with plant growth [J]. Acta Tabacaria Sinica, 2002, 8(3): 26-29.
9. Tang LN, Chen SH．Effects of application of different types of organic fertilizer combined with chemical fertilizer on the growth and quality of the Flue-cured tobacco leaves [J]．Chinese Agricultural Science Bulletin, 2008, 2 (11):258-262.
10. Liu LH，Nie H, Ding Y, Shi RR. Variation of soil humus and enzyme activity in paddy soil derived from red earth under organic planting methods. Hubei Agricultural Sciences, 2016, 55(17):4381-4384.

10/21/2019