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Study on Obstacles to Continuous Cropping of Vegetables and Soil Remediation Technology

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Abstract Firstly, this paper analyzes the cause of obstacles to continuous cropping of vegetables, and then introduces the soil ecological remediation technology used for overcoming obstacles to continuous cropping of vegetables. Finally, this paper analyzes the effect of applying soil ecological remediation technology in overcoming obstacles to continuous cropping of vegetables.

Key words Obstacles to continuous cropping of vegetables, Soil ecological remediation technology, Autotoxins, Application

1 Introduction

The obstacle to continuous cropping of vegetables is one of the major obstacles to facility cultivation and greenhouse production, causing serious vegetable diseases, reducing the yield and quality, and affecting the yield and quality of vegetables[1]. There are many researches at home and abroad on obstacles to continuous cropping of vegetables. In this paper, based on the cause of continuous cropping obstacles, with autotoxins and rhizosphere microbial community as the main line, we study the physiological and biochemical reaction, rhizosphere micro-ecology characteristics and autotoxicity of continuous cropping and autotoxins, and carry out experimental demonstration in Lianyungang.

2 Causes of obstacles to continuous cropping of vegetables

2.1 Autotoxicity of allelopathic autotoxins Autotoxin is one of the main causes of obstacles to continuous cropping of vegetables, and studies show that the autotoxins responsible for obstacles to continuous cropping of cucumbers and other vegetables mainly include hydroxybenzoic acid, ferulic acid, cinnamic acid, benzoic acid and the like. By ion absorption, moisture absorption, photosynthesis, protein and DNA synthesis and many other ways, autotoxins have a huge impact on vegetable seed germination, cell division, and plant growth[2-3]. (i) Autotoxin can inhibit the activity of important enzymes necessary for plant growth. It can inhibit the activity of root ATP enzyme, root dehydrogenase, nitrate reductase and superoxide dismutase and it can inhibit the activity of many enzymes in plants such as POD, CAT, SOD and ATP hydrolase. (ii) Autotoxin affects plant roots' absorption of water, NO3-, K + and other nutrients. (iii) Autotoxin also affects photosynthesis as well as protein and DNA synthesis of vegetables, and inhibits plant growth and development. Benzoic acid and cinnamic acid can reduce net photosynthetic rate, transpiration rate, intercellular CO2 concentration and stomatal conductance of vegetables. (iv) Autotoxin affects the cell membrane permeability, and studies show that cinnamic acid and para-hydroxybenzoic acid can significantly change the submicroscopic structure of plant chloroplast: capsula is dissolved; grana stacks and stroma lamella are reduced; photosynthetic rate lowers. (v) Autotoxins interfere with the synthesis of auxins, so that the root and stem cell growth is inhibited.

2.2 Pathogen increase in continuous cropping soil and deterioration of microbial species, quantity, population structure and soil enzyme activity[3-5] Due to the repetition of cropping systems and management practices in vegetable continuous cropping, after many years of planting and fertilization, vegetables selectively absorb the specific nutrients, resulting in soil nutrient imbalances. Continuous cropping affects the soil and rhizosphere microbial growth and reproduction, reduces the microbial population diversity, increases the number of pathogenic bacteria, lowers population density of beneficial microorganisms, changes the soil-borne micro-ecological structure, makes soil enzyme activity deteriorate and causes the soil microbial community's ability to resist the outside world to decline.

2.3 Considerable fertilizer consumption caused by continuous cropping The continuous cropping inhibits the plant growth and metabolism, and in order to promote plant growth, farmers would increase fertilizer and other inputs, and the soil fertilizer content increases. The relatively high temperature environment of facility cultivation increases relative soil evaporation, and the closed environment of facility prevents the rain from thoroughly rinsing soil. The fertilizer and salts in deep soil will rise by soil capillary with the evaporation of deep soil moisture, causing soil salinization phenomenon.

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3 Soil ecological restoration to overcome obstacles to continuous cropping

3.1 Agricultural measures

3.1.1 Companion planting. In the agricultural production process, using agronomic measures, choosing the appropriate crops and adopting the methods of crop rotation, intercropping and companion planting can significantly inhibit the obstacles to continuous cropping of vegetables, improve soil micro-ecological environment, control the occurrence of pests and diseases, improve the photosynthetic pigment content and photosynthetic rate of vegetables, and promote the growth of vegetables. Companion planting (crop rotation, intercropping) can improve the continuous cropping soil micro-environment. Companion crop root exudates and root's decaying substances can improve soil micro-ecological environment and enhance soil activity. Studies have shown that companion planting improves the physical properties of continuous cropping soil, activates soil nutrients and improves rhizosphere micro-environment. The soil bulk density decreases; the soil porosity increases; the organic matter, available P and available K content increases in varying degrees; the proportion of soil microbial flora is changed. Companion planting can promote the growth and development of vegetables. Research indicates that companion planting and other measures can promote the crop root growth, improve root activity, promote root absorption of nutrients, and improve the quality of vegetables. Suitable companion planting can significantly increase the vitamin C and soluble protein content of vegetables, and reduce fruit nitrates. The crop stubble from legume crop rotation, straw decomposition products, garlic root exudates and alfalfa straw mulch play a role in promoting root length, overground part fresh weight and root fresh weight of vegetables[1-4]. Companion planting can reduce the vegetable diseases in continuous cropping soil[5]. Intercropping can reduce the incidence of vegetable diseases and partly solve continuous cropping obstacles. By the crop rotation and intercropping between vegetables and wheat, oats, onion, garlic or celery, it can significantly reduce the incidence of downy mildew, angular leaf spot powdery mildew and other diseases, and significantly improve vegetable production. Crop rotation, intercropping and other agronomic measures can significantly control vegetable diseases, and they have been accepted and widely used by the majority of producers.

3.1.2 Solarization technology. The facility greenhouses use solarization to kill pathogens in soil, improve soil micro-ecological environment, reduce pests and diseases for succeeding crops and promote crop growth. In practice, we can use lime nitrogen, ammonium bicarbonate and other fertilizers which can produce ammonia to penetrate into the soil and kill pathogens and weed seeds. After cleaning greenhouse in the summer, 70-80 kg of solid lime nitrogen or ammonium bicarbonate is uniformly mixed and applied on the surface of soil, the organic fertilizers are mixed and buried deep in soil through rotary tillage, and the transparent film is used to completely close soil surface, in order to rapidly increase soil accumulated temperature. Then the furrow is filled with water from under the film, and the greenhouse is sealed. The sunlight is used to make the 20-30cm deep soil remain at 40℃ – 50℃ for a long time, and it can effectively kill the soil pathogens and weed seeds. Then the film is uncovered, greenhouse is aired, and the soil is turned over. After about seven days, the vegetable crops can be planted. By comparing the experimental results, it shows that solarization is an effective way to solve continuous cropping diseases.

3.2 Beneficial microorganism multiplication technology

After making the greenhouse stuffy under high temperature, the microbial population in soil is significantly reduced. In order to maintain healthy soil microbial balance and improve soil and crop quality, we can promote the use of microbial fertilizers, including bacterial fertilizer, fungi fertilizer, biological fertilizer and other organic fertilizers. This technology can accelerate the decomposition of crop straw, promote fermentation of organic nutrients, purify soil environment, maintain the diversity of soil biological population, promote the growth of crops, and enhance crop's disease resistance and drought tolerance capacity.

3.3 Slow release and balancing technology of organic nutrients in soil It is necessary to promote the slow release and balancing technology of organic nutrients in soil and reasonably applying organic fertilizer. Organic fertilizer can improve soil aggregate structure, keep the soil loose and balance nutrients. It has the functions of preserving moisture and fertility, regulating temperature and improving gas permeability of soil. It can also increase soil trace element content, improve soil fertility, improve soil's fertilizer storage performance, and enhance soil's pH buffering capacity. Studies have shown that the technology can promote crop growth, increase crop disease resistance, improve crop quality, and increase production efficiency.

4 Conclusions

This paper analyzes the cause of obstacles to continuous cropping of vegetables, and then introduces the soil ecological remediation technology used for overcoming obstacles to continuous cropping of vegetables. The technology has gone through experiment and demonstration in Jiangsu Province. In different regions of Jiangsu, the demonstration greenhouses are built and corresponding technical regulations and norms are developed. Through technical training, demonstration and extension, it eases the obstacles to continuous cropping of vegetables, promotes the development of vegetable industry, and achieves remarkable economic, social and ecological benefits.

References

[1] ZHANG SP, MIAO H, YANG YH, *et al*. A major quantitative trait locus conferring resistance to fusarium wilt was detected in cucumber by using recombinant inbred lines [J]. Mol Breeding, 2014(34):1805 – 1815.

[2] FANG SZ, LIU D, TIAN Y, *et al*. Tree species composition influences enzyme activities and microbial biomass in the rhizosphere: A rhizobox approach [J]. PlOS ONE, 2013, 8(4): 614 – 617.

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[18] COOMBS WT. Choosing the right words the development of guidelines for the selection of the "appropriate" crisis – response strategies[J]. Management Communication Quarterly, 1995(8):447 – 476.
[19] COOMBS WT. An analytic framework for crisis situations: Better responses from a better understanding of the situation[J]. Journal of Public Relations Research, 1998(10): 177 – 191.
[20] COOMBS WT. Information and compassion in crisis responses: A test of their effects[J]. Journal of Public Relations Research, 1999(11): 125 – 142.
[21] COOMBS WT. Impact of past crises on current crisis communication insights from situational crisis communication theory[J]. Journal of Business Communication, 2004(41): 265 – 289.
[22] COOMBS WT. The protective powers of crisis response strategies: Managing reputational assets during a crisis[J]. Journal of Promotion Management, 2006(12): 241 – 260.
[23] COOMBS WT. Attribution theory as a guide for post – crisis communication research[J]. Public Relations Review, 2007(33):135 – 139.
[24] COOMBS WT. Crisis management and communications[M]. Institute for Public Relations, 2007: 1 – 17.
[25] COOMBS WT. Protecting organization reputations during a crisis: The development and application of situational crisis communication theory[J]. Corporate Reputation Review, 2007(10): 163 – 176.
[26] COOMBS WT, HOOLADAY SJ. Helping crisis managers protect reputational assets initial tests of the situational crisis communication theory[J]. Management Communication Quarterly, 2002(16): 165 – 186.
[27] COOMBS WT, HOOLADAY SJ. Reasoned action in crisis communication: An attribution theory – based approach to crisis management[M]. Responding to Crisis: A Rhetorical Approach to Crisis Communication, 2004: 95 – 115.
[28] COOMBS WT, HOOLADAY SJ. An exploratory study of stakeholder emotions: Affect and crises[J]. Research on Emotion in Organizations, 2005(1): 263 – 280.
[29] COOMBS WT, HOOLADAY SJ. Unpacking the halo effect: reputation and crisis management[J]. Journal of Communication Management, 2006(10): 123 – 137.
[30] COOMBS WT, HOOLADAY SJ. The negative communication dynamic: Exploring the impact of stakeholder affect on behavioral intentions[J]. Journal of Communication Management, 2007(11): 300 – 312.
[31] COOMBS WT, HOOLADAY SJ. Comparing apology to equivalent crisis response strategies: Clarifying apology's role and value in crisis communication[J]. Public Relations Review, 2008(34): 252 – 257.
[32] DARDUS F, HAIGH MM. Prescribing versus describing: testing image restoration strategies in a crisis situation[J]. Corporate Communications: An International Journal, 2009(14): 101 – 118.
[33] DE BLASIO A, VEALE R. Why say sorry? Influencing consumer perceptions post organizational crises[J]. Australasian Marketing Journal (AMJ), 2009(17): 75 – 83.
[34] DUTTA S, PULLIG C. Effectiveness of corporate responses to brand crises: The role of crisis type and response strategies[J]. Journal of Business Research, 2011(64): 1281 – 1287.
[35] HUANG YH, LIN YH, SU SH. Crisis communicative strategies in Taiwan: Category, continuum, and cultural implication[J]. Public Relations Review, 2005(31): 229 – 238.
[36] LYU JC. A comparative study of crisis communication strategies between Mainland China and Taiwan: The melamine – tainted milk powder crisis in the Chinese context[J]. Public Relations Review, 2012(38): 79 – 791.
[37] MCCOY, M. Reputational threat and image repair strategies: Northern Ireland water's crisis communication in a freeze/thaw incident[J]. Journal of Nonprofit & Public Sector Marketing, 2014(26):99 – 126.
[38] Mitroff, I., & Anagnos, G. Managing crisis before the happen. What every executive and manager needs to know about crisis management[J]. Ed. Amacom, 1ra. Edición, Barcelona, 2001.
[39] MURALIDHARAN S, DILLISTONE K, SHIN JH. The gulf coast oil spill: Extending the theory of image restoration discourse to the realm of social media and beyond petroleum[J]. Public Relations Review, 2011(37):226 – 232.
[40] PEIJUAN C., TING LP, PANG A. Managing a nation's image during crisis: A study of the Chinese government's image repair efforts in the "Made in China" controversy[J]. Public Relations Review, 2009(35):213 – 218.
[41] WEINER B. An attributional theory of achievement motivation and emotion [J]. Psychological Review, 1985(92): 548.
[42] WEINER B. Social motivation, justice, and the moral emotions: An attributional approach[M]. Psychology Press, 2006.
[43] WEN WC, YU TH, BENOIT WL. The failure of 'scientific' evidence in Taiwan: a case study of international image repair for American beef[J]. Asian Journal of Communication, 2012(22): 121 – 139.
[44] WU Y, DING J. The research of crisis communication strategies in food safety: A comparative case study between Sanlu and IKEA[D]. Uppsala University, 2014.
[45] YAO X, CHEN J, LI Y. A critical analysis of the image repair discourses of some companies involved in the milk scandal[J]. Language Teaching and Linguistic Studies, 2011(2): 106 – 112.
[46] ZHANG E, BENOIT WL. Former Minister Zhang's discourse on SARS: Government's image restoration or destruction[J]. Public Relations Review, 2009(35): 240 – 246.
[47] ZHANG J, BENOIT WL. Message strategies of Saudi Arabia's image restoration campaign after 9/11[J]. Public Relations Review, 2004(30):161 – 167.

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[3] WANG Z, JIA CH, LI JY, *et al*. Activation of salicylic acid metabolism and signal transduction can enhance resistance to Fusarium wilt in banana (Musa acuminata L. AAA group, cv. Cavendish)[J]. Functional & Integrative Genomics, 2015, 15(1):47 – 62.
[4] ZHAO S, LIU DY, LING N, *et al*. Bio-organic fertilizer application significantly reduces the Fusarium oxysporum population and alters the composition of fungi communities of watermelon Fusarium wilt rhizosphere soil[J]. Biology and Fertility of Soils, 2014,50(5):765 – 774.
[5] LEI JL. Study on molecular microbial ecology of vegetable soil ecosystem [D]. Hangzhou: Zhejiang University, 2006. (in Chinese).
[6] WU CC,LI C, WEI ML, *et al*. Effect of continuous cropping soil extract liquor on cucumber germination and seedling growth[J]. Journal of Hebei Normal University of Science & Technology,2013,27(2): 23 – 25. (in Chinese).