How to Improve the Teaching Quality of *Plant Physiology*?

Qian MA, Lixia HOU, Xin LIU*

School of Life Sciences, Qingdao Agricultural University, Qingdao 266109, China

Abstract *Plant Physiology* is a compulsory specialized fundamental course, and plays an important role in the whole education of plant-related majors in agricultural institutions. In order to improve the educational effects and train specialized students in agriculture, the methods in *Plant Physiology* teaching in Qingdao Agricultural University are summarized in this paper. The results will provide a reference for improving the teaching of *Plant Physiology* in the future.

Key words *Plant Physiology*, Teaching content, Teaching methods, Teaching quality

1 Introduction

Plant Physiology is a subject which studies the activity patterns of plant life and reveals the essence of life phenomena[1]. It is a compulsory basic course, based on the basic courses of botany, physics, general chemistry, analytical chemistry, organic chemistry and biochemistry, for the majors related to plant in agricultural colleges. Meanwhile, it provides the necessary prerequisite knowledge for the learning of some courses such as crop cultivation, plant protection, genetics and breeding, molecular biology, and general genetics. In recent years, the molecular biology has made great strides, and the related research results have penetrated into almost all areas of biological research, so that people have more comprehensive understanding of life activity patterns. As new methods, new theories, new concepts, new technologies and new results continue to penetrate, many original ideas in *Plant Physiology* are constantly being updated, and even overthrown[2]. However, with the continuous adjustment of teaching programs in recent years, the credit hours of courses continue to be shortened. How to more comprehensively complete the course learning in the limited credit hours is one of the main challenges facing the current teachers of *Plant Physiology*. In order to improve the teaching quality of *Plant Physiology*, the Physiology Teaching and Research Group in Qingdao Agricultural University explores the teaching of this course and achieves certain results.

2 Rational selection of teaching content to reflect the disciplinary characteristics of *Plant Physiology*

2.1 Combined with other disciplines The teaching system of *Plant Physiology* includes four aspects: cell physiology, metabolic physiology, developmental physiology and stress physiology. Its content is very wide and it is intertwined with many disciplines such as botany, biochemistry and molecular biology. With the teaching material of *Plant Physiology*, edited by Wang Zhong, published by Chinese Agriculture Press in 2011, as a blueprint, our research group integrates other teaching materials, and makes a series of adjustments about the teaching content, to avoid unnecessary duplication between disciplines. For example, the content of glycolytic pathway, tricarboxylic acid pathway, pentose phosphate pathway and glyoxylate cycle during the respiratory metabolism, has been studied in detail in the textbooks of biology and chemistry, so we only give the lessons related to physiological functions; the structure and function of plant cell have been studied in detail in high school, so it is changed to after-school learning.

2.2 Compared with practice *Plant Physiology* is inextricably linked with agricultural production, so we should combine the teaching content with daily phenomenon and agricultural production, to enhance students' interest in learning. For example, water culture and nutrient deficiency experiment is used to guide students to use the theory to explain the relationship between mineral nutrition and chlorophyll formation or substance metabolism. There are many proverbs about agriculture in China, and it is a good teaching method to introduce these proverbs into the class. For example, the catchy and impressive proverb "weak seedlings like horse's ears, strong seedlings like mule's ears, flourishing seedlings like pig's ears" is used to describe the impact of fertilization on plant's phenotypic traits.

2.3 Compared with research progress The "teaching-research interaction" teaching model is considered to be the mainstream modern university teaching mode, which can help to improve students' practical ability, innovative ability and overall quality[5-7]. With the rapid development of *Plant Physiology*, our teaching and research group combines the teaching content with academic frontier in the actual teaching work, in order to build a bridge for students to explore new knowledge. For example, in vernalization introduction, the textbook only mentions that the plants after vernalization still "remember" their experience of vernalization at a high temperature, but the plant grown from seed must go through vernalization. Since there is no explanation of rea-

Received: May 20, 2016 Accepted: July 11, 2016
Supported by Shandong Undergraduate Education Reform Project (2012339); Characteristic Prestigious University Teaching and Research Project for Cultivating Applied Talents in Qingdao Agricultural University (XJG2013015; XJG2013152).
* Corresponding author. E-mail: liuxin6080@126.com

son, the traditional teaching methods only make the students just remember this theory, but the recent scientific research results can explain this theory in terms of molecular level. Vernalization can cause methylation of nucleotide of some important flowering genes, and the methylated genes can induce flowering. This methylation can be passed on to the next generation by mitosis, but it can not be passed on by meiosis, so the plant grown from the newly generated seed must undergo re-vernalization. It can be seen that adding academic frontiers on the basis of classical teaching can make students better understand knowledge, stimulate their interest in exploring new knowledge, and develop their thinking ability, self-learning ability and creative ability.

3 Using a variety of teaching methods to improve students' motivation to learn

3.1 Inquiry teaching *Plant Physiology* is an experimental subject, and the method of inquiry teaching is suitable for the explanation of the classical theory. Based on questions, combined with research methods, tools and analysis results, inquiry teaching introduces the basic theory to students step by step[3-4]. Raising questions at the beginning of a new lesson and a new section can cause students' longtime reflection. In explanation of impact of light quality on growth, it can be asked: "Why are the plants on the mountains short?"; in introduction of herbicides, it can be asked: " Why do some herbicide ingredient act as plant growth regulator?"; in introduction of impact of light on chlorophyll synthesis, it can be asked: "Why are the leek seedlings cultivated in the dark etiolated?". In this way can the students learn more efficiently with questions in mind.

3.2 Discussion method A lot of contents in *Plant Physiology* are related to people's production and life, and the discussion method can be adopted for some teaching contents. In addition, organizing classroom discussion is a good way to make students involved in classroom interaction. For example, the introduction of crops, crop fertigation principles, and application of growth regulators, can use this method for teaching. The teachers bring forward one or several topics for students to prepare for about one to two weeks, and then the students are organized to speak freely. The students are allowed to debate each other on different points of view, and finally the teachers make appropriate review. This helps students to participate in teaching, increase their interest in learning and improve the overall quality.

4 Improving the quality of multimedia courseware and highlighting the features of majors

Multimedia teaching dispenses with the blackboard-writing in traditional teaching, which effectively increases the amount of information in teaching, and improves teaching efficiency. Such treatment can reduce the pressure brought about by the compressed credit hours and increasing content, improve the image of teaching, and increase interest in learning by the rich illustrations, vivid animation and proper dubbing in the multimedia teaching[3]. In the production process of multimedia courseware, special attention is paid to the combination of courses and professional knowledge. It is necessary to focus on different chapters for different teaching objects. As for the major of resources and environment, teachers should focus on explanation of plants' selective absorption of ions and mechanism of salt injury; for the major of agronomy, teachers should place emphasis on organic matter transport, rational fertilization, reasonable irrigation, application of tissue culture in breeding, and the like; in terms of the major of fruit tree, there is a need to explain the source-sink relationship, and distribution of organic matter, and the like; for the major of landscape architecture, teachers should emphasize floral induction, tissue culture and other aspects. The teaching content focus of the same chapter should also vary with changes in the major. For example, in the chapter of plant tissue culture techniques, it is necessary to focus on explaining the application of rapid asexual propagation of orchids and other flowers in commerce for horticulture majors; for the plant protection majors, we can focus on explaining the production process and application of fruit, potato, or sweet potato virus-free seedlings; for agronomy students, we can describe the advantage of haploid produced from anther tissue culture in breeding. In this way can the students better use their expertise, stimulate interest in learning and cultivate innovative thinking. Although multimedia teaching has many advantages, it is always a kind of supplementary means which can not replace teachers' instruction in the classroom, so it is necessary to avoid echoing what the books say due to excessive use of multimedia courseware during teaching process.

5 Establishing multi-level evaluation model and cultivating students' learning ability

In order to mobilize the enthusiasm of students for learning and avoid making a hasty last-minute effort at the end of term, we use a variety of evaluation methods and establish multi-level evaluation model in the assessment of *Plant Physiology*. Firstly, it is necessary to increase the proportion of usual performance and break the decisive word given by the final exam performance. Our evaluation model consists of final exam performance (60%) and usual performance (40%). The usual performance is determined by taking a variety of ways, including attendance (10% of total score), course paper (10% of total score), quiz (10% of total score), and performance in answering questions and discussing in classes (10% of total score). The comprehensive evaluation is performed on students from collection of materials, expression of language and writing of paper. In this way can we not only achieve the purpose of the assessment, but also mobilize the students' enthusiasm for learning, and improve their innovation awareness and thesis writing ability.

6 Imparting knowledge and educating people while strengthening morality education

A teacher is one who can propagate the doctrine, impart profes-

sional knowledge, and resolve doubts. Classroom is the place where teachers get along with students frequently. In teaching, it is necessary to attentively analyze the learning state of students and observe students' class performance. If the students are absent-minded, dispirited, sleeping or play with the smartphone, the teachers should timely communicate with them and educate them. There is a need to encourage the students with mental burden, care for those students who need help, and tolerantly correct the error in students' studies. Teachers should use affection, experience and knowledge to set a good example to students and transfer positive social energy to students.

References

[1] WANG Z. *Plant Physiology*[M]. Beijing: China Agriculture Press,2011.
[2] HE Y, WANG YG, WANG JP, *et al*. Study on improving the teaching quality of *Plant Physiology*[J]. Journal of Shanxi Agricultural University: Social Science Edition,2005,4(6):7-8. (in Chinese).
[3] GUO HJ, WANG XY, LI H, *et al*. Application of multimedia technology in comprehensive and designing experiment of biochemistry[J]. Laboratory Science, 2009(2): 41-43. (in Chinese).
[4] WANG JF. Giving lessons diligently——Exploration on research-based teaching[J]. China Higher Education, 2004(9):20-22. (in Chinese).
[5] TONG GH. Personal understanding of *Plant Physiology* teaching reform at normal university[J]. Journal of Huainan Teachers College, 2002, 14(2): 41-42. (in Chinese).
[6] FAN MQ. Reform of *Plant Physiology* experimental teaching[J]. Auhui Agricultural Science Bulletin,2009,15(1):169-170. (in Chinese).
[7] DENG NH. On the application of research-based teaching in the experimental teaching of immunology test[J]. Health Vocational Education, 2008, 26(18):130-131. (in Chinese).

(From page 87)

[3] WU L, XIAO WH, LI LT, *et al*. The preservation of fresh grape by the acidic electrolyzed water[J]. Food Science and Technology, 2004, 39(9):81-83. (in Chinese).
[4] WEI XP, DONG Y, LUAN GZ, *et al*. Effect of electrolyzed water on controlling cucumber powdery mildew and cucumber growth and quality[J]. China Plant Protection, 2015,35(2):8-12. (in Chinese).
[5] KUMAR SV, GABRIEL OE, YENCON H, *et al*. Efficacy of electrolyzed oxidizing water for inactivating Escherichia coli O157:H7, Salmonella enteritidis, and Listeria monocytogenes[J]. Applied and Environmental Microbiology, 1999,65(9): 4276-4279.
[6] LI LT. Agriculture application research and prospect of functional water engendered from electricity[J]. China Agricultural Information,2006(1):15-16. (in Chinese).
[7] SHIGETO S, KOKI M, HIROMOTO Y. Acidic electrolyzed water in the disinfection of the ocular surface[J]. Experimental Eye Research, 2000, 70: 1-6.
[8] ABDULSUDI IZ, YOSHINORI K, NAMI M, *et al*. Application of slightly acidic electrolyzed water as a potential non-thermal food sanitizer for decontamination of fresh ready-to-eat vegetables and sprouts [J]. Food Control, 2011, 22(3-4): 601-607.
[9] TOYOAKL A, MAKOTO M. Continuous flow determination of free chlorine in water[J]. Analytical Chemistry, 1983, 55: 209-212.
[10] LIU YY, LIU HJ, TATSUMI E, *et al*. The application of UV spectrophotometry in the measuring of slightly acid electrolyzed water[J]. Modern Food Science and Technology, 2011, 27(11):1393-1397. (in Chinese).
[11] HAO JX, LI LT. Study on removal of pesticide residues on vegetables with electrolyzed functional water[J]. Science and Technology of Food Industry, 2006,27(5):164-166. (in Chinese).
[12] LI HZ, ZHENG SF, SONG SH, *et al*. Study on sterilization and preservation of fruits and vegetables using acidic electrolyzed oxidizing water[J]. Modern Food Science and Technology, 2011, 27(3):361-365. (in Chinese).
[13] XIAO WD, LI LT, LI ZG. Assay study on strawberries storage treated by electrolyzed acid water[J]. Food Science, 2003, 24(5):152-155. (in Chinese).
[14] SOO-VOON L, YEN-CON H, MARILYN E, *et al*. Ultraviolet spectrophotometric characterization and bactericidal properties of electrolyzed oxidizing water as influenced by amperage and pH[J]. Journal of Food Protection, 2000,63 (11):1534-1537.
[15] XIAO WH, LI LT, LI ZG. Tests of functional water produced by electrolytic action against powdery mildew disease on cucumber[J]. Plant Protection,2003,29(2):50-51. (in Chinese).
[16] SEYMOUR S, BLOCK. Disinfection, sterilization, and preservation, 3rd ed[M]. Philadelphia: Lea and Febiger, 1983.
[17] FABRIZIO KA, CUTTER CN. Application of electrolyzed oxidizing water to reduce Listeria monocytogenes on ready-to-eat meats[J]. Meat Science, 2005, 71:327-333.
[18] LUO XX. The effect analysis of acidic electrolyzed water on controlling cucumber powdery mildew[J]. Journal of Anhui Agricultural Sciences, 2015,43(36):207-209. (in Chinese).
[19] GAO XH, LIU ZH, LI XL, *et al*. Sterilization mechanism and application of strong acidic electrolyzed water[J]. Chinese Agricultural Science Bulletin, 2008,24(7):393-399. (in Chinese).