ECRONICON OPEN ACCESS

EC AGRICULTURE
Research Article

# Inoculation Effect of *Piriformospora indica* on *Oenothera biennis*

**Wu Weijia, Sun Taoze, Zeng Longjun and Mu Hongna***

*College of Horticulture and Gardening, Yangtze University, Jingzhou, Hubei, China*

***Corresponding Author:** Mu Hongna, College of Horticulture and Gardening, Yangtze University, Jingzhou, Hubei, China.

**Received:** August 23, 2019; **Published:** September 30, 2019

**DOI:** 10.31080/ecag.2019.05.00209

## Abstract

In this paper, the effects of inoculation of *P. indica* on the growth of *Oenothera biennis* had been carried out in greenhouse. During the whole experimental process no application any chemical fertilizer except for water supply. The results showed that the inoculation of *P. indica* can promote the growth of *O. biennis*. The soluble sugar content, chlorophyll, soluble protein content, total glomalin content and easy-to-extract glomalin content were higher than control. The biomass (fresh and dry weight, plant height, leaves number) of inoculated group was much higher compared with the control. The soluble sugar was the significantly different between inoculated group and control. Our finding illustrated that *P. indica* can prompt the growth and increase some soluble compound content for *O. biennis*.

***Keywords:*** *Piriformospora indica; Oenothera biennis; inoculation effect; GRSP*

## Introduction

*Piriformospora indica*, a genus of the genus Basidiomycetes of the genus Basidiomycetes, was discovered in 1998 by Indian scientist Verma in the Thar Desert of northwest India [1,2]. It is an endophytic fungus different from mycorrhizal fungi. It is easy to culture and can colonize a variety of plant roots, promote the absorption of nutrients in the soil by plants and has a significant growth-promoting effect on host plants [1,3,4]. In addition, there were positive effect on plants resistance to abiotic stresses (such as high salt, drought and heavy metals) and biotic stress (plants to various diseases), increase crop yield finally [6-10]. In view of its obvious promoting effect, the is getting more and more attention from researchers [4].

*Oenothera biennis L.*, belong to Onagraceae family, commonly known as evening primrose, is distributed natively in North America. There are numerous therapeutic value, such as anti-inflammatory, hypotensive, astringent and sedative, which has been applied in ordinary therapeutic action in North American [12]. The gallic acid, extracted and purified from the seeds of *O. biennis*, possess anti-tumor potential [13]. It was reported that new Oenotheralanosterol A and B constituents isolated from *O. biennis* root [14]. There are diverse phytochemicals in *O. biennis* organs, those active ingredients play vital role in keeping human health. In addition, the ornamental value, beautiful and fragrant flower, is the second important trait.

Seeing that the excellent character of *O. biennis* and the profitable fungi strain, new question emerge, is there any good effect of *P. indica* on *O. biennis* phytochemicals? Then a pre- experiment had been carried out to explore the above question.

## Materials and Methods

### Material

*O. biennis* seeds were utilized as plant material. Seeds was sterilized in 75% ethanol and washed with sterile water. Then sowed in sterilized soil (121℃, 30 minutes, sterilized twice) and set in greenhouse in Spring season in 2019. When two true leaves unfolded, the

seedlings were planted in plastic pot filled with sterilized soil (from deep soil of forest farm, with less fertility), cultivated in greenhouse still, One week later, *P. indica* hypha was added (0.4g fresh hypha per kilogram soil) except control pots. During the whole experimental procession, offered water at regular intervals, without additional mineral elements.

### Methods

The harvested plant were take the height, fresh weight, dry weight. Fresh leaves were detected chlorophyll content, by dimethyl sulfoxide extraction method [15]. The soluble protein content was determined by Coomassie Brilliant Blue G-250 staining method [16]. The soluble sugar content was determined by fluorenone colorimetric method [17,18]. The content of total glomalin-related soil protein (T-GRSP) and easily extracted glomalin-related soil protein (EE-GRSP) was determined by WRIGHT [19,20].

### Data statistics and analysis

Data statistical analysis was performed using SPSS software.

### Results

### Inoculation effect of *P. indica* on the growth of *O. biennis*

After 80 days of inoculation with *P. indica*, the effect on the growth of *O. biennis* was listed in table 1. As for fresh weight and dry weight, those inoculated plant were 26.7% and 58.59% higher than control respectively. Leaves number had increased by 18.96%. Plant height increased by 1.05 cm compared to control, which is equivalent to an increase of 15.92%.

| Treatment | Fresh weight (g) | Leaves number | Dry weight (g) | Plant high (cm) |
|---|---|---|---|---|
| Control | 9.53 | 15.83 | 1.28 | 12.12 |
| *P. indica* | 12.07 | 18.83 | 2.03 | 14.05 |

***Table 1:*** *The effect of P. indica on growth of O. biennis after inoculated 80days.*

### Inoculation effect of *P. indica* on the quality of *O. biennis*

The effect of *P. indica* on *O. biennis* quality was illuminated as following. The soluble protein content in leaves was 28.60% in *P. indica* inoculated plant higher than control (Figure 1). The chlorophyll and soluble sugar content increased 13.98% and 78.71% respectively compared with the control (Figure 2). Compared with control, total glomalin content and easy extraction of glomalin content significantly increased 41.16% and 24.26% respectively (Figure 3).

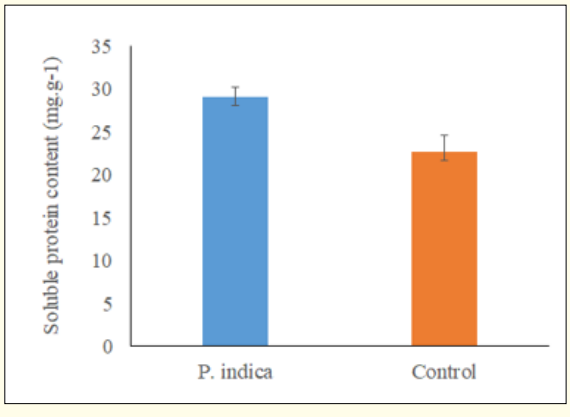


***Figure 1:*** *The effect of P. indica on soluble protein content of O. biennis.*

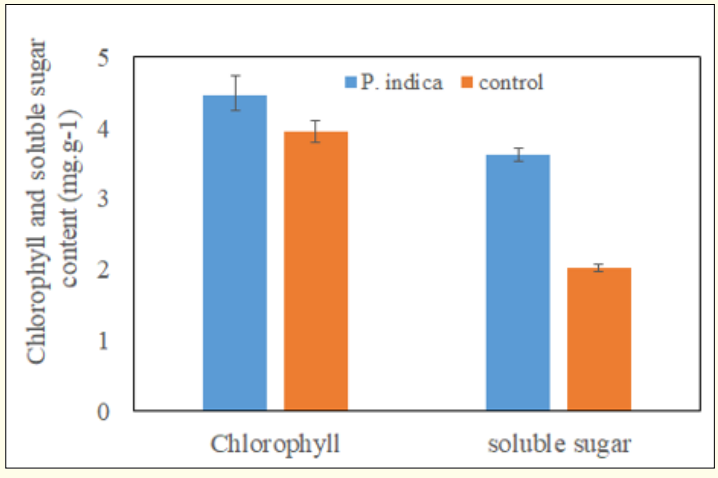


***Figure 2:*** *The effect of P. indica on chlorophyll and soluble sugar content of O. biennis.*

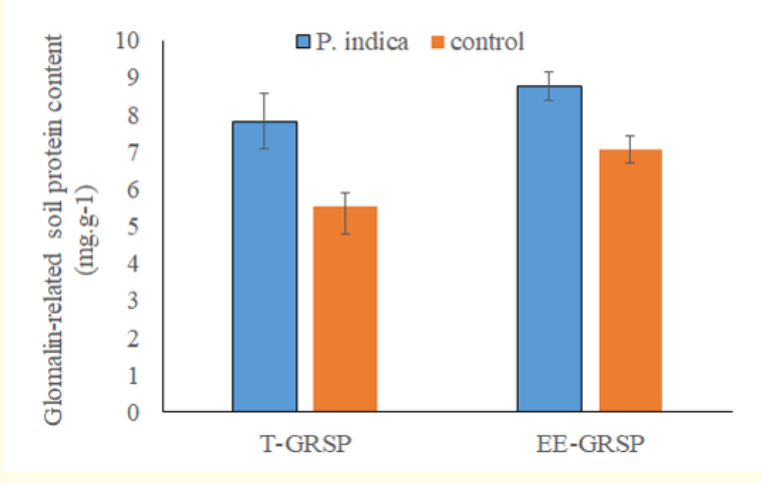


***Figure 3:*** *The effect of P. indica on glomalin-related soil protein content of O. biennis.*

## Discussion

*P. indica* can interact with plant roots to form symbiosis, which promotes the absorption of nutrients by plant roots and promotes plant growth [21,22]. In our experiment, plant height, fresh and dry weight were promoted, which presented there must exist positive interaction between *O. biennis* root and *P. indica*.

*O. biennis* chlorophyll content was higher in inoculated plant. It was reported that chlorophyll is mainly synthesized by nitrogen and phosphorus P elements in soil [23] while *P. indica* accelerates the synthesis of chlorophyll by accelerating the absorption of minerals such as nitrogen and phosphorus [24]. The chlorophyll content of *in O. biennis* inoculated by *P. indica* was higher than control. High chlorophyll can improve photosynthetic capacity. More leaves, higher soluble sugar and soluble protein were ascribed to high chlorophyll to some extent.

The soluble sugar content was the most outstanding matter in this experiment, which increased reaching 78.81%. The soluble sugar is one of the important constituent of plant quality, which reflect the resistance of plant to stress [25]. *O. biennis* was cultivated in greenhouses (located on the top of our Laboratory Building) and the temperature is extremely high. *O. biennis* can grow well, which must be closely related to high soluble sugar and other soluble contents in plant.

Glomalin-related soil protein (GRSP), produced by soil fungi, plays crucial roles in the global carbon cycle and improves soil quality. GRSP and soil organic carbon (SOC) contribute to the formation and stability of soil aggregates [26]. "Soil" aggregates improve the physicochemical characters of soil, then plants that rooted in the soil are beneficiaries. In this paper, the treatment group inoculated with *P. indica*, both biomass and inner physiological index (soluble sugar and protein, chlorophyll) were higher than control, which contribute to higher contents of GRSP.

The use of GRSP has been suggested as a biological indicator of soil quality, because it undergoes limited decomposition and has low sensitivity to environmental fluctuations [27]. However, GRSP contents were affected by urbanization [28], high manure amendments [29], the deep of soil layers, plant diversity and climate condition [30]. In this paper, the soil condition was similar when experiment began. The difference between control and treatment groups was ascribed to the inoculation of *P. indica*.

## Conclusion

This experiment found out inoculation of *P. indica* can accelerate the growth *O. biennis*, which illustrated by more plant biomass (fresh weight, dry weight, plant height) and inner soluble compound in treatment group. Meanwhile, soluble sugar was significantly promoted by inoculation of *P. indica* ($p < 0.05$). In addition, the GRSP content of inoculated group was higher than control group. So, conclusion that there was positive interaction between *P. indica* and *O. biennis* can be draw. It will be amazing in application *P. indica* in *O. biennis* cultivation, as soon as prospects is concerned.

## Conflicts of Interest

The authors declare there is no conflicts of interest.

## Bibliography

1. Verma S., *et al*. "Piriformospora indica, gen.et sp. nov., a new root-colonizing fungus". *Mycologia* 90.5 (1998): 896-903.
2. Zhang WY., *et al*. "Endophytic fungus Piriformospora indica promotes growth and confers drought tolerance in sesame (Sesamum indicum L.)". *Chinese Journal of Oil Crop Sciences* 36.1 (2014): 71-75.
3. Trivedi DK., *et al*. "Piriformospora indica: a friend in need is a friend in deed". *Journal of Botanical Sciences* 5.1 (2016): 16-19.
4. Oelmulle R., *et al*. "Piriformospora indica, a cultivable root endophyte with multiple biotechnological applications". *Symbiosis* 49.1 (2009): 1-17.
5. Lou BG., *et al*. "Piriformospora indica with multiple functions and its application prospects". *Journal of Plant Protection* 34.6 (2008): 653-656.
6. Song FM., *et al*. "Biological functions of Piriformospora indica and its action mechanisms". *Journal of Zhejiang University (Agriculture and Life Sciences)* 37.1 (2011): 1-6.
7. Fakhro A., *et al*. "Impact of Piriformospora indica on tomato growth and on interaction with fungal and viral pathogens". *Mycorrhiza* 20.3 (2010): 191-200.
8. Varma A., *et al*. "Piriformospora indica, a cultivable plant-growth-promoting root endophyte". *Applied and Environmental Microbiology* 65.6 (1999): 2741-2744.

9. Sherameti I., *et al*. "PYK10, a beta-glucosidase located in the endoplasmatic reticulum, is crucial for the beneficial interaction between Arabidopsis thaliana and the endophytic fungus Piriformospora indica". *Plant Journal for Cell and Molecular Biology* 54.3 (2008): 428-439.

10. Steine., *et al*. "Systemic resistance in Arabidopsis conferred by the mycorrhizal fungus Piriformospora indica requires jasmonic acid signaling and the cytoplasmic function of NPR1". *Plant and Cell Physiology* 49.11 (2008): 1747-1751.

11. Sun C., *et al*. "Piriformospora indica confers drought tolerance in Chinese cabbage leaves by stimulating antioxidant enzymes, the expression of drought-related genes and the plastid-localized CAS protein". *Journal of Plant Physiology* 167.12 (2010): 1009-1017.

12. Singh R., *et al*. "HILIC quantification of Oenothera lanosterol A and B from Oenothera biennis and their suppression of IL-6 and TNF-α expression in mouse macrophages". *Journal of Ethnopharmacology* 141.1 (2012): 357-362.

13. Verona U D S D., *et al*. "Anti-tumour potential of a gallic acid-containing phenolic fraction from Oenothera biennis". *Cancer Letters* 226.1 (2005): 17-25.

14. Ateeque A., *et al*. "New Oenothera lanosterol A and B Constituents from the Oenothera biennis Roots". *Chinese Journal of Chemistry* 28.12 (2011): 2474-2478.

15. Hiscox J D and G F Israelstam. "A method for the extraction of chlorophyll from leaf tissue without maceration". *Revue Canadienne De Botanique* 57.12 (1979): 1332-1334.

16. Wang C., et al. "Proteomic analysis on roots of Oenothera biennis under copper-stress conditions". *Scientific Reports* 7.1 (2017): 10589.

17. Gao JF. "Experimental guidance of plant physiology". Beijing: Higher Education Press (2006): 144-147.

18. Yang XY and Wang SL. "Determination of Soluble Polysaccharides in Loquat Leaves by Anthrone-Sulfuric Acid Colorimetric Method". *Asia-Pacific Traditional Medicine* 4.8 (2008): 26-27.

19. Wright SF., *et al*. "Comparison of Efficacy of Three Extractants to Solubilize Glomalin on Hyphae and in Soil". *Chemosphere* 64.7 (2006): 1219-1224.

20. Wright SF., *et al*. "Glomalin in Aggregate Size Classes from Three Different Farming Systems". *Soil and Tillage Research* 94.2 (2007): 546-549.

21. Rai M and Varma A. "Arbuscular mycorrhiza like biotechnological potential of Piriformospora indica, which promotes the growth of Adhatoda vasica Nees". *Electronic Journal of Biotechnology* 8.1 (2005): 107-112.

22. Ansari MW., *et al*. "A critical review on fungi mediated plant responses with special emphasis to Piriformospora indica on improved production and protection of crops". *Plant Physiology and Biochemistry* 70 (2013): 403-410.

23. Yu FX., *et al*. "Effects of soil fertility on chlorophyll fluorescence characteristics and yield of high-yield wheat variety Yannong 1212". *Journal of Triticeae Crops* 38.10 (2018): 1222-1228.

24. Fu GW., *et al*. "Effects of Soil Nitrogen and Phosphorus Stoichiometry on Photosynthetic Gas Exchange Parameters and Chlorophyll Fluorescence Parameters in Wheat". *Acta Botanica Boreali Sinica* 36.7 (2016): 1435-1442.

25. Waller F., *et al*. "The endophytic fungus Piriformospora indica reprograms barley to salt-stress tolerance, disease resistance, and higher yield". *Proceedings of the National Academy of Science of the United States of America* 102.38 (2005): 13386-13391.

26. Sun L., *et al*. "Nitrogen addition increases the contents of glomalin-related soil protein and soil organic carbon but retains aggregate stability in a Pinus tabulaeformis forest". *Peer J* 6 (2018): 1-16.

27. Wang Q., *et al*. "Role and variation of the amount and composition of glomalin in soil properties in farmland and adjacent plantations with reference to a primary forest in North-Eastern China". *PLOS One* 10.10 (2015): 1-19.

28. Wang Q., *et al*. "Urbanization-induced glomalin changes and their associations with land-use configuration, forest characteristics, and soil properties in Changchun, Northeast China". *Journal of Soils and Sediments* 19.5 (2019): 2433-2444.

29. Xie H., *et al*. "Long-term manure amendments reduced soil aggregate stability via redistribution of the glomalin-related soil protein in macroaggregates". *Scientific Reports* 5 (2015): 1-9.

30. Wang Q., *et al*. "Variation in glomalin in soil profiles and its association with climatic conditions, shelterbelt characteristics, and soil properties in poplar shelterbelts of Northeast China". *Journal of Forest Research* (2019): 1-12.

**Volume 5 Issue 10 October 2019**