Apigenin and Apigenin-7-O-β-d-Glucoside Enhance Pepper Defense Against *Phytophthora capsici* by Inhibiting Pathogen Growth and Reproduction

Linying Li[1+], Jiayuxuan Ren[1+], Bingting Lai[1], Kaidi Zhang[1], Xiang Qiu[1], Lili Lin[4], Ruqi Shi[1], Wenbo Liu[1], Moosa Sedibe[1, 3], Jiandong Bao[2*], Justice Norvienyeku[1*]

[1] Key Laboratory of Green Prevention and Control of Tropical Plant Diseases and Pests, Ministry of Education, Danzhou Invasive Species Observation and Research Station of Hainan Province, School of Tropical Agriculture and Forestry, Hainan University, Haikou 570228, China.

[2] Key Laboratory of Agricultural Microbiome, Ministry of Agriculture and Rural Affairs, Institute of Plant Protection and Microbiology, Zhejiang Academy of Agricultures Science, Hangzhou, 310021, China.

[3] Department of Agriculture, Central University of Science and Technology, Bloemfontem 9301, South Africa.

[4] Ministerial and Provincial Joint Innovation Centre for Safety Production of Cross-Strait Crops, Fujian Agriculture and Forestry University, Fuzhou 350002, China.

[+]These authors should be considered joint first authors.

[*]Correspondence: author: Justice Norvienyeku, School of Tropical Agriculture and Forestry, Hainan University, Haikou 570228, China, E-mail: jk_norvienyeku@hainanu.edu.cn, ORCID: 0000-0002-0889-7233.

[*]Co-Correspondence: author: Jiandong Bao, Institute of Plant Protection and Microbiology, Zhejiang Academy of Agricultures Science, Hangzhou, 310021, China. E-mail: baojd@zaas.ac.cn, ORCID: 0000-0003-3423-5118.

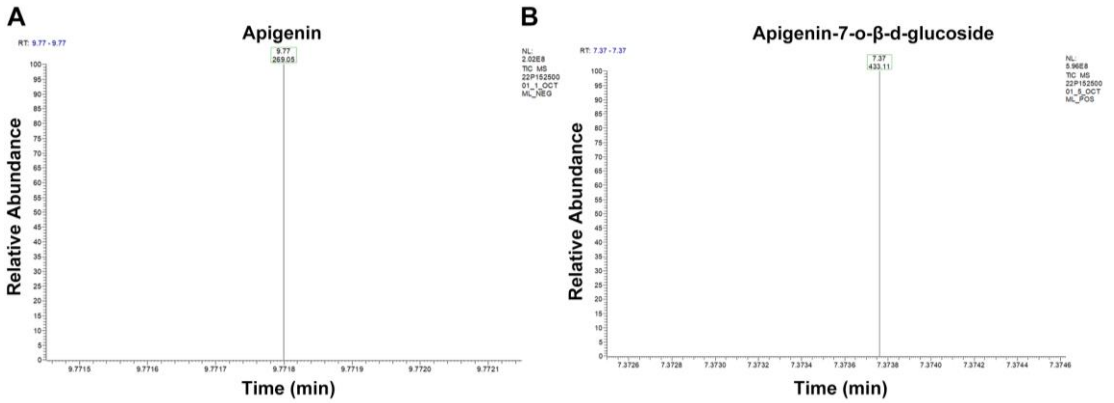

Figure S1. The exclusive generation of Apigenin and Apigenin-7-O-β-d-glucoside in pepper seedlings inoculated with *P. capsici*. (A) Displayed mass relative abundances recorded for Apigenin identified in pepper seedling under negative (Neg –) ionization mode. (B) Displayed mass relative abundances recorded for Apigenin-7-O-β-d-glucoside identified in pepper seedling under positive (Pos +) ionization mode.

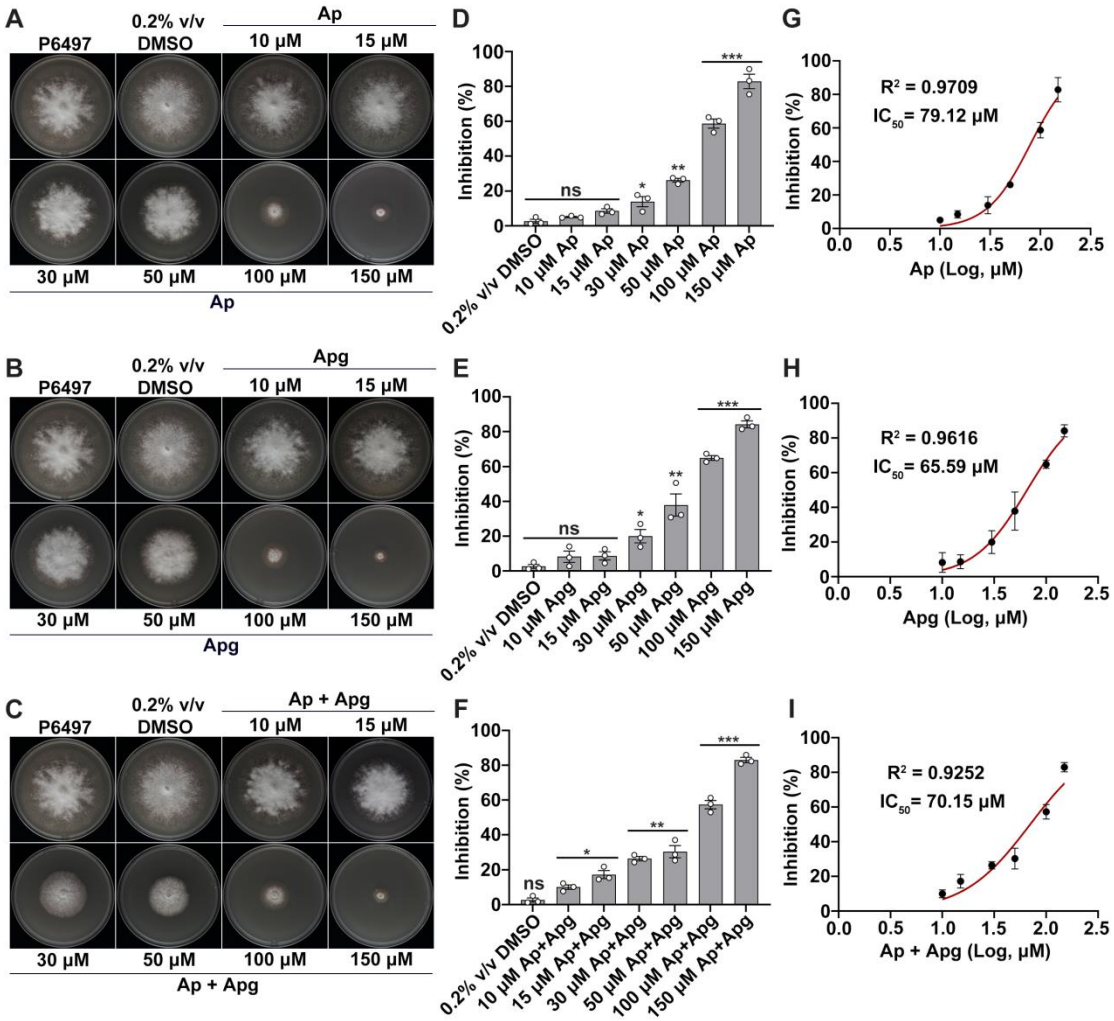

Figure S2. Influence of different concentrations of Apigenins on the vegetative growth of *P. sojae*. (A-C) Inhibitory effects of different concentrations of either Apigenin, Apigenin-7-O-β-d-

glucoside, or Apigenin and Apigenin-7-O-β-d-glucoside on the vegetative growth of *P. sojae*. (D-F) Histogram represents statistical computation of the inhibitory either Apigenin, Apigenin-7-O-β-d-glucoside, or Apigenin and Apigenin-7-O-β-d-glucoside on the vegetative growth of *P. sojae*. (G-I) The line graph showed analysis of the effective concentrations (IC_{50}) that corresponds to 50% inhibition in the vegetative growth of *P. sojae*. Ap: Apigenin; Apg: Apigenin-7-O-β-d-glucoside. *, P＜0.05; **, P＜0.01, ***, P＜0.001; ns: no signifcant. Non-parametric one-way analysis.

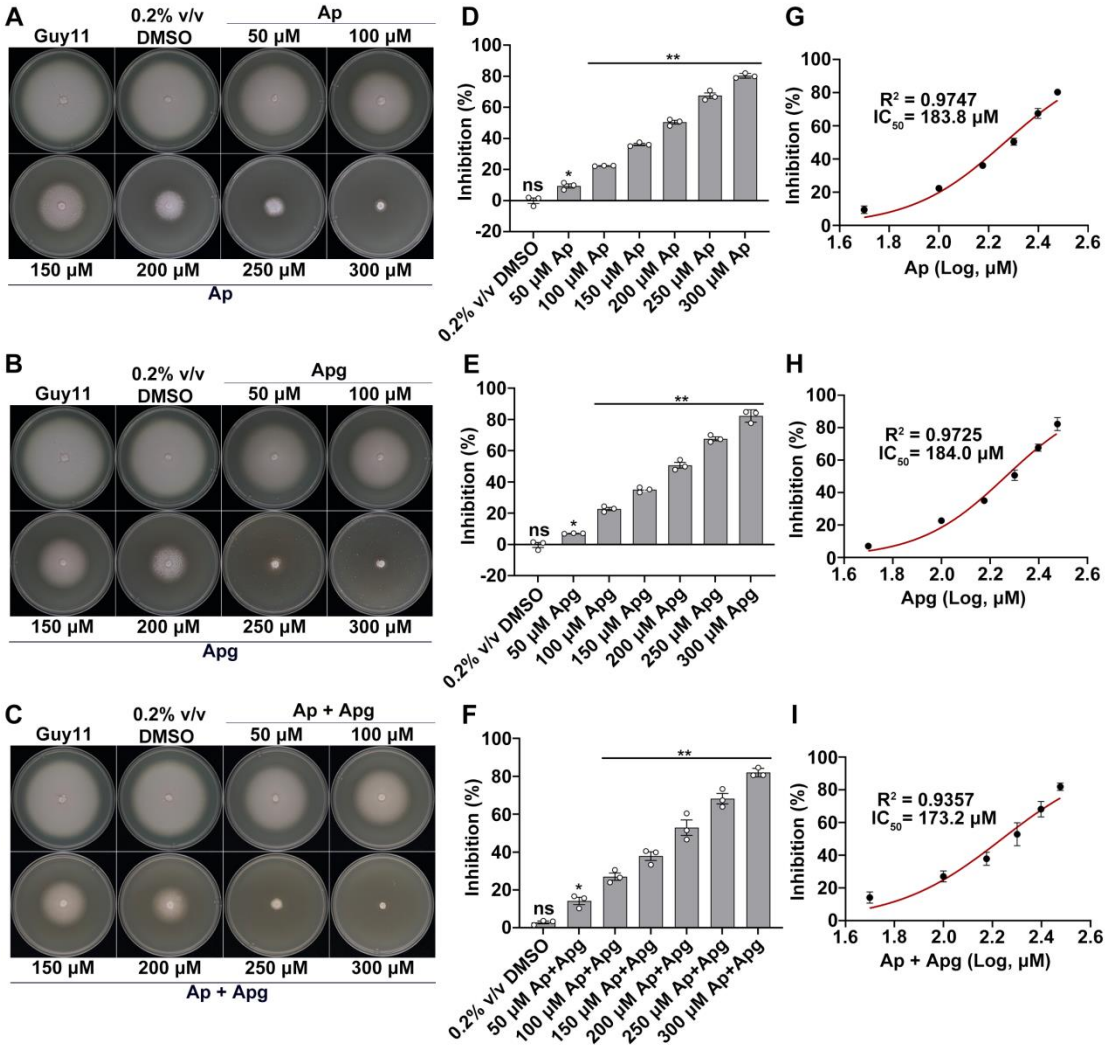

Figure S3. Apigenins treatment significantly inhibited the vegetative development of *P. oryzae*. (A-C) Inhibitory effects of different concentrations of either Apigenin, Apigenin-7-O-β-d-glucoside, or Apigenin and Apigenin-7-O-β-d-glucoside on the vegetative growth of *P. oryzae*. (D-F) Histogram represents statistical computation of the inhibitory either Apigenin, Apigenin-7-O-β-d-glucoside, or Apigenin and Apigenin-7-O-β-d-glucoside on the vegetative growth of *P. oryzae*. (G-I) The line graph showed analysis of the effective concentrations (IC_{50}) that corresponds to 50% inhibition in the vegetative growth of *P. oryzae*. Ap: Apigenin; Apg: Apigenin-7-O-β-d-glucoside. *, P＜0.05; **, P＜0.01; ns: no signifcant. Non-parametric one-way analysis.

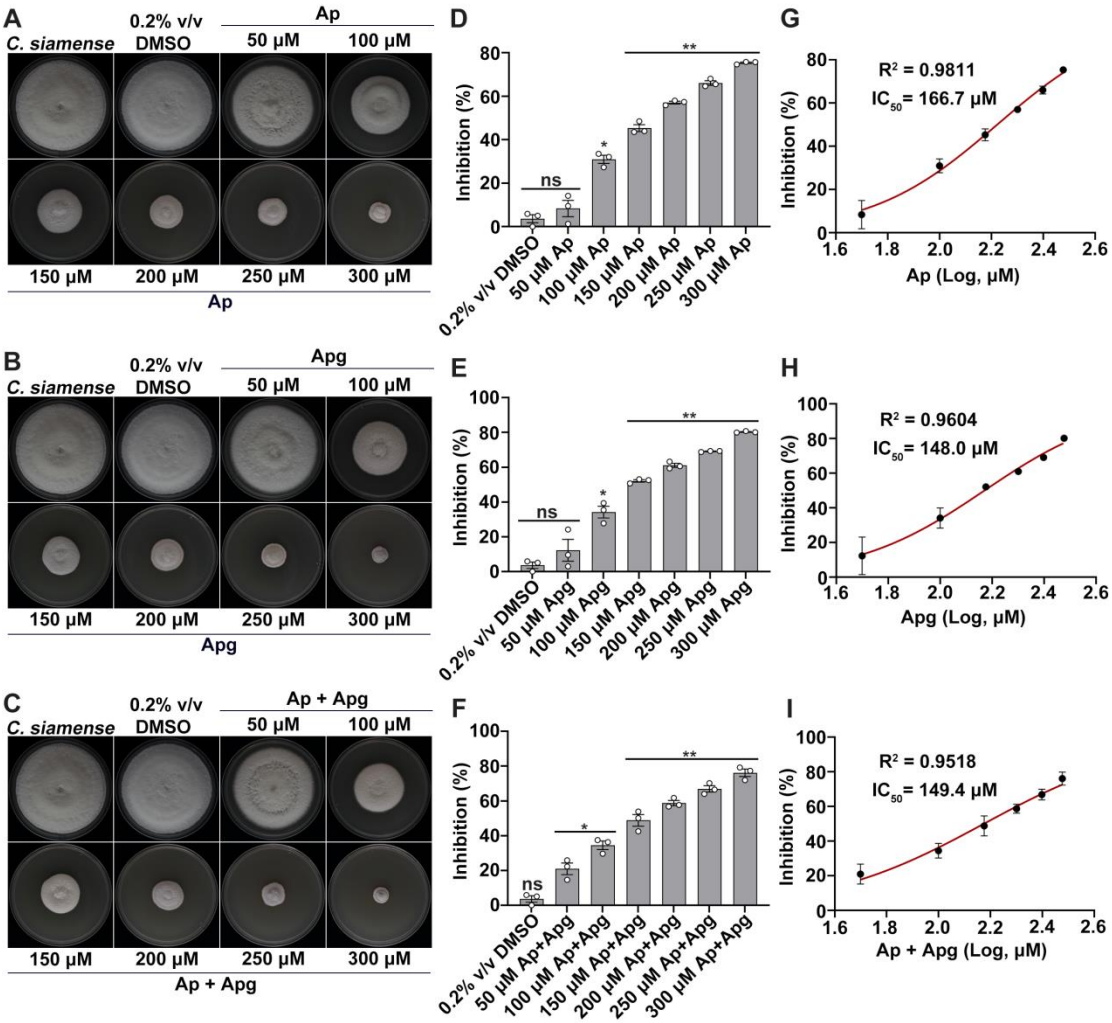

Figure S4. Apigenins suppress morphological development of *C. siamense*. (A-C) Inhibitory effects of different concentrations of either Apigenin, Apigenin-7-O-β-d-glucoside, or Apigenin and Apigenin-7-O-β-d-glucoside on the vegetative growth of *C. siamense*. (D-F) Histogram represents statistical computation of the inhibitory either Apigenin, Apigenin-7-O-β-d-glucoside, or Apigenin and Apigenin-7-O-β-d-glucoside on the vegetative growth of *C. siamense*. (G-I) The line graph showed analysis of the effective concentrations (IC_{50}) that corresponds to 50% inhibition in the vegetative growth of *C. siamense*. Ap: Apigenin; Apg: Apigenin-7-O-β-d-glucoside. *, $P<0.05$; **, $P<0.01$; ns: no signifcant. Non-parametric one-way analysis.

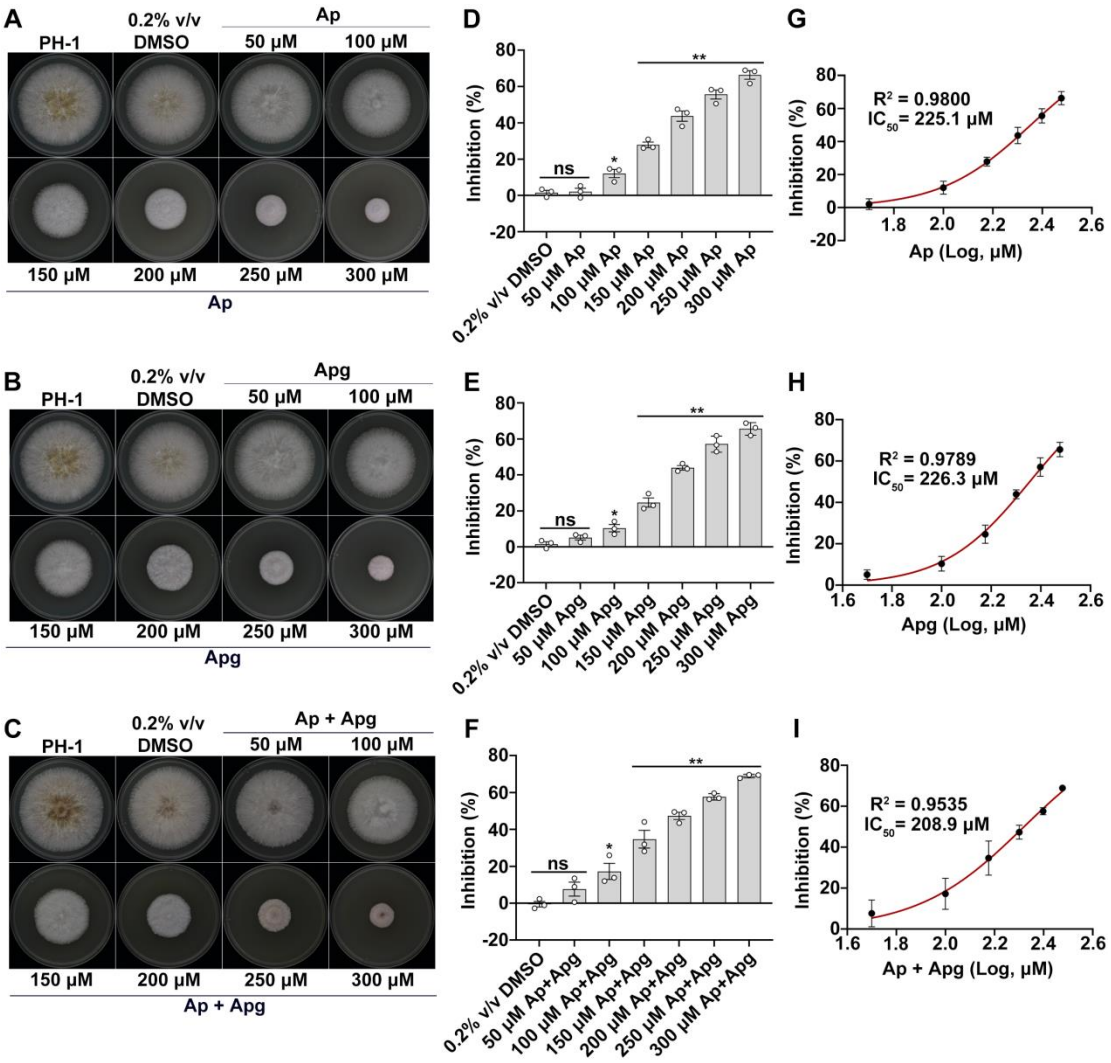

Figure S5. Effects of either Apigenin, Apigenin-7-O-β-d-glucoside, or Apigenin and Apigenin-7-O-β-d-glucoside on the vegetative growth of *F. graminearum*. (A-C) Inhibitory effects of different concentrations of either Apigenin, Apigenin-7-O-β-d-glucoside, or Apigenin and Apigenin-7-O-β-d-glucoside on the vegetative growth of *F. graminearum*. (D-F) Histogram represents statistical computation of the inhibitory either Apigenin, Apigenin-7-O-β-d-glucoside, or Apigenin and Apigenin-7-O-β-d-glucoside on the vegetative growth of *F. graminearum*. (G-I) The line graph showed analysis of the effective concentrations (IC_{50}) that corresponds to 50% inhibition in the vegetative growth of *F. graminearum*. Ap: Apigenin; Apg: Apigenin-7-O-β-d-glucoside. *, $P < 0.05$; **, $P < 0.01$; ns: no signifcant. Non-parametric one-way analysis.

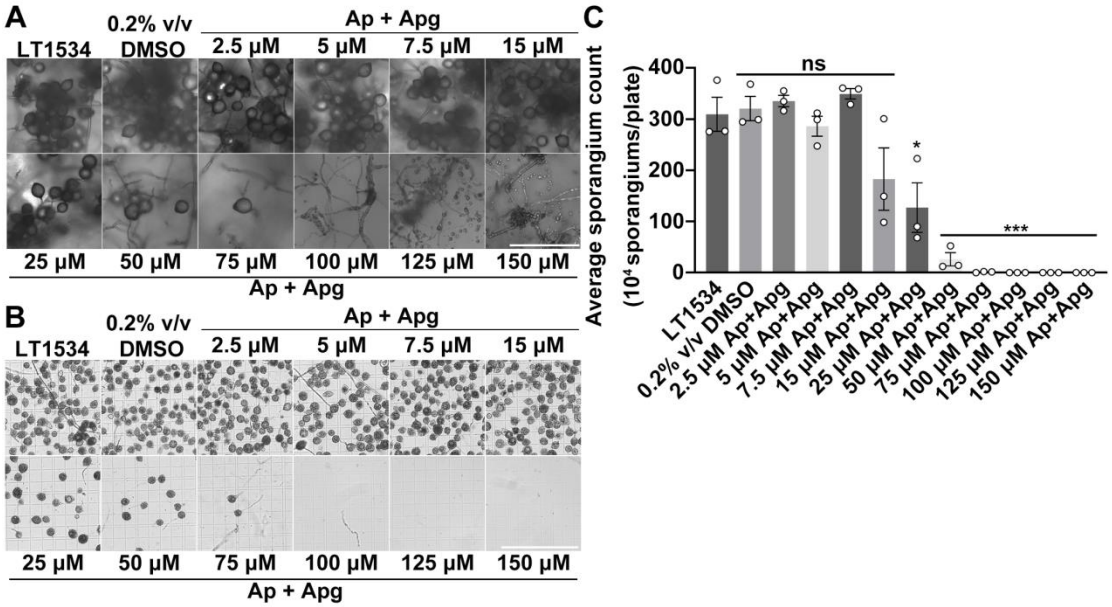

Figure S6. Effects of the combination of Apigenin and Apigenin-7-O-β-d-glucoside on sporangium production of *P. capsici*. (A-B) Impacts of different concentrations of the combination of Apigenin and Apigenin-7-O-β-d-glucoside on the sporangium production of *P. capsici*. (C) Histogram represents statistical computation of the impacts of the combination of Apigenin and Apigenin-7-O-β-d-glucoside on sporangium production of *P. capsici*. Ap: Apigenin; Apg: Apigenin-7-O-β-d-glucoside. Bars in (A) is 50 μm; Bars in (B) is 100 μm. *, P ＜0.05; ***, P＜0.001; ns: no signifcant. Non-parametric one-way analysis.