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Incidence of clubroot in Shanghai and effect of exogenous salicylic acid on seedling growth, physiological characteristics and resistance-clubroot (*Plasmodiophora brassicae*) in Pakchoi (*Brassica campestris* ssp. chinensis Makino)

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Clubroot, which is caused by the soil-borne obligate biotrophic protist *Plasmodiophora brassicae* Woron., is the most important root disease of Brassica crops worldwide. In recent years, the incidence of clubroot in the suburbs of Shanghai, China, has increased yearly. Until 2017, 39 counties and 9 towns of Shanghai had clubroot brake out and the occurrence area had reached 47.12 hm^2. The identification results showed that the clubroot of Qingpu district in Shanghai was physiological races No.7. SA, as a signal molecule, can induce plants to resist pathogens and produce resistance. We studied the protective effect of exogenous salicylic acid (SA) on the reactions of physiological indicators and inducing clubroot- resistance of Pakchoi. In this study Pakchoi variety 'Xinaiqing' was inoculated with clubroot (*P. brassicae*) by soil bacteria inoculation method. We have selected 0.2~0.8 $mmol{\cdot}L^{-1}$ exogenous salicylic acid (SA) to treat the inoculated Pakchoi plants, and then investigated the effects on growth, clubroot-resistance, reactive oxygen and defense enzyme activity of leaf and root. We discussed the mechanism of SA to induce the clubroot-resistance. The results showed that clubroot inhibited the growth significantly and increased the damage of membrane lipid peroxidation. The best effect on the alleviation of clubroot damage was 0.6$mmol{\cdot}L^{-1}$ SA obviously. At this concentration, the growth, clubroot-resistance, the activity of superoxide dismutase (SOD), peroxidase (POD), ascorbate peroxidase (APX), polyphenol oxidase (PPO), phenylalanine ammonia lyase (PAL), glutathione reductase (GR) in leaves and root were increased significantly, while malondialdehyde (MDA), hydrogen peroxide (H_2O_2) and the production rate of superoxide anion ($O_2{\cdot}^-$) were significantly decreased. The results indicated that dosage effect of SA existed on the alleviation of clubroot in Pakchoi plants, and the best alleviating effect on clubroot disease stress damage was 0.6$mmol{\cdot}L^{-1}$ SA by irrigating at the plant roots, which was favorable for the plant to grow, and improve the ability of clubroot-resistance.

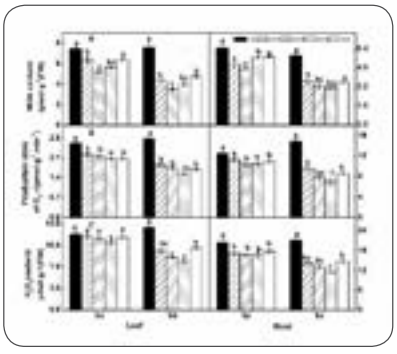

Figure 1: Effects of clubroot on the MDA content(A), production rate of O2·- (B) and H2O2 content (C) of Pakchoi leaf and root.

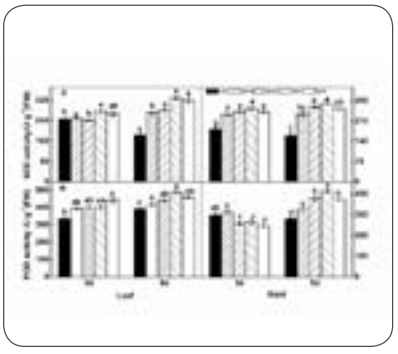

Figure 2: Effects of clubroot on the SOD (A) and POD (B) activity of Pakchoi leaf and root.

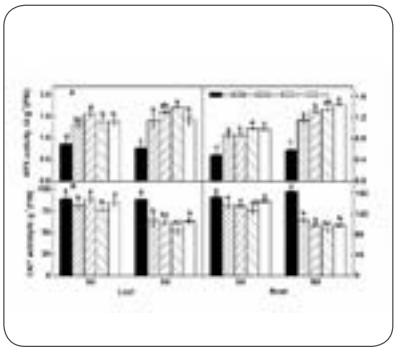

Figure 3: Effects of clubroot disease on the APX (A) and CAT (B) activity of Pakchoi leaf and root.

Recent Publications:

1. Amil Ruiz et al. (2016) Partial activation of SA- and JA-defensive pathways in strawberry upon *Colletotrichum acutatum* interaction. Frontiers in Plant Science. 7:1036.

2. Gravot A et al. (2012) Arginase induction represses gall development during clubroot infection in Arabidopsis. Plant & Cell Physiology. 53(5):901-911.
3. Kageyama K and Asano T (2009) Life cycle of *Plasmodiophora brassicae*. Journal of Plant Growth Regulation. 28(3):203-211.
4. Lemarié S et al. (2015) Both the jasmonic acid and the salicylic acid pathways contribute to resistance to the biotrophic clubroot agent *Plasmodiophora Brassicae* in Arabidopsis. Plant & Cell Physiology. 56(11):2158-2168.
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Biography

Yuying Zhu has working on Shanghai Academy of Agricultural Sciences since 1984. Now he has his expertise in pakchoi cultivation and breeding. He has chosen 15 pakchoi varieties that have large area. .

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Notes: