

多次施用化学农药对梨园土壤线虫群落结构及土壤理化性质的影响

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摘要:【目的】对多次施用化学农药和仅施3次化学农药的试验梨园土壤线虫群落结构及土壤理化性质进行研究, 评价农药过度使用对土壤污染的质量状况。【方法】比较多次施用农药和仅施3次农药的梨园根际浅层(0~20 cm)和深层(>20~40 cm)土壤线虫群落结构, 分析线虫多样性、生态功能指数。【结果】仅施3次药的梨园浅层土壤pH值显著低于常规梨园土壤, 速效钾质量分数($129.2 \text{ mg} \cdot \text{kg}^{-1}$)显著提高; 深层土壤铵态氮及有机质含量显著降低。多次施药的梨园土壤线虫数量显著低于施3次药的梨园。绕线属(*Plectus*)和小杆属(*Rhabditis*)耐受农药干扰的能力强, 矮化属(*Tylenchorhynchus*)对农药过度使用反应灵敏。施3次药的梨园浅层土壤杂食/捕食线虫比例、深层土壤植物寄生线虫比例显著高于多次施药梨园。对线虫生态指数分析表明, 仅施3次药的梨园深层土壤TD、SR、MI均显著高于多次施药梨园。【结论】施3次药改变了土壤线虫群落结构, 增加了土壤线虫丰富度和营养类群多样性, 使得土壤更趋向于成熟。因此, 土壤线虫关键属、生态功能指数可以作为评价农药过度使用对土壤造成污染的良好生物指标。

关键词: 梨园; 施药次数; 土壤线虫; 土壤理化性质

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Soil nematode community and soil properties in pear orchards as affected by frequent applications of pesticides

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Abstract: 【Objective】Pear is a fruit with high economic value, but diseases and insect pests always restrict the development of the pear industry, the dominant pests are *Psylla chinensis*, mites, and aphids in the northern pear orchard. When *Psylla chinensis* seriously occurs in pear orchards, farmers will spray pesticides more than 10 times. The technique of applying pesticides for 3 times is more popular for effectively controlling the main pests in northern orchards. Nematodes are ideal bioindicators for terrestrial ecosystems and their community structure can provide important insights regarding many aspects of the ecosystem function. In addition, they are food-specific, and sensitive especially in their response to anthropogenic disturbances and management changes, such as pollution, and agricultural management. So the effects of pesticides with applications of only 3 times or many times on nematode communities and soil properties were examined to evaluate the soil pollution caused by overuse of pesticides in pear orchards. 【Methods】Ten cores of samples were collected from the soil surface layer (0–20 cm) and sub-surface layer (>20–40 cm), respectively. Nematodes were extracted from 100 g of fresh soil from each sample by using the shallow dish method and were identified at the genus level by using a Leica microscope. Nema-

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todes were classified according to their feeding behavior as bacterivores, fungivores, herbivores, omnivores or predators. The nematode community, using indices of biodiversity and ecological function in the soil at 0–20 cm and > 20–40 cm in depth in applications of many times (M) and only 3 times of pesticides (T) in pear orchards, were observed respectively. 【Results】 It is clear that the two management methods had different impacts on all soil properties. Soil samples were alkaline in both soil layers through the two management methods, with pH values between 7.90 and 8.27. The surface soil pH value in pesticides for 3 times per orchard was significantly lower than applications of many times of pesticides per orchard ($P < 0.05$), and the content of available potassium ($129.2 \text{ mg} \cdot \text{kg}^{-1}$) increased significantly. While in the sub-surface soil, the content of ammonium nitrogen and organic matter decreased. The total number of nematodes in application of many times pesticides per orchard was significantly lower than pesticides for applications of 3 times at the two soil layers. We identified seventeen nematode genera in the two management methods, and observed that the nematode community was significantly affected by the frequency of pesticide applications. *Plectus* and *Rhabditis* had strong pesticide tolerances, but *Tylenchorhynchus* responded quickly to overuse of pesticides. At the depth of 0–20 cm, *Plectus* was eudominant genera in applications of the many times pesticides orchards, but not found in applications of pesticides for 3 times; *Tylenchorhynchus* was the dominant genera in M and eudominant in T. At the depth of > 20–40 cm, *Rhabditis* was the dominant genera in M and decreased to subdominance in T; *Tylenchorhynchus* had the same change at 0–20 cm. There were no significant differences in the percentage of bacterivores and fungivores between the two management methods at the two soil layers. The percentage of omnivores/predators in shallow soil and the herbivorous nematodes in the sub-surface soil with applications of pesticides for 3 times in orchards were remarkably higher than in applications of the pesticides in the many times orchards. According to the analysis of ecological indices, at the soil layer of 0–20 cm, the nematode channel ratio and the indices of trophic diversity (*TD*), species richness (*SR*) and maturity (*MI*) had no significant differences between M and T. However, significant differences were observed in the indices (*TD*, *SR* and *MI*) between the different management methods in the sub-surface soil. The indices of *TD*, *SR* and *MI* in applications of pesticides for 3 times in orchards were significantly higher than in applications of pesticides for many times. The soil food webs of the tea plantation ecosystems were plotted along their respective enrichment index (*SI*) and structure index (*EI*) trajectories. For applications of many times and 3 times of pesticides, no significant differences were found in the nematode faunal profile, with surface layers located in quadrant D and sub-surface layers in quadrant A. 【Conclusion】 In applications of pesticides for 3 times in orchards, the soil nematode communities have been changed, the species richness of the soil nematodes and trophic diversity have been increased. Moreover, applications of pesticides for 3 times made the soil in the pear orchards tend to maturity. Therefore, the key genus and ecological function indices of the soil nematodes are good bioindicators for evaluating the soil pollution caused by overuse of pesticides.

Key words: Pear orchard; Times of pesticides; Soil nematode; Soil properties

梨树病虫目前主要依靠药剂防治,尤其在梨木虱发生比较严重的梨园,每年用药10次甚至更多,5月至果实采收前,平均每周喷1次化学农药,造成了严重的农药残留。随着药剂的长期施用,梨木虱对毒死蜱、吡虫啉、齐螨素的抗药性逐年增加^[1]。因此,针对以上问题,刘奇志等^[2]发明专利“一种北方梨园病虫害防控方法”(专利号:ZL201310529371.4),以

防治梨木虱为主,在梨树整个生长季共喷施3次化学药剂,并结合其他非化学防治技术。该项发明与多次施药梨园相比,虫害发生数量无显著变化甚至显著减少,用药次数和数量减少了2/3,且增加了天敌数量^[3–4]。

线虫在土壤中分布广泛、数量众多、种类丰富,其群落组成能够反映出气候条件、土壤质地、土壤有