Cropping Systems and Root-lesion Nematodes

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Root-lesion nematodes (*Pratylenchus* species) occur in soils worldwide. These pests were recently found to be common in many fields of the low-precipitation region of the Pacific Northwest. The two species (*Pratylenchus neglectus* and *Pratylenchus thornei*) that are most prevalent in our dryland fields are capable of causing substantial reductions in grain yield. This is particularly well defined for annual spring wheat but had not been critically evaluated in other cropping systems. A replicated long-term experiment was established at Moro (11 inches annual precipitation) to examine agronomic, weed and pest management aspects of eight cropping systems. Soil at the site was naturally infested with *Pratylenchus neglectus*.

A uniform crop of spring wheat was planted over the experimental area during 2003. The area was mapped into 42 plots (each 48 × 350 feet) representing three replicates of eight crop treatments. The cropping systems included annual winter wheat, annual spring wheat, annual spring barley, winter wheat-summer fallow rotation with either cultivated or chemical fallow, a 2-year rotation of winter wheat and winter pea, and a 3-year rotation of winter wheat, spring barley and chemical fallow. Each phase of each multiyear crop treatment was present in all years to allow treatment data to be collected for each year. Two flexible cropping systems were also established to allow decisions to be made annually depending upon market prices, soil moisture, weeds and diseases. The flex-crop treatments have included winter wheat, chemical fallow, and spring-planted crops of barley, camelina, pea, mustard and wheat. Seven of the eight crop treatments were managed without tillage (no-till). Spring crops were planted in April and winter crops were planted into no-till plots during October or November and into cultivated fallow during mid-September. Measurements included the soil water content throughout the year, numbers of lesion nematodes in the spring, and grain yield.

Population densities and the vertical distribution of lesion nematodes in soil profiles were strongly influenced by cropping systems. In general, the highest numbers of lesion nematodes over the 5-year sampling period corresponded with the frequency that wheat or another host (pea or mustard) was planted. The greatest numbers occurred in annual winter wheat and annual spring wheat, the 2-year wheat-pea rotation, the winter wheat-summer fallow sequences in which wheat was produced in 3 of 5 years, and in the flex-crop rotation in which spring wheat and spring mustard were produced in 3 of 5 years. The lowest numbers occurred in annual spring barley, the winter wheat-summer fallow sequences in which wheat was produced in only 2 of 5 years, and in the 3-year rotations in which wheat was produced in only 1 or 2 of 5 years. Populations after spring barley and fallow were about half the populations following wheat or pea (Table 1). The influence of spring mustard was intermediate between wheat and barley. Populations diminished when winter wheat was rotated with either chemical or cultivated fallow, and the type of fallow had no effect on nematode populations. The peak population density was about 12 inches deeper in the profile under winter wheat compared to spring wheat. Although 12 inches was the minimally acceptable sampling depth for determining nematode numbers, we found that sampling to 18-inch depth was much more informative.

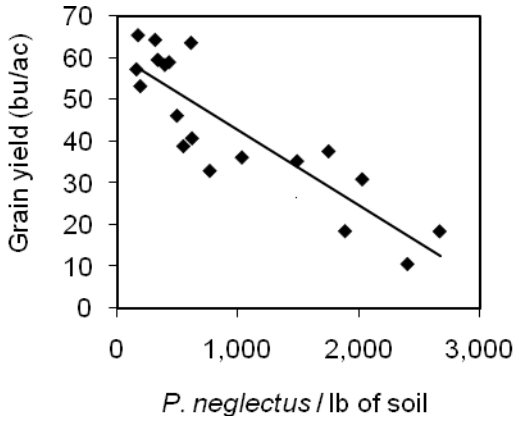
Table 1. Average number of lesion nematodes in the top foot of soil during the spring following a specific crop or fallow treatment in eight cropping systems. The number of times each crop or fallow occurred over the 4-year interval (2005-2008) is shown in parenthesis.

Previous crop or management	*nematodes/ pound of soil*
Spring wheat (21)	1,174
Winter pea (12)	1,145
Winter wheat (63)	1,035
Spring mustard (3)	836
Cultivated fallow (12)	527
Chemical fallow (30)	441
Spring barley (27)	440

Soil sampling to assess nematode populations was performed as spring cereals were being planted. Populations of nematodes in winter wheat-summer fallow rotations, six months after the wheat was planted, were numerically higher in the fallow phase than the 'in-crop' phase in four out of 10 comparisons and were significantly lower than the 'in-crop' phase in only one of 10 comparisons. A similar phenomenon also occurred in samplings of wheat and fallow near Heppner. We found in other studies that lesion nematode populations can become very high in roots of volunteer cereals and grass weeds as early as late in the fall. Management of lesion nematode populations must therefore include eliminating the potential for them to multiply during the fallow period. In soils infested with these nematodes, living plants must not be allowed to persist during the intervals between planted crops.

Highest average grain yields over the life of the experiment were achieved with winter wheat in the 3-year rotation and in the winter wheat-cultivated fallow. These highest-yielding systems were followed, in order of diminishing yield, by winter wheat-chemical fallow, winter wheat in wheat/pea rotation, annual spring barley, spring barley in the 3-year rotation, annual spring wheat, and annual winter wheat. The yields for winter wheat in five of the crop sequences (all except the flex-crops) from 2005 to 2008 were strongly and negatively correlated with the population of lesion nematodes in soil (Fig. 1). Moreover, compared to winter wheat in other crop sequences, annual winter wheat not only had the greatest population of lesion nematodes and lowest grain yield, but also extracted a lower amount of water from soil profile. It was clear that root dysfunction caused by lesion nematodes reduced the capacity of plants to extract deeply stored water, which induced premature moisture stress towards the end of the growing season and left unused water in the profile. Cropping systems that allow development of the highest numbers of lesion nematodes become least efficient for extracting the deeply stored soil water. This is particularly problematic during dry years.

Figure 1. Relationship between lesion nematode numbers and winter wheat yields from 2005 to 2008 in five cropping systems at Moro.



A more-detailed accounting of this research will be published in the 2009 Annual Report from the Columbia Basin Agricultural Research Center. That report will become available online at: http://cbarc.aes.oregonstate.edu/ResearchReports.htm