Drip Irrigation Placement and the Development of Phytophthora Root Rot in Woody Ornamentals

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Drip irrigation is used widely in commercial, institutional, and home landscaping throughout drier regions of the West. In comparison to other forms of irrigation, drip systems offer significant water savings and, in many situations, relatively low installation and maintenance costs.

When container-grown plants are transplanted into landscapes, the first concern in irrigation is the delivery of adequate water directly to the existing root system. Therefore, drip irrigation emitters are initially installed near the stem of transplants, and the central part of the root system may be in very wet soil for considerable periods of time. Unfortunately, not only are very wet soil conditions unfavorable for root growth and activity, they promote the development of root rots caused by fungi in the genus *Phytophthora*.

Ceanothus plant with advanced symptoms of Phytophthora root rot (foreground) next to healthy plants 14 months after transplanting. Less root rot developed in ceanothus when drip irrigation emitters were placed away from rather than near the stems.

Phytophthora root rots are serious diseases of many woody and herbaceous plants commonly used in landscaping, and pathogenic *Phytophthora* species frequently occur in nursery stock and the soil into which landscape plants are transplanted. Therefore, Phytophthora root rot is a disease that must be managed in many landscapes. Because Phytophthora root rots develop rapidly under very wet soil conditions, even small degrees of drainage can greatly reduce disease severity. As a result, Phytophthora root rots are frequently managed in field and orchard crops by adjusting irrigation methods to avoid excessive saturation of the soil near plants with water.

With drip irrigation, the extent to which the soil and roots are wetted can be manipulated by adjusting emitter location, flow rates and irrigation schedules. Our project sought to determine the optimum placement of drip irrigation to reduce damage caused by Phytophthora root rot, while still maintaining an adequate water supply to woody ornamentals, following transplanting into field soil.

Research Methods

We conducted our experiments in the Plant Pathology field area at the University of California, Davis, on a site where the soil did not contain detectible populations of *Phytophthora* species. The soil was a well-drained Yolo loam, and the site was irrigated thoroughly and allowed to drain just before the experiments were installed in the spring of 1989. Three different plant species, two irrigation treatments, and two inoculum treatments (a noninoculated control and a treatment with *Phytophthora* species added) were used. The three plant species were *Juniperus sabina* 'Tamariscifolia', *Viburnum tinus* 'Robustum', and *Ceanothus* 'Julia Phelps'. Because of their differing water requirements, separate experiments were set up with 48 plants of each species, with 12 plants in each specific treatment combination. We obtained plants in one-gallon containers from local nurseries and sampled all for the presence of *Phytophthora* species before transplanting. None of the juniper plants were found to contain *Phytophthora* species, while five viburnum plants were positive. Three of these were used in the experiment, all in inoculated treatments. All of the ceanothus plants contained *Phytophthora cactorum*.

Isolates of *Phytophthora cinnamomi* used as inoculum were originally isolated from chestnut trees in Marin County or from walnut trees in Merced County, California, and were found to be highly pathogenic. One isolate of *Phytophthora cryptogea* from juniper plants grown locally was also used. For the field we prepared inoculum by culture on a sterile vermiculite medium.

Plants were transplanted and inoculated in May, 1989. Planting holes were approximately 15 centimeters in diameter by 10 centimeters deep and were filled with water once before transplanting. After the water drained completely, control plants were removed from their containers with root balls intact and placed into the centers of the holes, which were then backfilled with soil to the tops of the root balls. A shallow basin was made around each plant and filled slowly with water once. Each inoculated ceanothus and viburnum plant received 1,000 milliliters of *P. cinnamomi* inoculum consisting of a vermiculite mixture of three isolates. Juniper plants were each inoculated with 1,000 milliliters of the same *P. cinnamomi* isolates and 500 milliliters of *P. cryptogea* inoculum. The inoculum was mixed thoroughly with the soil used to backfill most of the space around the container soil in the planting holes. Water was added to the inoculated soil, and additional clean soil was used to finish backfilling. Subsequent irrigations were done by the drip system. Most plants grew well following transplanting, and the small number that did not were replaced within the first two months.

The soil surface was irrigated with one-half-gallon-per-hour drip emitters, and the two irrigation treatments differed in the distance from the stem at which the two emitters at each plant were placed. In the first treatment, one emitter remained near the stem while the other emitter was moved away from the stem as fast as root growth allowed. In the second treatment, while the position of the emitters was initially the same, both were subsequently moved away from the stems as the roots grew into the soil surrounding the original root balls. Those emitters that were moved from the junipers and ceanothus were moved to 10-, 15-, 20- and 25-centimeter distances from the stems at approximately 1, 2, 11, and 12 months after transplanting, respectively. Those used for viburnum were not moved beyond 20 centimeters. To summarize, the first treatment had one emitter that remained near the stem and one that was moved away from the stem as roots grew; in the second treatment, both emitters were moved and were finally 20 to 25 centimeters from the stems.

During the first month after transplanting, each plant received 800 to 1,200 milliliters of water daily. Subsequent irrigations in 1989 were done on alternate days (approximately 1,500 milliliters per plant) as needed to maintain moisture levels (as measured with tensiometers) near the soil's moisture capacity 15 centimeters beneath selected emitters. Irrigations were suspended during the rainy season from late November, 1989, to early April, 1990. In 1990, we replaced tensiometers with electronic soil moisture sensors and applied irrigation for 20 minutes whenever the soil under selected emitters was drier than field capacity.

Disease symptoms on shoots were measured periodically using a relative scale in which "0" represented health and "4" represented a dead plant. At the end of the experiments plants were excavated to a depth of 60 centimeters to evaluate symptoms of root rot and measure plant size. Experiments on ceanothus and juniper ended in October, 1990, while the one on viburnum lasted until September, 1991.

Research Results

Viburnum: All of the viburnum grew well for the duration of the experiment, and none developed visible symptoms of Phytophthora root rot. Furthermore, the two methods of drip irrigation yielded similar growth rates in viburnum. Evidently, viburnum is less susceptible to the *Phytophthora* species used than is juniper or ceanothus.

Ceanothus: Only one plant developed clear symptoms of Phytophthora root rot in the first year, and most of the plants that became diseased showed first symptoms in the spring of the second year. The foliage of diseased plants turned slightly off-color, became unusually brittle, and finally desiccated until the shoot appeared completely dead. This progression of symptoms occurred in as little as two weeks during hot weather, but took longer in early spring. Ratings of the final severity of disease symptoms are shown in the accompanying table.

Final Severity of Disease Symptoms				
Inoculum added	Location of drip emitters relative to stem	Severity of disease symptoms (0-4)		
		Ceanothus		Juniper
		Roots	Stems	Roots
No	Far	0.2	0	0
No	Near	1.8	1.8	0
Yes	Far	0.7	0.7	2.1
Yes	Near	2.4	2.4	2.6

In the absence of added inoculum, little or no disease developed when emitters were moved away from the stems of ceanothus, while moderate disease developed on 6 of 12 plants when one emitter remained close to the stem. *P. cactorium* was on the ceanothus when it was purchased from the nursery, and that fungus was recovered from some of the plants at the end of the experiment. Evidently, this pathogen was much more active when soil near the stem was wetted by irrigation, and moving the drip emitters away from the stem reduced disease to a level that could be tolerated in most landscape settings. Those ceanothus plants that remained healthy were equivalent in size, suggesting that the water supply was adequate for good growth by the plants that escaped disease regardless of emitter location.

The addition of inoculum to soil increased disease in both irrigation treatments, but considerably more disease developed when the drip emitter remained close to the trunk of ceanothus (see table). Clearly, moving the drip emitters away from the stem also reduced the amount of disease caused by *P. cinnamomi*.

Juniper: The time course of symptom development in juniper was similar to that in ceanothus. None of the uninoculated junipers, however, became diseased, while most of the inoculated ones did, regardless of irrigation treatment (see table). *P. cinnamomi* was frequently recovered from diseased juniper roots. Unfortunately, the pathogenic activities of this fungus on juniper were not reduced by moving drip emitters farther from the stem. There is also the possibility that moisture from rainfall contributed to disease development, thereby reducing differences due to method of irrigation.

Implications of the Work

The risk of Phytophthora root rots can be reduced by keeping irrigation water away from the stems or trunks of susceptible plants. The value of this recommendation is demonstrated clearly by the results obtained with ceanothus under drip irrigation and is also suggested by considerable experience with a variety of crop plants under irrigation.

While it is certainly important to supply some water to the original root ball for a period after transplanting, the results show that shifting drip irrigation emitters away from stems as roots grow into surrounding soil reduces disease losses to some Phytophthora root rots while providing adequate water supply to the plants. It is also important to grade the soil surface to prevent water from irrigation or rain from accumulating around stems and trunks.

The main difficulty in implementing the recommendations of this work is knowing the rate of root growth into the soil following transplanting. This can be determined by digging small soil samples periodically to look for roots, as was done here, or in many circumstances landscapers may have sufficient experience to estimate root growth. A second limitation is that not all Phytophthora root rots can be avoided by manipulating the location of drip irrigation, as was the case here for junipers infected by *P. cinnamomi*. Once junipers are established in the landscape, it is probably better not to irrigate them in the warm season when *P. cinnamomi* is most active, and to rely on rainfall or irrigation during cooler seasons.

Nevertheless, since moving drip emitters out from the stems as the plants grew did not increase disease or limit growth, this method of irrigation management is recommended whenever drip irrigation of woody ornamentals is required and there is a risk of Phytophthora root rot.

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