Protection of Seedling Carrot from Frost Heaving

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Introduction

Hybrid carrot seed is the single most highly valued crop in central Oregon, having a gross value in 2007 of $9.6 million. Carrot seed acreage has consistently been from 2,000 to 3,000 acres in recent years. Approximately 75 percent of carrot seed acres are planted from seed in August the year before harvest (seed-to-seed); the other 25 percent are spring transplanted from roots (root-to-seed). Frost heaving is a major risk factor for seed-to-seed carrot production in the region. Frost heaving tends to occur during January through March when the soil is moist and frequently freezes and thaws in response to daily temperature fluctuations. The freezing and thawing soil can result in seedling carrots being pushed up out of the soil, or heaved, which results in plant mortality. In some cases frost heaving can result in complete stand failure.

To avoid this type of catastrophic crop loss, growers have attempted various methods to insulate seedling carrots and prevent them from heaving. One method of protecting carrots involves drop spreading spent mint hay over each carrot row. The machinery that is used for this operation is slow so this approach is time consuming, but it does an acceptable job of protecting seedling carrots. The spent mint hay has been readily available in the past because it was a waste product from peppermint grown for oil. Unfortunately, peppermint is no longer widely grown for oil in the region, so the availability of the spent hay has become limited.

Another method of protecting carrots that is commonly used covers several rows at once with a material called Agribond® nonwoven protective fabric. This material does a very good job of protecting carrots but has several drawbacks. First, it is expensive and putting it on and taking it off correctly is labor intensive. Second, the material is susceptible to being blown off the carrots by high winds. Third, it allows pests such as aphids and weeds to proliferate over the winter months. Fourth, the timing for removal in the spring can be risky because any frost after the material is removed can be fatal to the carrots.

Hydro-seeders may be able to overcome some of the limitations that existing methods present for protecting carrots from frost heaving. Hydro-seeders use a sprayable slurry made of water, a shredded biomass product (usually wood product waste or newspaper), and seed; this slurry is frequently used to sow seeds on highly erodible land. A hydro-seeder consists of a large tank with an agitator, a pump, and some type of hose and nozzle system to deliver the slurry. Our interest in this technology was not in sowing seeds, but merely in spraying the mulch over the top of seedling carrots and comparing that to other biomass mulches.

Other biomass products like cattle manure or wood chips are available in large quantities and might serve as a replacement for spent mint hay. However, there are at least two

criteria that a mulch must meet to be an acceptable replacement for mint hay: 1) it must not injure the carrots, and 2) it must not get blown away. Other criteria not discussed here are cost and availability.

The objective of this research was to evaluate the potential of several mulch products to prevent frost heaving in seed-to-seed carrots.

Methods and Materials

Two trials were conducted in a commercial field of hybrid carrot grown for seed near Metolius, Oregon. The treatments in one trial consisted of hydro-mulch at five different rates and an untreated check, none of which were replicated. The treatments in the other trial consisted of wood chips, manure, manure plus straw, spent mint hay, and an untreated check that were arranged in randomized complete blocks replicated two times. Hydro-mulch was applied with a small commercial hydro-seeder. The dry mulch products were applied by hand. Application rates for all mulch products are shown in Tables 1 and 2. The treatments were applied to two rows of female carrots spaced 30 inches apart and plots were 20 ft long. The hydro-mulch was applied on January 9, 2008 and the dry mulches were applied on January 14, 2008.

Results and Discussion

The trials were placed in a low area of the field and the soil was very wet from December through early February, making the location likely to experience frost heave. There were major stand differences associated with each row, irrespective of the treatment, and the design was such that it did not account for these stand differences.

The hydro-mulch product was a finely shredded wood-fiber product that included a tacifier and green dye. The hydro-mulch was commercially available in 50-lb bales wrapped in plastic. During calibration of the hydro-seeder we estimated that 25 lb in 200 gal of water was too low a concentration because the slurry was too runny and that 50 lb in 200 gal was too high a concentration because it plugged the hoses. The mixture that seemed to work the best was 50 lb of hydro-mulch in 300 gal of water. Different application techniques were tested on a trial and error basis and as a result, the treatments listed in Table 1 were not replicated.

Low pressure and low volume were needed to successfully apply the hydro-mulch. When the output pressure or volume was too high the mulch would not stay in a narrow band over the row, but instead would tend to splash out of the row when it hit the ground. The largest nozzle that came with the hydro-seeder created a 5-inch band of mulch when held 12 inches above the ground. Removing the nozzle and simply applying the mulch through the standard 0.5-inch garden hose fitting created a 3-inch band of mulch when held 12 inches above the ground. In our opinion the 3-inch band of hydro-mulch made with the garden hose fitting was the best application technique compared to any of the nozzles that we tried (Fig. 1).

The hydro-mulch met the two criteria described above because it did not blow away throughout the spring and it did not show any signs of being injurious to the carrots (Fig. 2). However, there were a few problems that could preclude hydro-mulch as a workable practice. First, the volume of water that we used to apply the hydro-mulch was equivalent to 1,250 gal/acre. We had problems trying to reduce the amount of water because the hoses tended to clog. However, this could have simply been a shortcoming of the hydro-seeder we tested. Another difficult aspect of the hydro-mulch was getting it to dissolve in water. Mixing the hydro-mulch in water was time consuming because the mulch bale had to be broken up by hand and fed into the top of the hydro-seeder tank (Fig. 3). The hydro-seeder we used did not agitate with a paddle, but instead used recirculation from the pump. A paddle-type agitator in the hydro-seeder may have sped up the mixing process.

Another treatment was included where the hydro-mulch was applied dry by hand (Table 1). As mentioned above, the hydro-mulch came in a compressed bale wrapped in plastic. The compressed material could be peeled apart by hand, but the consistency was fluffy. We presumed that the dry hydro-mulch would simply blow away once it was spread on the ground; surprisingly it did not.

Four other dry mulches were evaluated: 1) spent mint hay, 2) commercially available wood chips sold for livestock bedding and landscaping, 3) manure that was aged and sifted, and 4) manure that was aged, sifted, and mixed with chopped straw (Table 2). These mulch products were first applied to two rows by hand at an excessively high rate on January 14. On January 21, about 80 percent of the mulch was removed from one of the rows to obtain a more realistic evaluation. Therefore carrot evaluations were made for each row, at a high and a low rate. All of the mulch treatments were extremely stable in wind and did not blow away throughout the spring. This was surprising for the wood chip mulch because it did not retain water like the mint hay and it was much lighter than the manure mulches. All of the manure products caused the carrots to rot. The soil was very warm under the manure compared to the other mulches. Even though the manure was aged, there was still too much biological activity for use at these rates on seedling carrots.

The variability in the carrot stand alone was not accounted for in the experimental design; therefore it was difficult to determine if there was any reduction in frost-heaving from the mulch treatments.

Table 1. Seedling carrot response to hydro-mulch applied January 9, 2008 near Metolius, Oregon.

		April 25, 2008		
		Carrot	Carrot stand	
Hydro-mulch treatments	Rate	injury	Row A	Row B
	lbs/acre	%	--------- plants/yd ---------	
Check	---	0	16	23
Wet in 3-inch band	7,425	0	5	21
Wet in 5-inch band	4,950	0	10	19
Wet in 3-inch band	3,712	0	15	38
Wet in 5-inch band	2,475	0	16	32
Dry in 2-inch band	unknown	0	13	---

Table 2. Seedling carrot response to mulches applied on January 14, 2008 near Metolius, Oregon. [1]

		April 25, 2008 [2]	
Treatments	Rate	Carrot injury	Carrot stand
	lbs/acre	%	plants/yd
Check for high mulch row	---	0	13
Check for low mulch row	---	0	5
Wood chips in 8-inch band	61,200	0	5
	12,200	0	6
Mint hay in 6-inch band	15,300	0	15
	3,060	0	12
Manure in 6-inch band	273,000	95	1
	54,600	80	5
Manure + straw in 6-inch band	216,000	60	4
	43,200	10	10

[1] Shading in table corresponds to the row in which the treatment was applied.
[2] Data shown are means across two replications.

Figure 1. Photograph of hydro-mulch application.

Figure 2. Photograph of seedling carrots under a hydro-mulch covering.

Figure 3. Photograph of hydro-mulch slurry mixing.