Evaluation of Ground Covers to Prevent Frost Heaving to Carrot

Richard Affeldt, Bruce Martens, Larry Carpenter, and Linda Samsel

Introduction

A trial was conducted last year to evaluate the potential of several mulch products to prevent seed-to-seed carrot from frost heaving (Affeldt et al. 2009). In that trial we learned about effective ways to apply different mulches and that manure caused problems with the carrots rotting. However, the variability in the carrot stand was not accounted for in the experimental design and therefore it was difficult to determine if there was any reduction in frost heaving from the mulch treatments. In an effort to better evaluate mulch products to prevent frost heaving, a redesigned trial was conducted t at two locations.

Hybrid carrot seed production is the single most valuable crop in central Oregon, having a gross value in 2009 of $14.7 million. Carrot seed acreage has consistently been 2,000-3,000 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 from January through March when the soil is moist and frequently freezes and thaws in response to daily temperature fluctuation. 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 severe cases, frost heaving can result in complete stand failure.

To avoid 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 of 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 Agri-Bond® paper. This does a very good job of protecting carrots but has some drawbacks. First, the paper is expensive with labor intensive installation and removal. Second, the paper is susceptible to being blown off the carrots by high winds. Third, the paper allows pests such as aphids and weeds to proliferate over the winter months. Fourth, the timing for paper removal in the spring can be risky because a hard frost after the paper is removed can be fatal to the carrots.

Hydro-seeders may have the potential to overcome some of the limitations of methods for protecting carrots from frost heaving. Hydro-seeders make a sprayable slurry from water, a shredded biomass product (usually wood product waste or newspaper), and seed, which is then typically used to sow seeds on highly erodible land. Hydro-seeders consist 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 spraying the mulch over the top of seedling carrots and comparing that to other biomass mulches.

Other biomass products like wood chips are available in large quantities and might serve as a replacement for spent mint hay. However, despite the availability of wood chips there is still not an efficient and uniform way to apply this material. Overall, there are at least two criteria that mulch must meet to be an acceptable replacement for mint hay, 1) it must not injure the carrots, and 2) it must not be susceptible to wind displacement. Other criteria not discussed here are cost and availability.

Methods and Materials

Two trials were conducted in separate fields of commercial hybrid carrot grown for seed, one near Madras and one near Culver, Oregon. The treatments in each trial consisted of four types of mulch (Tables 1 and 2), Agri-Bond paper as a standard, and an untreated check. Each treatment was replicated four times in randomized complete blocks. The plots for each treatment were placed in 2 rows of female (male-sterile) carrots; each row was 20 ft long. Each mulch treatment was applied in a 4-inch-wide band over the row. The trial near Madras was in a field that had previously grown wheat, and straw residue was burned prior to seedbed preparation. The trial near Culver was in a field that had previously grown Kentucky bluegrass for seed, and straw residue was baled prior to seedbed preparation.

The wood mulch product used was shredded western Juniper that was locally available from a landscape supplier (Best of the West Organic Products, Inc., Redmond, OR). Wood particle size varied, but the average-size particles were 2 inches long and 0.5 inch wide. The hydro mulch was a finely shredded wood product with particles less than 0.125 inch and commercially available in 50-lb bales. The hydro mulch was applied two different ways. In one treatment it was mixed with water and then sprayed on with commercial equipment. In a separate treatment hydro mulch was applied by hand as a loose dry material in a similar manner to the mint hay and wood mulch treatments.

The carrots were seeded in August 2008 and the treatments were applied October 29. Prior to treatment application the numbers of carrots in each row were counted. In April the numbers of surviving carrots in the same rows were counted again in order to determine winter mortality.

Results and Discussion

It was not possible for us to differentiate carrot mortality caused by frost heaving from other factors such as poor vigor or freezing. In April, only live carrots that had not heaved were counted. Some carrots that had heaved still had green leaves, but their fitness and survival was doubtful. A carrot was considered to have heaved if at least 0.25 inch of the root was exposed above the soil surface.

Differences in crop residue for the seedbeds between the Culver and Madras locations probably influenced the winter survival of carrots in the two trials. At Madras, the soil surface after planting was smooth and became hard and somewhat impermeable to sprinkler irrigation; these

conditions were favorable for frost heaving. As a result, 50 percent of the carrots in the untreated check died over the winter (Table 1). At Culver, the soil surface was cloddy and had clumps of Kentucky bluegrass sod still intact; these conditions were not favorable for frost heaving. As a result, less than 4 percent of the carrots in the untreated check died over the winter (Table 2). Furthermore, there were no treatment differences at Culver. The negative numbers for stand difference in Table 2 may have resulted from late germinating seed or counting errors; regardless the values were not statistically significant.

At Madras, all of the ground covers resulted in significantly lower carrot mortality over the winter than the check. None of the mulch treatments differed from each other in the amount of carrots that survived the winter. The mulches tended to be less effective than the Agri-Bond paper, but only the wet hydro-mulch treatment was significantly worse.

It is not clear why the wet hydro mulch did not perform as well as other treatments. It may have to do with the amount of water necessary as a carrier for the hydro mulch. Without adequate dilution the hydro mulch slurry will clog the equipment hoses. For the equipment used in this study 12.5 lb of hydro mulch in 100 gal of water was an appropriate dilution to avoid clogging. Given the amount of water necessary to apply this treatment, it does not seem feasible for commercial-scale use. When the hydro mulch was applied without water it was much more difficult than the other mulches to apply uniformly. Because of this difficulty the dry hydro mulch also does not seem feasible for commercial-scale use.

For fields with a high risk of frost heaving and winter injury the Agri-Bond paper is probably the best protection for seedling carrots. Wood mulch was comparable to mint hay and may be a more feasible management option than Agri-Bond paper for fields with low to moderate risk for frost heaving. However, the problem of applying the wood mulch still remains. One suggestion from a grower-cooperator as a possible solution to the problem of efficient and uniform mulch application is to use a pelletized biomass material, such as seed screenings or cereal straw. Two of the potential advantages of pelletized material over the materials tested in this project are 1) a uniform rate could be applied with a drop spreader and 2) the raw material would be available from on-farm sources.

References

Affeldt, R., B. Holliday, D. Oppenlander, and B. Martens. 2009. Protection of seedling carrot from frost heaving. Central Oregon Agricultural Research Center 2008 Annual Report. Special Report 1093:5-9. http://extension.oregonstate.edu/catalog/html/sr/sr1093-e/sr1093_02.pdf

Acknowledgements

We would like to thank Madras Farms and H&T Farms for accommodating these trials in their production fields.

Table 1. Winter survival of seedling carrots with mulch treatments applied in October near Madras, Oregon, 2008-2009.

Treatment	Application rate	Carrot stand count		Stand difference
		October	April	
	(in 4-inch band)	---------- (plants per 40 ft) ----------		
Check	N/A	143.5	72.3	71.3
Mint hay	8 yd^3/acre	157.0	145.0	12.0
Wood mulch	8 yd^3/acre	147.0	132.8	14.3
Hydro mulch (wet)	238 lb/acre[a]	155.0	122.5	32.5
Hydro mulch (dry)	4 yd^3/acre[b]	151.5	130.8	20.8
Agri-Bond paper	N/A	161.3	153.0	8.3
LSD (P = 0.05)		---	---	20.1
CV		---	---	50.4
P value		---	---	>0.01

[a]12.5 lb/100 gal at 1,900 gal/acre.
[b]Approximate application rate.

Table 2. Winter survival of seedling carrots with mulch treatments applied in October near Culver, Oregon, 2008-2009.

Treatment	Application rate	Carrot stand count		Stand difference
		October	April	
	(in 4-inch band)	---------- (plants per 40 ft) ----------		
Check	N/A	166.8	160.3	6.5
Mint hay	8 yd^3/acre	159.3	158.5	0.8
Wood mulch	8 yd^3/acre	174.8	176.0	-1.3
Hydro mulch (wet)	238 lb/acre[a]	147.5	150.3	-2.8
Hydro mulch (dry)	4 yd^3/acre[b]	159.8	160.0	-0.3
Agri-Bond paper	N/A	156.8	160.8	-4.0
LSD (P = 0.05)		---	---	NS
CV		---	---	0.0
P value		---	---	0.50

[a]12.5 lb/100 gal at 1,900 gal/acre.
[b]Approximate application rate.