



Effects of Seeding Depth and Mix Compatibility on the Establishment and Growth of Lacy Phacelia (*Phacelia tanacetifolia*)

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ABSTRACT

Pollinator habitat protection and enhancement has been a priority resource concern for the Natural Resources Conservation Service (NRCS) for several years. This study investigates the effects of seeding depth and seed mix compatibility on lacy phacelia (*Phacelia tanacetifolia* Benth.) establishment. Lacy phacelia is a pollinator-friendly annual cover crop species showing promise in trials in Montana. It was sown at 0.5- and 1.0-inch depths, both individually and in seed mixes with Austrian winter pea (*Pisum sativum* L. ssp. *sativum* var. *arvense*). The plots were evaluated for aboveground biomass production, stand count, and percent stand. The null hypotheses were that seeding depth and seed mix (monoculture versus mixed) have no effect on the establishment and growth of lacy phacelia. Results indicate seeding depth did not interact with seed mix for any evaluation criteria. There were no significant differences among seeding depths for biomass production, stand count, or percent stand for either species. There was significantly more aboveground Austrian winter pea biomass produced when planted in a mix versus monoculture. There was also significantly greater total percent stand (both species combined) and percent stand for each species when sown together versus in a monoculture. The results of this one-year study conclude that lacy phacelia should establish and grow well when planted at 0.5- or 1.0-inch seeding depths. Mixing lacy phacelia with Austrian winter pea at the tested rates will increase stand count and percent stand. Mixing lacy phacelia with Austrian

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winter pea should not negatively impact lacy phacelia establishment in pollinator habitat enhancement plantings under conditions comparable to testing.

INTRODUCTION

Montana and Wyoming producers have expressed an interest in well adapted plant species that provide habitat for native pollinators. Incorporation of pollinator-friendly plant species into plantings increases biodiversity which promotes healthier habitat and increases the chance of pollinator insect reproduction (Xerces, 2011). Lacy phacelia is an annual plant considered native to ten U.S. states including droughty areas of Arizona, California, and Nevada (USDA, 2020) and is popular as a cover crop in parts of Europe (Smither-Kopperl, 2018). Study evidence suggests it may be well suited as a conservation species for Montana and Wyoming (Hybner et al., 2018). It is also listed in the top 20 pollen producing flowers for honeybees and is capable of yielding large amounts of biomass with minimal water input (Hayden, 2014). There is evidence lacy phacelia attracts hoverflies, the larvae of which have been shown to reduce the incidence of leaf aphids, a serious pest of sugar beets which is an important economic crop in Montana and Wyoming (Kilian, 2016). Lacy phacelia has been shown to support other generalist insect predators, such as parasitoids and spiders, which can in turn help reduce insect pest populations (Smither-Kopperl, 2018).

In addition to well-adapted plants for pollinator habitat, producers have expressed a desire for cover crop species with additional conservation and economic benefits including weed suppression, soil carbon sequestration, nitrogen provisioning and sequestration, and increased mycorrhizal colonization. Specific agricultural benefits of lacy phacelia may include increased soil cover, resources for beneficial insects, and improved cash crop yields (Murrell et al., 2017). This study tested lacy phacelia in a simple cover crop mix and assessed agricultural production in terms of aboveground biomass production.

We selected the legume Austrian winter pea to test with lacy phacelia because it has demonstrated success in Montana and Wyoming. Peas are grown for a variety of reasons; however, Austrian winter pea is best suited as a green manure and can also be used in a mix as a forage crop. Pea seed and forage are used by many classes of livestock, ungulates, and waterfowl (Hybner, 2014). They have good potential for fixing soil nitrogen and have been found to produce 90 to 150 pounds of nitrogen per acre (Pavek, 2012). This species also provides pollinator insect habitat, and its growth habit compliments lacy phacelia, making it a good candidate for mixing with lacy phacelia.

The objective of this study was to determine the ability of lacy phacelia to establish and grow in pollinator-friendly, conservation, and agricultural plantings in order to provide pollen resources, prevent soil erosion, and produce aboveground biomass. Our null hypotheses were that seeding depth and seed mix would have no effect on aboveground biomass production, stand count, or percent stand establishment.

MATERIALS AND METHODS

The study was conducted at the USDA-NRCS Bridger Plant Materials Center in Bridger, Montana (45°17'12.7", 108°53'9.7"). The study was seeded in a Haverson silty clay loam soil (Parker et al., 1975) in a clean tilled (no soil cover) and leveled field to ensure good seed-to-soil contact with minimal weed competition. The experiment was maintained under dryland

conditions. Long-term average annual precipitation in the area is 10 to 11 inches.

The study was a factorial arrangement of two seeding depth treatments and two seed mix treatments. The seeding depth treatments compared 0.5- versus 1-inch seeding depths. The seed mix treatments consisted of single versus mixed species seedings of ‘Angelia’ lacy phacelia and Variety Not Stated (VNS) Austrian winter pea. The study included four replications each containing six treatments for a total of 24 test plots in a randomized complete block design. Each treatment was seeded on June 6, 2019 with a 4-row, precision cone planter (Kincaid Equipment Manufacturing®, Haven, KS) equipped with double disk furrow openers, depth bands, and double packer wheels and planted on 14-inch between-row spacing. Each plot was 20 feet long and 4.7 feet wide, with a 5-foot space between each replication. For each individual treatment plot, seeding depth was set by adjusting the depth bands on the plot drill. Solid stands of lacy phacelia were seeded at 25 seeds per foot whereas Austrian winter pea was seeded at 20 seeds per foot. The mixed seeding rate was 15 seeds of lacy phacelia and 10 seeds of Austrian winter pea per foot for a total of 25 seeds per foot.

Each treatment was evaluated for aboveground biomass production, stand count (number of emerged seedlings per unit area), and percent stand (ocular estimate of percent of seeded row with an emerged seedling). Stand count and percent stand were evaluated weekly during the first month after planting using three 20- by 12-inch frames per plot randomly located in the center two rows of each plot. Aboveground biomass samples were collected on August 8, 2019, by cutting the aboveground plant material from 24 inches of row from three random locations in the middle two rows of each plot. In mixed species treatments, biomass samples were separated by species. Prior to weighing, all samples were dried in a forage drier at 50°C for 48 hours.

Lacy phacelia and Austrian winter pea aboveground biomass production, stand count, and percent stand data were analyzed separately using a two-factor analysis of variance (ANOVA). The factors were mix (one species or two species) and seeding depth (0.5 and 1.0 inch). The interaction was tested. Tukey’s HSD ($\alpha=0.05$) mean separations were used when main effects were significant ($P<0.05$).

RESULTS AND DISCUSSION

Using a two factor ANOVA, the interaction for aboveground biomass production, stand count, and percent stand were not significant for lacy phacelia or Austrian winter pea (Tables 1 and 2). These results indicate that Austrian winter pea and lacy phacelia, planted alone or in combination within the first inch of soil, will establish a relatively consistent stand and biomass production.

Table 1. Mean (N=4) Aboveground biomass, stand count, and percent stand of lacy phacelia as effected by seed mix and seeding depth, USDA-NRCS Bridger, MT.

Seed Mix	Seeding Depth	Aboveground Biomass	Stand Count	Percent Stand
		P=0.9680	P=0.6628	P=0.9043
	--inch--	--lb/acre--	--plants/ft ² --	--%--
Phacelia	0.5	2696	11.3	75
Phacelia	1.0	2708	11.8	80
Phacelia + Pea	0.5	2976	11.9	90
Phacelia + Pea	1.0	2531	12.4	95

Table 2. Mean (N=4) Aboveground biomass, stand count, and percent stand of Austrian winter pea as effected by seed mix and seeding depth, USDA-NRCS Bridger, MT.

Seed Mix	Seeding Depth	Aboveground Biomass	Stand Count	Percent Stand
		P=0.0515	P=0.4308	P=0.4191
	--inch--	--lb/acre--	--plants/ft ² --	--%--
Pea	0.5	2029	10.0	75
Pea	1.0	2190	11.5	86
Pea + Phacelia	0.5	2976	11.9	90
Pea + Phacelia	1.0	2531	12.4	95

Lacy phacelia biomass, stand count, and percent stand were not affected by seeding depth. The results for the main effects seeding depth analysis for lacy phacelia indicate no statistical difference in aboveground biomass, stand count, or percent stand between the 0.5-inch and 1.0-inch treatments (Table 3). There was also no significant difference in aboveground biomass, when evaluated for the effects of seed mix (Table 4). Stand count (P=0.0158) and percent stand (P=0.0016) were significantly greater when lacy phacelia was planted with Austrian winter pea than when planted alone. The number of plants per square foot doubled when lacy phacelia was mixed with Austrian pea even though the number of seeds planted per linear foot remained constant (Table 4).

Table 3. Mean (N=4) aboveground biomass, stand count, and percent stand of lacy phacelia as effected by seeding depth, USDA-NRCS Bridger, MT.

Seeding Depth	Aboveground Biomass ¹	Stand Count ¹	Percent Stand ¹
	P=0.0689	P=0.4072	P=0.1721
--inch--	--lb/acre--	--plants/ft ² --	--%--
0.5	2836	16.7	82
1.0	2618	18.0	87

¹Values include lacy phacelia alone and lacy phacelia with Austrian winter pea mix.

Table 4. Mean (N=4) aboveground biomass, stand count, and percent stand of lacy phacelia as effected by seed mix, USDA-NRCS Bridger, MT.

Seed Mix	Aboveground Biomass	Stand Count	Percent Stand
	P=0.5553	P=0.0158	P=0.0016
	--lb/acre--	--plants/ft ² --	--%--
Phacelia	2700 A	11.5 B	77 B
Phacelia + Pea	2753 A ¹	23.2 A ¹	92 A ¹

¹Values include lacy phacelia plus Austrian winter pea.

Austrian winter pea was also not affected by seeding depth as indicated by no significant difference in aboveground biomass production, stand count, or percent stand between the 0.5-inch and 1.0-inch treatments (Table 5). Aboveground biomass (P=0.0010), stand count (P=0.0114) and percent stand (P=0.0080) were significantly greater when Austrian winter pea was planted with lacy phacelia than when planted alone (Table 6). Aboveground biomass increased approximately 25%, the number of plants per square foot doubled, and percent stand increased by 15% when Austrian winter pea was mixed with lacy phacelia even though the number of seeds planted per linear foot remained constant.

Table 5. Mean (N=4) aboveground biomass, stand count, and percent stand of Austrian winter pea as effected by seeding depth treatment, USDA-NRCS Bridger, MT.

Seeding Depth	Aboveground Biomass P=0.3840	Stand Count P=0.2363	Percent Stand P=0.0571
--inch--	--lb/acre--	--plants/m ² --	--%--
0.5	1922	133	83
1.0	1763	140	90

Table 6. Mean (N=4) aboveground biomass, stand count, and percent stand of Austrian winter pea as effected by seed mix treatment, USDA-NRCS Bridger, MT.

Seed Mix	Aboveground Biomass P=0.0010	Stand Count P=0.0114	Percent Stand P=0.0080
	--lb/acre--	--plants/ft ² --	--%--
Pea	2109 B	10.7 B	81 B
Pea + Phacelia	2753 A	23.2 A	92 A

CONCLUSION

The results indicate that for both lacy phacelia and Austrian winter pea, we can accept the null hypothesis that seeding depth does not affect aboveground biomass, stand count, or percent stand when seeded under tested conditions. This is especially noteworthy for lacy phacelia since the literature suggests seeding is optimum at 0.25-inches deep or less. This suggests lacy phacelia planting may be more compatible with larger-seeded species than previously thought. To determine the threshold of planting depth for lacy phacelia, either alone or in a mix, we recommend additional testing with expanded parameters for seeding depth to 3.0 inches in order to determine if seeding depth is compatible with recommended depths for large-seeded cover crop species.

Findings from the analysis for seed mix indicate we should accept the null hypotheses for lacy phacelia aboveground biomass. Lacy phacelia biomass was not affected when planted alone compared to in a seed mix. However, we reject the null hypothesis for the other parameters. The stand count and percent stand for both species and aboveground biomass for Austrian winter pea were greater when planted in a seed mix than as an individual species. It should be noted that when biomass production for each component of the mix is summed, total biomass production for the mixed treatments outproduced the monoculture treatments.

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