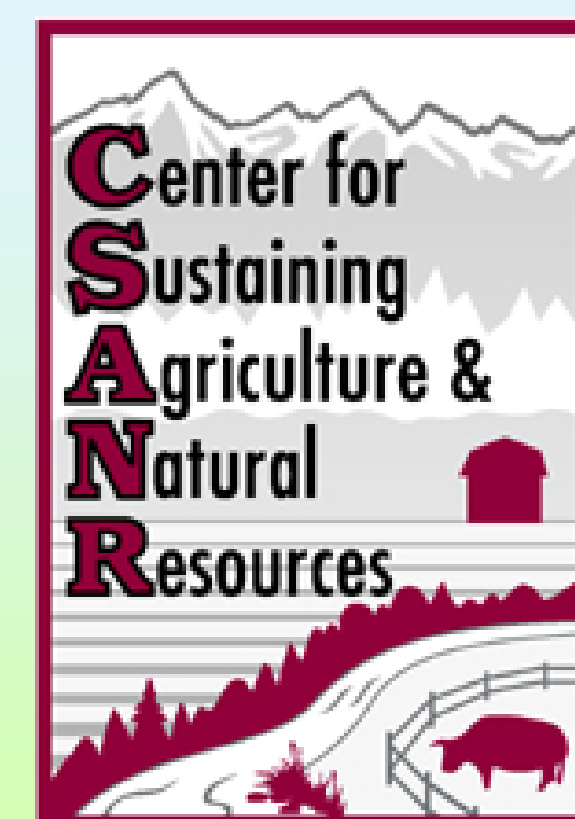


# Direct-seeding Legumes into Orchard Alleys for Nitrogen Production



D. Granatstein<sup>1</sup>, E. Kirby<sup>1</sup>, J. Davenport<sup>2</sup>, W. Morgan<sup>3</sup>, A. Kukes<sup>3</sup>

<sup>1</sup> WSU Center for Sustaining Agriculture and Natural Resources, Wenatchee, WA  
<sup>2</sup> WSU IAREC, Prosser, WA    <sup>3</sup> Warren Morgan Orchards, Quincy, WA



## Introduction

Nitrogen is a critical nutrient needed in most Pacific Northwest orchards, and can be challenging to provide to organic orchards. Planting legumes instead of grass in orchard alleys offers the opportunity to grow a portion of the orchard nitrogen need from N fixation, a renewable source. However, the orchard alley presents unique hurdles to legume production, especially shade and machinery traffic. Little screening, much less breeding, of legume species or cultivars has been done for their adaptability as an orchard understory crop. Orchard irrigation systems must be sufficient to supply the needed water to the legume. The legume can be mowed in place or mowed and blown on to the tree row for maximum effect with a special mower. Tilling the drive alley to plant a legume can lead to dust and mite problems, as well as stimulate weeds. A direct seeding strategy overcomes this problem, but it is not clear how much the existing vegetation needs to be suppressed in order for the legumes to establish. The field trial described here attempts to answer some of these questions.

## Methods

The trial was established in April 2008 in a mature block of 'Gala'/M.26 apple on a multi-wire trellis with a 3-dimensional canopy. Just over 4-ft width was present between the limbs on each side of the alley. Each plot consisted of a full-length tree row (900') straddled on each side by the same vegetation treatment. Prior to planting, a 4-ft strip down the center of the alley was treated with herbicide (17 April) to kill or suppress the existing vegetation, except for about 100' at the north end of each alley which was unsprayed to represent the situation most organic growers would face. Legumes were then planted on 19 May with a 4-ft wide Truax Flex-II no-till drill with double-disk openers and press wheels (Fig. 1-4). Seed was planted 1/4-1/2" deep. The block was irrigated frequently as needed to maintain a moist soil surface until the seeds emerged (27 May).

Legume treatments were alfalfa (*Medicago sativa* 'Radiant'), Jumbo Ladino white clover (*Trifolium repens*), birdsfoot trefoil (*Lotus corniculatus* 'Norcen'), and Kura clover (*Trifolium ambiguum* 'Prairie'). A fifth treatment was the established grass as a control. All legumes were inoculated with the appropriate *Rhizobium* species prior to planting. Each treatment was replicated 4 times. Germination and stand establishment were monitored during Year 1 (2008), with a single 'mow and blow' cutting on 27 August, when cover crop biomass was measured and samples taken for total N in the tissue. In 2009, cover crops were mowed 4 times (29 May, 3 July, 20 August, 1 October). Ladino clover tended to be flowering by mowing but not the other species. Soil samples from the tree row (0-12" depth) were taken bi-weekly for nitrate and ammonium. Plant Root Simulator probes were recovered at the same interval to monitor root available N adsorbed onto their anion-exchange membranes. In 2010, the same procedures were followed, with 5 mow and blow dates (6 May, 17 June, 23 Jul, 25 August, 24 September).



Figure 1. Truax Flex-II no-till drill.



Figure 2. Drill mounted on 3-pt hitch.



Figure 3. Double-disk openers, press wheels.



Figure 4. Coulters on front of drill.



Figure 5. Ladino clover on 26 June, 2008.

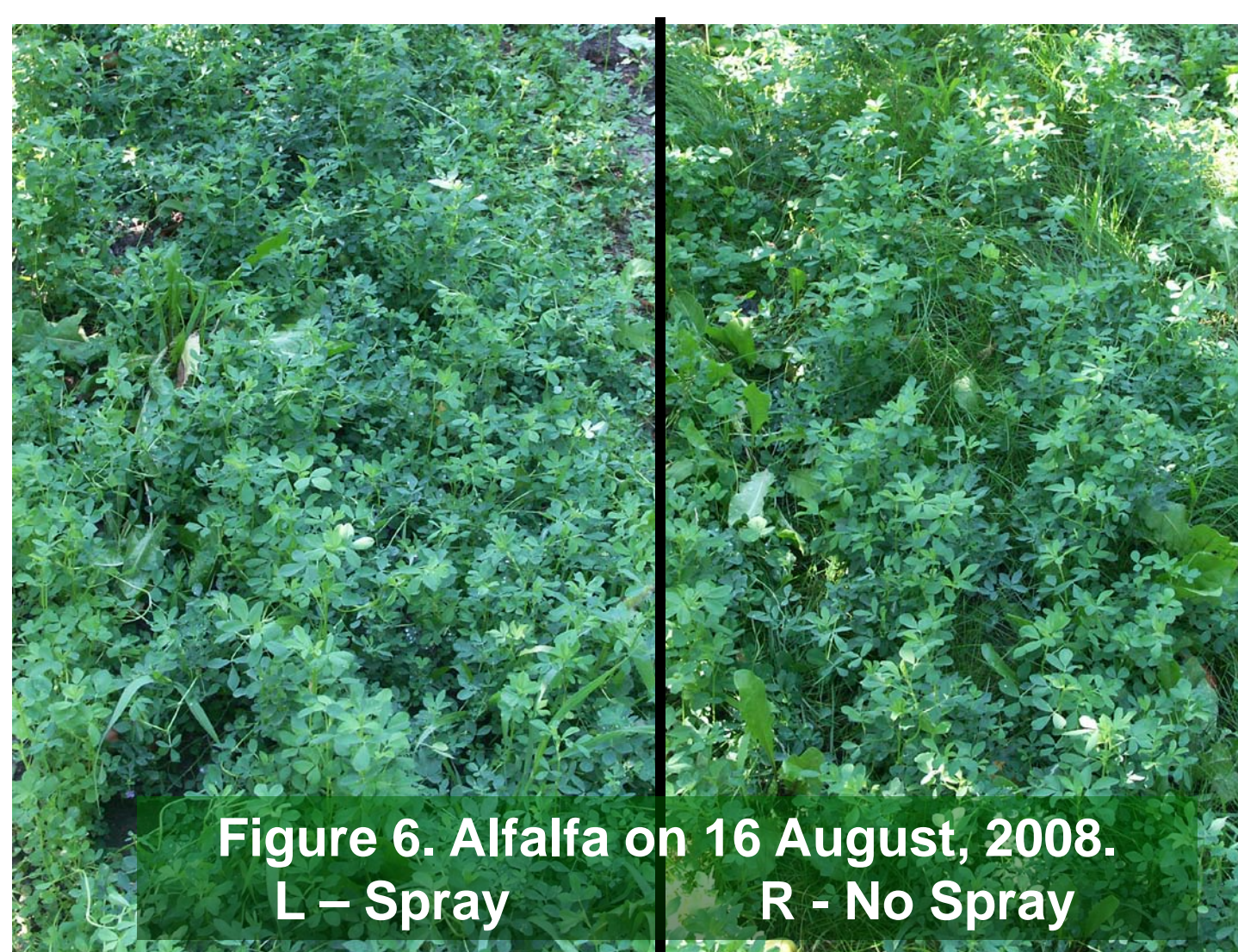


Figure 6. Alfalfa on 16 August, 2008. L - Spray, R - No Spray

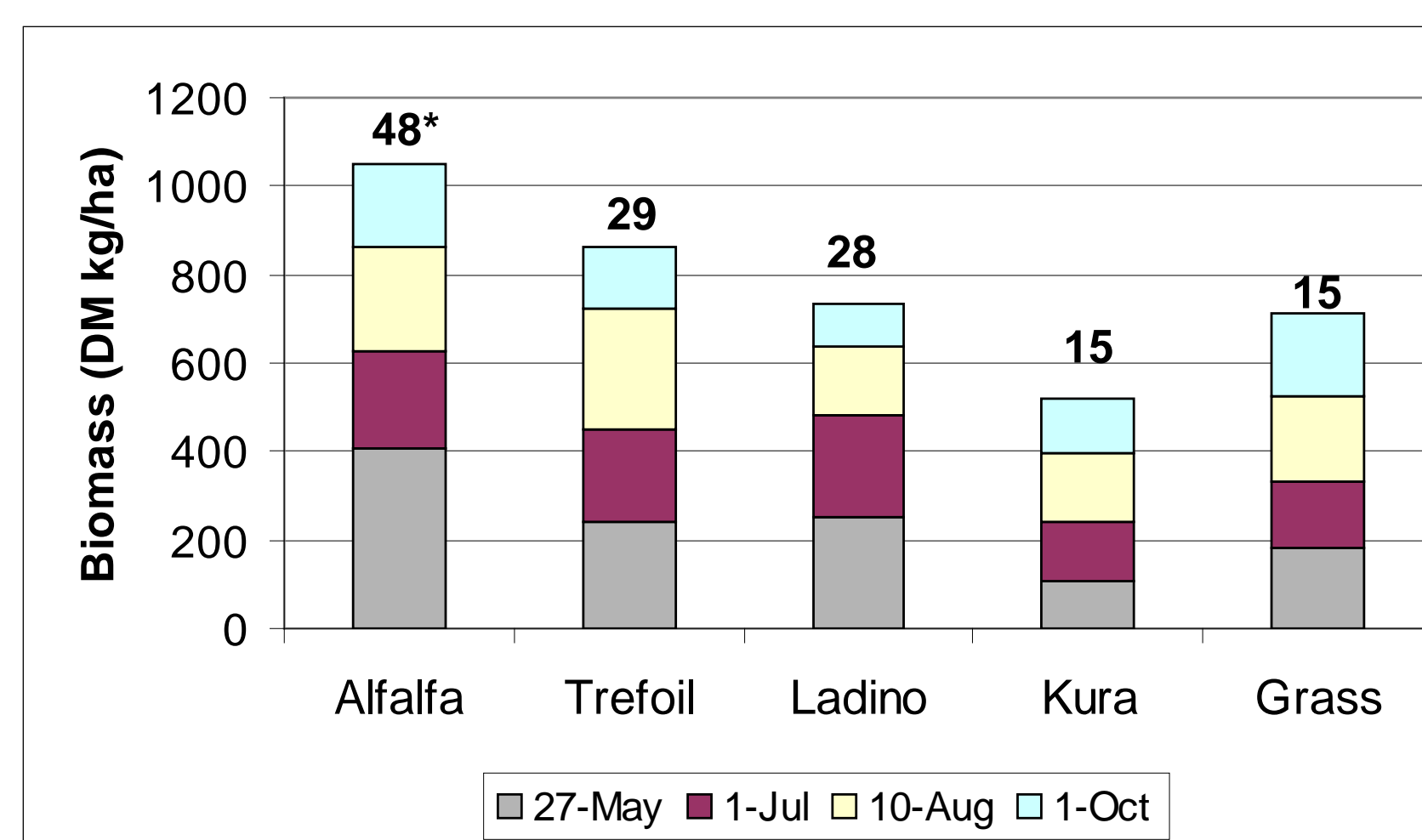


Figure 7. Cover crop biomass in 2009 by mowing date, and total season N content (\* numbers on top)

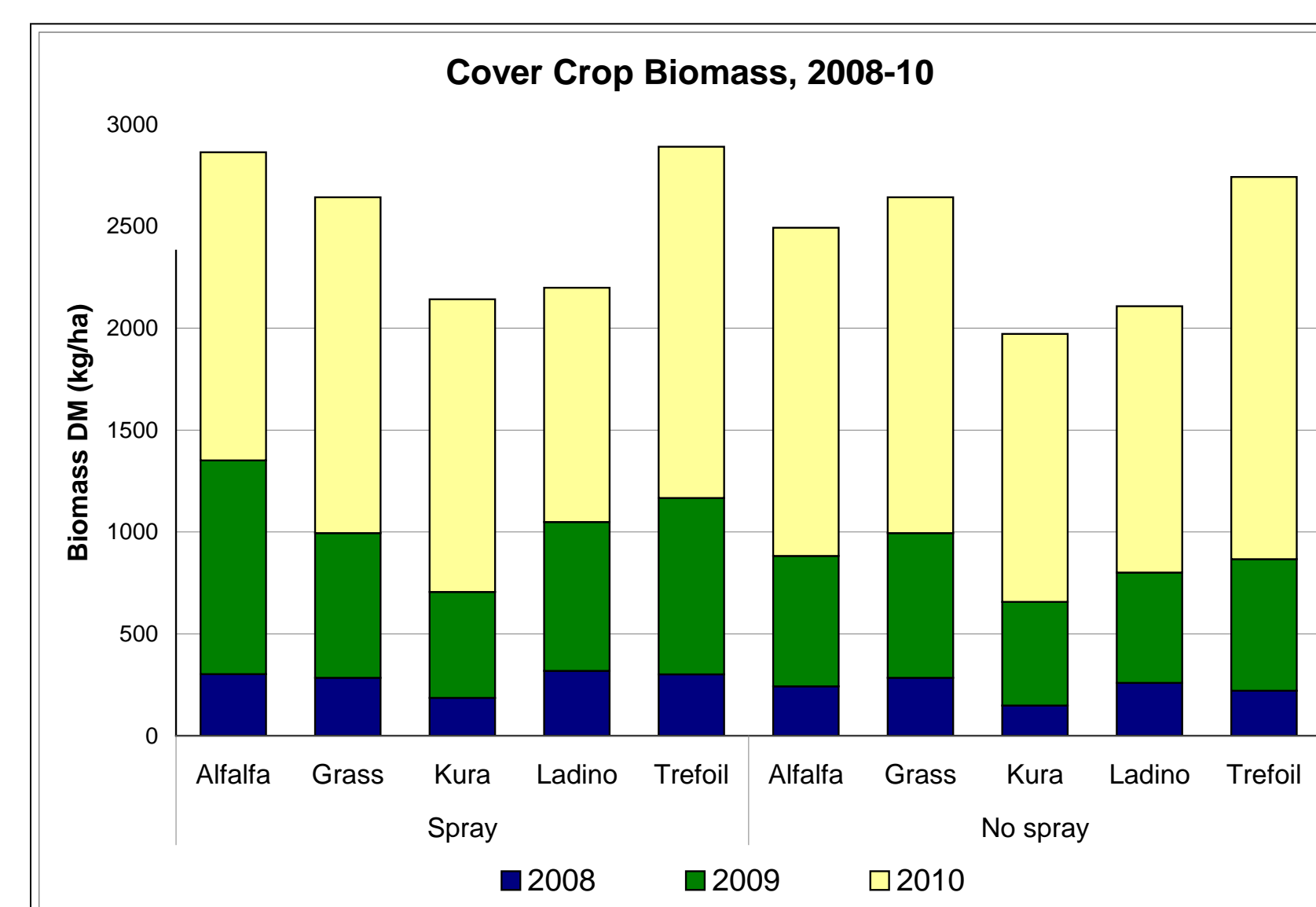


Figure 8. Cover crop biomass for Years 1-3, and effect of pre-plant herbicide spray.



Figure 9. Alfalfa in 2010, 40 days after mow.

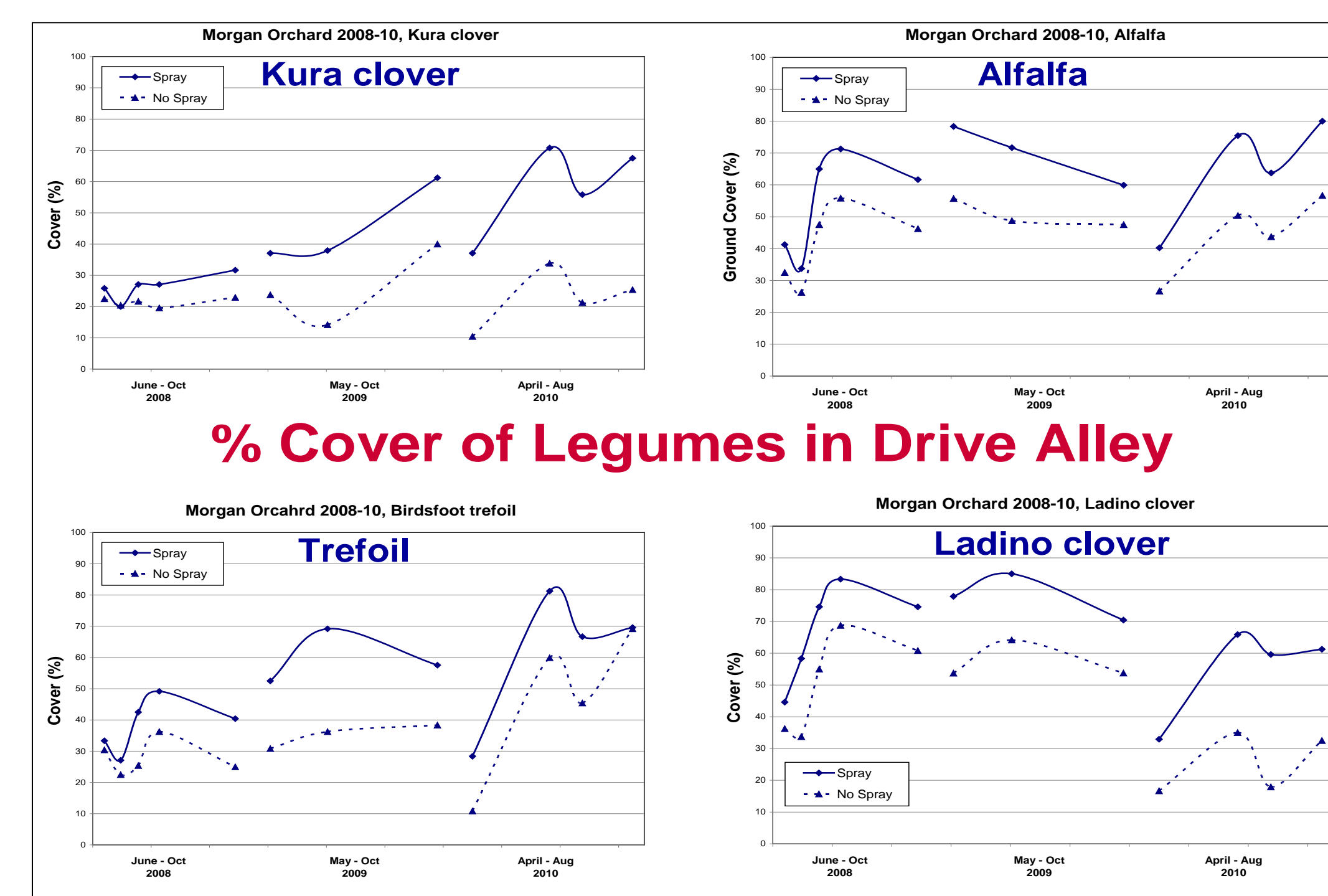


Figure 10. Change in cover crop legume percent cover over three years, with and without pre-plant herbicide spray.



Alfalfa on 16 June 16, 2010



Alfalfa on 23 June, 2010



White clover on 23 June, 2010

Alfalfa and white clover direct seeded on May 20, 2010, into existing sod (no herbicide treatment) in a grafted apple block. 7-ft planting swath (double pass).

## Results

All the legumes had excellent emergence in 2008 (Fig. 5, 6). Ladino clover closed its canopy by mid-summer, while alfalfa grew 20-24" tall with little branching. Kura clover is known to be slow at establishment, and steadily improved its stand over the three years. The tissue N concentration in the legumes exceeded that of the grass control (Table 1).

In 2009 (Yr 2), all species performed well. While there was no significant difference in cover crop biomass between pre-emergent herbicide and not, the sprayed samples had a higher concentration of the legume in the biomass, boosting their total N content (Table 2).

	% N	C:N
Alfalfa	4.06	10.6
Ladino	3.77	11.2
Trefoil	3.36	13.0
Kura	2.83	14.9
Grass	2.15	18.8
Non-legume	2.32	17.7

Table 1. Tissue N concentration and C:N of cover crops.

	Sum of 8/08, 7/09, 8/09		Legume only, 7/09	
	Spray	No Spray	Spray	No Spray
----- Dry matter (kg/ha) -----				
Alfalfa	759 a	685 a	157 a	105 b
Ladino	701 a	719 a	191 a	131 b
Trefoil	783 a	716 a	141 a	74 b
Kura	476 a	486 a	56 a	18 a

Table 2. Effect of pre-plant herbicide on cover crop biomass.

Cover crop biomass for each mowing date in 2009 is shown in Fig. 7. Total N content of the mowed biomass ranged from 15 kg N/ha (13.4 lb/ac) in the grass and kura clover to 48 kg N/ha (42.8 lb/ac) in the alfalfa. Given the low C:N of the biomass, about half this N is likely to be mineralized in the growing season. Total biomass increased each season and was similar for Spray and No Spray (Fig. 8, 9), with alfalfa and trefoil as the best producers. The Ladino clover stand diminished in 2010 (Yr 3), while the kura became more vigorous and productive (Fig. 10). Plant Root Simulator soil probes did show enrichment in soil N in proportion to the total N delivered in the cover crop mowings.

## Conclusions

- Direct seeding legumes into existing vegetation was successful
- Can grow nearly half the available N needed for apples (3' effective swath)
- Wider seeding swath will provide proportionally more N
- Need more assessment of N release and volatile losses
- Narrower drill row spacing will enhance establishment and competitiveness
- Shade, traffic are affecting cover crop growth
- Spraying out grass before planting helped, but all legumes had reasonable stands; compensate with double pass, higher seeding rate
- Need multiple years to assess species performance, need testing of more novel species
- Combinations of species should be explored; alfalfa + Ladino clover to exploit different spaces; alfalfa + kura to extend stand longevity

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More information at our website:

<http://organic.tfrec.wsu.edu/OrganicIFP/OrchardFloorManagement/Index.html>