# TECHNICAL NOTE

USDA Natural Resources Conservation Service

Spokane, Washington

Plant Materials Technical Note No. 24 August 2014

# EVALUATION OF COVER CROPS AND PLANTING DATES FOR IRRIGATED ROTATIONS IN CENTRAL WASHINGTON

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**Spring-planted cover crop plots at the WSU Othello Experiment Station, May 2014.**

This technical note presents findings from the Cover Crop Biomass Study conducted near Othello, WA, which compared the above-ground biomass of 41 cover crop species, varieties and mixes with two fall and two spring planting dates. The Technical Note contains recommendations for optimal species and planting dates for cover crops in irrigated central Washington rotations.

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**KEY POINTS**

- Cover crops planted for late fall incorporation in the Columbia Basin should be planted no later than August 15 for optimal biomass production. Cover crops planted after this date produce significantly less biomass and may not provide any agronomic benefits.
- Cover crops planted for soil erosion protection during the winter months should be planted around September 15. Winter-tolerant cover crops planted before this date do not over-winter well and produce less biomass.
- Cover crops planted in the spring should be planted as soon as the soil can be worked in order to maximize biomass production prior to planting a late spring crop. Cover crops planted on March 14 in this study produced about 3 times more biomass than cover crops planted on April 3.
- Mixes generally produced more biomass than individual species in this study, which is likely a result of more efficient light capture in the canopy due to various plant architecture types.
- The August-planted cover crops with the most biomass were the mixes, oriental mustard, yellow mustard, oat and sorghum-sudangrass.
- Sixteen of the 41 fall-planted cover crops over-wintered, and the ones with the most biomass were winter triticale, winter wheat and hairy vetch.
- The March-planted cover crops with the most biomass were the mixes, spring barley, oil seed radish and spring wheat.

## INTRODUCTION

Cover crops in the Columbia Basin are planted for a variety of reasons, including prevention of wind erosion, sequestration of nutrients, suppression of soil-borne pathogens, and improvement of soil organic matter. Extensive research has been conducted on the use of mustards as a fall-planted cover crop in the Columbia Basin, which is a practice producers sometimes use to suppress soil-borne pathogens such as *Verticillium dahliae* and parasitic nematodes, and/or to sequester unused nitrogen remaining in the soil following the previous crop. Cover crops other than mustards may be able to provide more diverse cover cropping options and benefits. Information is lacking in regards to other cover crops; specifically how cover crops perform as individual species compared to mixes, and how different planting dates affect cover crop biomass production. The objectives of this trial were to:

1) Determine the best performing cover crops based on above-ground biomass production.
2) Compare cover crop biomass production at different planting dates.
3) Compare the biomass production of individual cover crop species with mixes.

We chose above-ground biomass production as the primary measurement in this study because it is an indicator of how well the cover crop is adapted to particular growing conditions. Plants that establish well and are adapted to the environment accumulate more biomass (carbon) as they perform photosynthesis. Adding more carbon to the agroecosystem may be a way to improve "soil health" because the carbon provides food for microorganisms and improves soil structure and water-holding capacity. Cover crops that produce large amounts of biomass are also more likely to out-compete weeds, and may provide more economic return to justify seed and operational costs.

However, above-ground biomass production may not be the best or only criterion for selecting a cover crop. Cover crops that produce large amounts of biomass may also use substantial amounts of water, which may result in a moisture deficit. (This may not be a serious concern in irrigated fields, however it is a concern in non-irrigated fields.) Also, plants that produce large amounts of biomass may not provide benefits such as the interruption of a disease cycle, attraction of beneficial insects, or suppression of soil-borne pathogens which may be provided by other cover crops.

In addition, above-ground biomass may not always be directly correlated with below-ground biomass, and root exudates of some cover crops may be better for supporting beneficial soil microbes than others. Unfortunately, research on these subjects is very difficult to conduct and there is little information for specific crops. Until more research can be conducted on these subjects, tangible factors such as above-ground biomass production and measurable agronomic benefits are our best criteria for selecting cover crops.

## MATERIALS AND METHODS

This study was conducted at the WSU Othello Experimental Research Station near Othello, WA. The area receives an average of 9 inches of annual precipitation and has an average of 6890 growing degree days (GDD) (base temperature 32°F). During the time of this study (August 1, 2013 to May 31, 2014) the Othello Experiment Station received approximately 4.45 inches precipitation. The number of GDDs and average maximum and minimum temperatures for the periods of cover crop growth are listed in Table 1. There were two extremely cold episodes during the winter months, one in December and one in February, with low temperatures at or below 0°F, high temperatures not exceeding 20°F, gusty winds, and no snow cover.

Table 1. Number of calendar days, growing degree days (GDD), and average maximum and minimum temperatures during the periods of growth for the fall- and spring-planted cover crops.

| Fall | Calendar Days | GDD (base 32°F) | Ave Max Temp (°F) | Ave Min Temp (°F) |
|---|---|---|---|---|
| 8/8/13 - 10/22/13 | 69 | 2279 | 71.8 | 43.1 |
| 9/12/13 - 10/22/13 | 40 | 920 | 66.6 | 42.3 |
| Overwintering | | | | |
| 8/8/13 - 5/19/14 | 278 | 4224 | 52.1 | 33.1 |
| 9/12/13 - 5/19/14 | 249 | 2865 | 47.6 | 30.8 |
| Spring | | | | |
| 3/14/14 - 5/20/14 | 67 | 1314 | 64.3 | 38.3 |
| 4/3/14 - 5/20/14 | 47 | 1048 | 67.1 | 40.6 |

Cover crop species were selected for this study based on their potential to provide an agronomic benefit, availability and low cost. Cultivars were selected based on what the seed companies had on hand or, in the case of the mustards, good performance in other studies. The NRCS Irrigated Mix and the NRCS Dryland Mix were developed by Washington NRCS technical staff for previous cover crop guidelines. The Diana's Cool and Warm 9 Species Mix was developed by Diana Roberts, WSU Extension Specialist in Spokane County in cooperation with a landowner. Roberts has evaluated this mix in other trials. Other mixes were developed to compare various numbers of species, and cool season, warm season, or cool and warm season mixes.

The following table (Table 2) lists the cover crops planted, the timing of planting (fall/spring), seeds per pound and pure live seed (PLS) seeding rates. Most individual species plots were seeded at rates of 10 to 60 PLS per sq ft, depending on seed size, and mixes were seeded at rates of 20 to 30 total PLS per sq ft, depending on species components.

Table 2. Cover crops, varieties and mixes planted in this study with indication of fall or spring planting and seeding rate.

| Variety | Common Name | Scientific Name | Fall | | Spring | | Season | Seeds/lb | PLS lb/ac |
|---|---|---|---|---|---|---|---|---|---|
| Nemat | arugula | *Eruca sativa* | 1 | x | 1 | x | cool | 280,000 | 5 |
| | spring barley | *Hordeum vulgare* | | | 2 | x | cool | 14,000 | 93 |
| Wintmalt | winter barley | *Hordeum vulgare* | 2 | x | 3 | x | cool | 14,000 | 93 |
| Koto | buckwheat | *Fagopyrum esculentum* | 3 | x | | | warm | 20,000 | 65 |
| Balady | berseem clover | *Trifolium alexandrinum* | 4 | x | | | cool | 206,880 | 6 |
| | spring chickpea | *Cicer arietinum* | | | 4 | x | cool | 2,300 | 189 |
| | crimson clover | *Trifolium incarnatum* | 5 | x | | | cool | 150,000 | 9 |
| | white Dutch clover | *Trifolium repens* | 6 | x | | | cool | 712,000 | 4 |
| | red clover | *Trifolium pratense* | 7 | x | | | cool | 272,000 | 5 |
| | sweet clover | *Melilotus officinalis* | 8 | x | 5 | x | cool | 260,000 | 5 |
| small seed | faba bean | *Vicia faba* | 9 | x | 6 | x | cool | 2,000 | 22 |
| | flax | *Linum perrene* | 10 | x | 7 | x | cool | 88,000 | 15 |
| | spring lentil | *Lens culinaris* | | | 8 | x | cool | 10,000 | 44 |
| Red Chief | winter lentil | *Lens culinaris* | 11 | x | 9 | x | cool | 10,000 | 44 |
| German | foxtail millet | *Setaria italica* | 12 | x | | | warm | 216,000 | 6 |
| White Huntsman | proso millet | *Panicum miliaceum* | 13 | x | | | warm | 84,800 | 15 |
| Caliente | oriental mustard | *B. juncea* + *S. alba* | 14 | x | 10 | x | cool | 180,000 | 7 |
| Martigena | yellow mustard | *Sinapis alba* | 15 | x | 11 | x | cool | 140,000 | 8 |
| Monida | oat | *Avena sativa* | 16 | x | 12 | x | cool | 19,400 | 67 |
| Fenn | Austrian winter pea | *Pisum sativum* | 17 | x | 13 | x | cool | 3,800 | 115 |
| Granger | Austrian winter pea | *Pisum sativum* | 18 | x | 14 | x | cool | 3,800 | 115 |
| Melrose | Austrian winter pea | *Pisum sativum* | 19 | x | 15 | x | cool | 3,800 | 115 |
| Specter | Austrian winter pea | *Pisum sativum* | 20 | x | 16 | x | cool | 3,800 | 115 |
| F210 | Austrian winter pea | *Pisum sativum* | 21 | x | 17 | x | cool | 3,800 | 115 |
| 1269 | Austrian winter pea | *Pisum sativum* | 22 | x | 18 | x | cool | 3,800 | 115 |
| VNS | Austrian winter pea | *Pisum sativum* | 23 | x | 19 | x | cool | 3,800 | 115 |
| Banner | spring pea | *Pisum sativum* | | | 20 | x | cool | 2,000 | 218 |
| daikon type | oil seed radish | *Raphanus sativus* | 24 | x | 21 | x | cool | 39,200 | 33 |
| Longtail Delight | safflower | *Carthamus tinctorius* | 25 | x | | | warm | 44,000 | 30 |
| | sorghum | *Sorghum bicolor* | 26 | x | | | warm | 27,300 | 48 |
| MS9000 | sorghum-sudangrass | *Sorghum bicolor* x *S. bicolor* | 27 | x | | | warm | 21,000 | 62 |
| | teff | *Eragrostis tef* | 28 | x | | | warm | 1,300,000 | 1 |
| Trical102 | winter triticale | x *Triticosecale* | 29 | x | 22 | x | cool | 12,000 | 109 |
| | spring triticale | x *Triticosecale* | | | 23 | x | cool | 12,000 | 109 |
| | forage turnip | *Brassica rapa* ssp. *rapa* | 30 | x | 24 | x | cool | 220,000 | 6 |
| | spring wheat | *Triticum aestivum* | | | 25 | x | cool | 12,000 | 109 |
| Norwest553 | winter wheat | *Triticum aestivum* | 31 | x | 26 | x | cool | 12,000 | 109 |
| | common vetch | *Vicia sativa* | 32 | x | 27 | x | cool | 40,000 | 33 |
| | hairy vetch | *Vicia villosa* | 33 | x | 28 | x | cool | 16,300 | 80 |
| | Mix 1 NRCS Dryland Mix | | 34 | x | 29 | x | cool | see Mix Calculations | |
| | Mix 2 NRCS Irrigated Mix | | 35 | x | 30 | x | cool | see Mix Calculations | |
| | Mix 3 Winter Hardy Mix | | 36 | x | 31 | x | cool | see Mix Calculations | |
| | Mix 4 Warm Season Mix | | 37 | x | | | warm | see Mix Calculations | |
| | Mix 5 Cool Season 2 Species | | 38 | x | 32 | x | cool | see Mix Calculations | |
| | Mix 6 Cool Season 3 Species | | 39 | x | 33 | x | cool | see Mix Calculations | |
| | Mix 7 Cool and Warm Season 6 Species | | 40 | x | 34 | x | c & w | see Mix Calculations | |
| | Mix 8 Diana's Cool and Warm 9 Species | | 41 | x | 35 | x | c & w | see Mix Calculations | |

Mixes were composed of the following species, each represented equally on a percentage basis.

| Mix 1: NRCS Spring Dryland Mix | |
|---|---|
| **Variety** | **Common Name** |
| | spring barley |
| VNS | sweetclover |
| | spring rapeseed |
| Banner | spring pea |

| Mix 2: NRCS Spring Irrigated Mix | |
|---|---|
| **Variety** | **Common Name** |
| VNS | spring triticale |
| VNS | sweetclover |
| Martigena | yellow mustard |
| daikon type | oil seed radish |
| Koto | buckwheat |
| Banner | spring pea |

| Mix 3: Winter Hardy Mix | |
|---|---|
| **Variety** | **Common Name** |
| VNS | Austrian winter pea |
| Red Chief | winter lentil |
| Norwest553 | winter wheat |
| Trical102 | winter triticale |
| Winfred | winter rapeseed |

| Mix 4: Warm Season Mix | |
|---|---|
| **Variety** | **Common Name** |
| Koto | buckwheat |
| White Huntsman | proso millet |
| VNS | safflower |
| VNS | sunflower |
| MS9000 | sorghum-sudangrass |

| Mix 5: Cool Season 2 species Mix | |
|---|---|
| **Variety** | **Common Name** |
| Monida | oat |
| Banner | spring pea |

| Mix 6: Cool Season 3 species Mix | |
|---|---|
| **Variety** | **Common Name** |
| Monida | oat |
| Banner | spring pea |
| VNS | hairy vetch |

| Mix 7: Cool and Warm Season 6 species Mix | |
|---|---|
| **Variety** | **Common Name** |
| Monida | oat |
| Banner | spring pea |
| VNS | hairy vetch |
| Martigena | yellow mustard |
| White Huntsman | proso millet |
| Koto | buckwheat |

| Mix 8: Diana Robert's Cool and Warm 9 sp | |
|---|---|
| **Variety** | **Common Name** |
| Monida | oat |
| Banner | spring pea |
| VNS | crimson clover |
| VNS | hairy vetch |
| VNS | forage turnip |
| VNS | safflower |
| VNS | sunflower |
| Martigena | yellow mustard |
| MS9000 | sorghum-sudangrass |

The plots were planted in a field with Shano silt loam soil. Seedbeds were prepared by rotovating and disking. Fall-planted plots were planted on August 8 and September 12, 2013, and spring-planted plots were planted on March 14 and April 3, 2014. Plots were 7 ft wide by 20 ft long and were seeded at a depth of 0.75″ with a Hege dual cone double disk drill. Legume species were inoculated with the appropriate *Rhizobium* bacteria at the time of planting. The experimental design is a randomized complete block with three replications of each plot. Fall-planted plots were irrigated with 0.25 – 0.35″ water every 2 to 3 days from the time of planting until Oct 1, and with 0.40″ every 2 to 3 days Oct 2 – Oct 23. Irrigation resumed on March 25, 2014 and all plots were irrigated with 0.25″ water every 4 to 5 days until biomass sampling.

Biomass was sampled in the fall and spring by cutting all plant material in a 0.5 $m^2$ frame to a height of 2 inches with a gas- or battery-powered hedge trimmer. The biomass was weighed, weeds were removed and the biomass was weighed again. A grab sample was taken from the material, weighed, dried, and weighed again to calculate percent dry matter. Percent dry matter was multiplied by cover crop biomass to calculate dry matter (DM) lb/ac values. Other data collected include percent establishment 6 weeks after planting, percent cover of the over-wintering plots in early spring, and height at the time of biomass sampling.

## RESULTS AND DISCUSSION

### Fall Biomass Production

At the time of biomass sampling (October 22, 2013), there were dramatic differences in the August- and September-planted plots. The August-planted plots were approximately 5 to 50 inches tall, and the September-planted plots were 0.3 to 8 inches tall. The slow growth in the September-planted plots was surprising, considering Othello had warm, sunny days throughout the end of September and beginning of October, and the plots had sufficient moisture provided by irrigation. However, the August-planted plots had 2.5 times more growing degree days, with 2279 GDD, compared to the September-planted plots, which had 920 GDD (base temperature 32 °F) (Table 1).

In addition to fewer growing degree days, plant growth of the September-planted plots was also slowed by shorter day length and lower sun angle. These factors reduce the amount of solar radiation the plants receive, which decreases their photosynthetic activity.

**August-planted cover crops (right) and September-planted cover crops (left) on October 22, 2013.**

Our results are consistent with previous mustard planting date trials conducted by Andy McGuire, which demonstrate mustard biomass production declines significantly when planted after September 1 (Figure 1). McGuire recommends planting mustards during the second week of August for maximum biomass production prior to incorporation in late October.

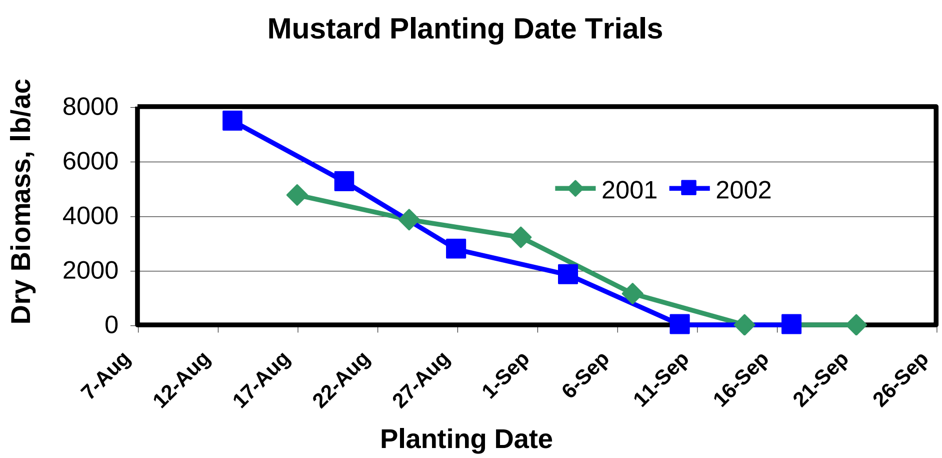


Figure 1. Dry matter biomass production of mustards planted at different dates mid-August through late September. Andy McGuire

We determined the September-planted plots were too short to sample, and only collected biomass from the August-planted plots. Biomass production among the August-planted plots ranged from 6279 DM lb/ac to 24 DM lb/ac. The top five cover crops that produced the most biomass were, in order: the NRCS Irrigated Mix, the Cool and Warm Season 6 Species Mix, 'Caliente' oriental mustard, 'Monida' oat, and 'Martigena' yellow mustard (Table 2 and Figure 2).

Table 2. Comparison of height and biomass production of the 17 top-performing cover crops planted on August 8 and September 12, 2013 near Othello. Plots were sampled on October 22, 2013.

| | | Planting Date | | | |
|---|---|---|---|---|---|
| | | 8/8/2013 | | 9/12/2013 | |
| Variety | Common Name | Height (in) | Biomass (DM lb/ac) | Height (in) | Biomass (DM lb/ac) |
| | Mix 2 NRCS Irrigated Mix | 41 | 6279 a[1/] | 5 | . |
| | Mix 7 Cool and Warm Season 6 Species Mix | 45 | 6259 a | 8 | . |
| Caliente | oriental mustard | 50 | 6008 a | 6 | . |
| Monida | oat | 37 | 5885 a | 7 | . |
| Martigena | yellow mustard | 46 | 5853 a | 5 | . |
| | Mix 3 Winter Hardy Mix | 31 | 4945 a | 3 | . |
| | Mix 8 Diana's Cool and Warm 9 Species Mix | 41 | 4864 a | 7 | . |
| MS9000 | sorghum-sudangrass | 37 | 4206 a | 1 | . |
| | Mix 4 Warm Season Mix | 37 | 4149 a | 2 | . |
| | Mix 1 NRCS Dryland Mix | 30 | 4034 a | 7 | . |
| | forage turnip | 22 | 3703 a | 3 | . |
| | Mix 5 Cool Season 2 Species Mix | 35 | 3628 a | 7 | . |
| | Mix 6 Cool Season 3 Species Mix | 37 | 3603 a | 8 | . |
| Nemat | arugula | 20 | 3555 a | 3 | . |
| | teff | 20 | 3445 a | 1 | . |
| | safflower | 26 | 3430 a | 2 | . |
| daikon type | oil seed radish | 22 | 3149 a | 5 | . |

1/ Means within the same column followed by the same letter are not significantly different in Tukey HSD means comparisons at $\alpha = 0.05$.

The NRCS Irrigated Mix and the Cool and Warm 6 Species Mix produced more biomass than the component species grown individually, even though the seeds per sq ft rate was lower in the mixes (~30 seeds/sq ft for the individual species, and ~26 seeds/sq ft for the mixes). Two species were predominant in each of the mixes; they were yellow mustard and oil seed radish in the NRCS Irrigated Mix, and yellow mustard and millet in the Cool and Warm 6 Species Mix. The yellow mustard ('Martigena') and oriental mustard ('Caliente') have performed well in Andy McGuire's other evaluations.

The cover crops with the least amount of biomass were legume species. They likely performed poorly in the August planting because they did not tolerate the heat. Also, the clovers may have been seeded too deep and the peas may have been seeded too shallow. Most of the legumes are poor competitors with weeds. In addition, some of the clovers are perennial species and are slow to establish. Weed biomass in all of the plots was usually inversely proportional to cover crop biomass.

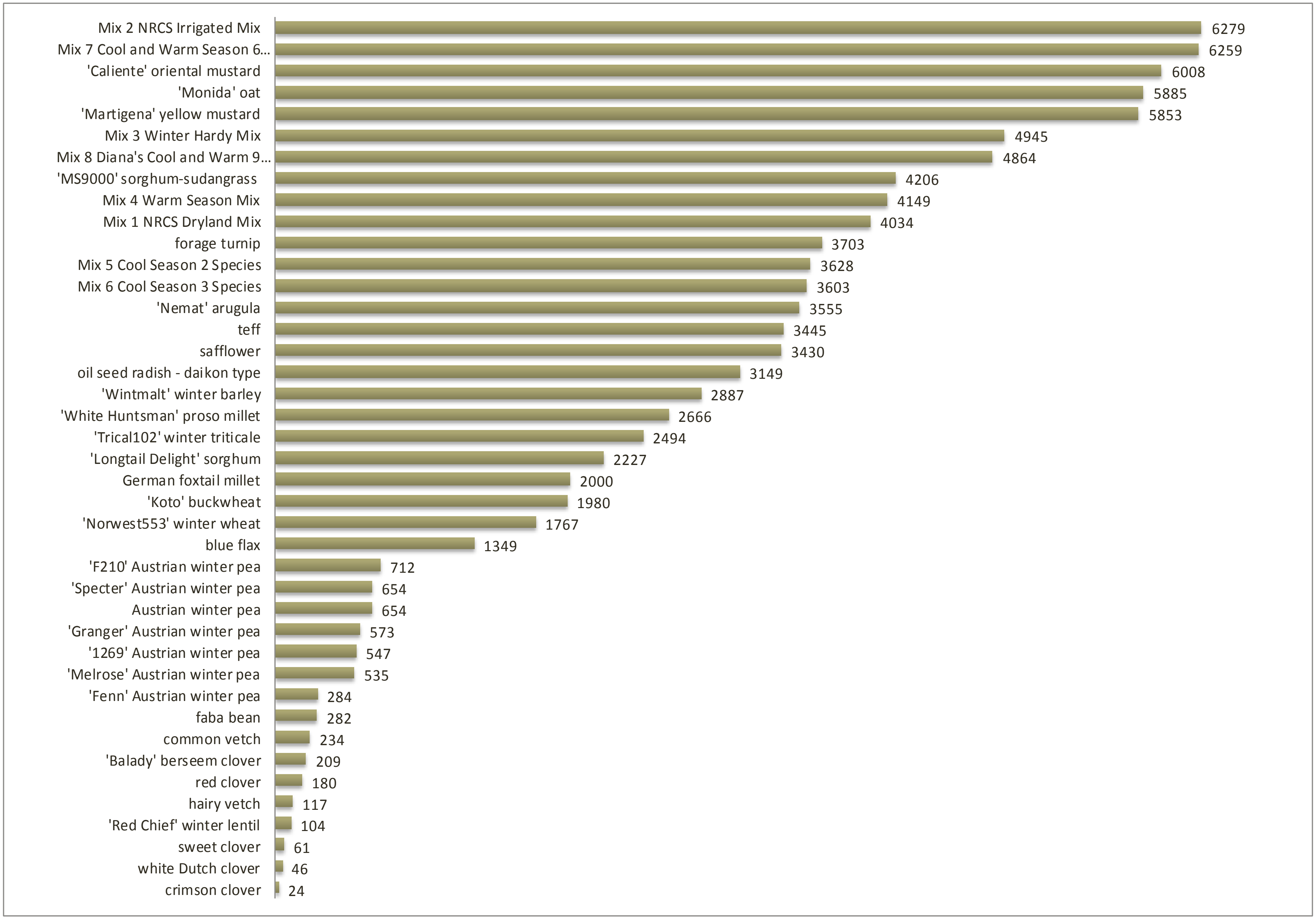


Figure 2. Average fall biomass produced by cover crops planted August 8, 2013 and grown with irrigation near Othello, WA (DM lb/ac). Biomass was sampled on October 22, 2013.

Despite the differences in biomass production, there was no statistical difference among the top 17 cover crops with the most biomass using the Tukey's HSD All-Pairwise Comparison test ($\alpha$ =0.05) (Table 2) due to the large variation in values among the replicated plots, and having the minimal number of replications. Transforming the data or using a different test may result in statistical differences.

Cover Crop Over-Wintering

Rotations in the Columbia Basin typically require incorporation of a fall-planted cover crop prior to the winter months in order to be prepared for early-season planting the following spring. However, sometimes an over-wintering cover crop may be desired, for example, to provide protection of the soil from wind erosion. This practice may only be practical when preceding a late-planted spring crop such as dry beans, sweet corn, and silage corn, which allows more time for cover crop growth.

Sixteen of the 41 fall-planted cover crops survived the winter (Table 3). The clover species (white Dutch clover, red clover, and sweet clover) had higher percent cover the following spring when they had an earlier planting date and more time to establish in the fall, however spring percent cover was still low (less than 35%). Some cover crops fared better over winter when they were planted later, during cooler temperatures. These included several Austrian winter pea varieties, winter barley, winter triticale, winter wheat, and five of the mixes. Among the mix components, however, the only species that survived the winter were the winter triticale, winter wheat, and hairy vetch. The September-planted winter triticale and winter wheat individual species plots had the highest percent spring cover among all plots, and the triticale was the tallest.

The poor performance of the Austrian winter peas, winter barley, and other typically winter-tolerant species was likely due to the two exceptionally cold periods during the winter months. The cold temperatures combined with wind, dry soil and no snow cover caused loss of winter peas and winter wheat throughout the region. Farther east, in the Palouse, temperatures were even lower but snow cover and moist soils protected the crops.

Table 3. Average percent cover and height of the over-wintering cover crops on April 7, 2014.

| | | Planting Date | | | |
|---|---|---|---|---|---|
| | | 8-Aug-13 | | 12-Sep-13 | |
| **Variety** | **Common Name** | **Ave % Cover** | **Ave Ht (in)** | **Ave % Cover** | **Ave Ht (in)** |
| Wintmalt | winter barley | | | 32 | 3.7 |
| | white Dutch clover | 13 | 1.2 | 6 | 0.1 |
| | red clover | 25 | 2.2 | | |
| | sweet clover | 32 | 1.8 | 13 | 0.5 |
| Fenn | Austrian winter pea | | | 6 | 0.4 |
| Melrose | Austrian winter pea | | | 6 | 0.5 |
| Specter | Austrian winter pea | | | 6 | 0.3 |
| VNS | Austrian winter pea | | | 19 | 1.3 |
| Trical 102 | winter triticale | 70 | 14.4 | 95 | 13.3 |
| Norwest 553 | winter wheat | 19 | 8.7 | 95 | 9.3 |
| | hairy vetch | 19 | 2.9 | 76 | 2.2 |
| | Mix 2 NRCS Irrigated Mix | 19 | 8.7 | 70 | 8.1 |
| | Mix 3 Winter Hardy Mix | 19 | 8.4 | 76 | 6.7 |
| | Mix 6 Cool Season 3 Species | | | 32 | 3.1 |
| | Mix 7 Cool and Warm Season 6 Species | | | 13 | 1.0 |
| | Mix 8 Diana's Cool and Warm 9 Species | | | 13 | 1.2 |

## Over-Wintering Biomass Production

We sampled the winter triticale, winter wheat, hairy vetch, NRCS Irrigated Mix, and Winter Hardy Mix from the August- and September-planted plots, and the sweet clover from the August-planted plots for biomass. The remainder of the over-wintering plots had negligible biomass. The September-planted winter triticale and winter wheat produced 2 and 4.5 times the amount of biomass as the August-planted plots, respectively, whereas hairy vetch biomass production was about the same from the two planting dates (Table 4 and Figure 3).

Table 4. Comparison of height and biomass production of over-wintering cover crops planted on August 14 and September 12, 2013 near Othello at the time of sampling on May 19, 2014.

| | | Planting Date | | | |
|---|---|---|---|---|---|
| | | 8/8/2013 | | 9/12/2013 | |
| Variety | Common Name | Height (in) | Biomass (DM lb/ac) | Height (in) | Biomass (DM lb/ac) |
| Trical102 | winter triticale | 37 | 5040 a[1/] | 49 | 10714 a |
| VNS | hairy vetch | 29 | 3521 ab | 32 | 3275 b |
| VNS | sweet clover | 35 | 2837 ab | | |
| Norwest553 | winter wheat | 16 | 1692 b | 25 | 7617 ab |
| | Mix 2 NRCS Irrigated Mix | 31 | 1398 b | 46 | 7099 ab |
| | Mix 3 Winter Hardy Mix | 28 | 867 b | 43 | 7320 ab |

1/ Means within the same column followed by the same letter are not significantly different with Tukey HSD means comparisons at $\alpha = 0.05$.

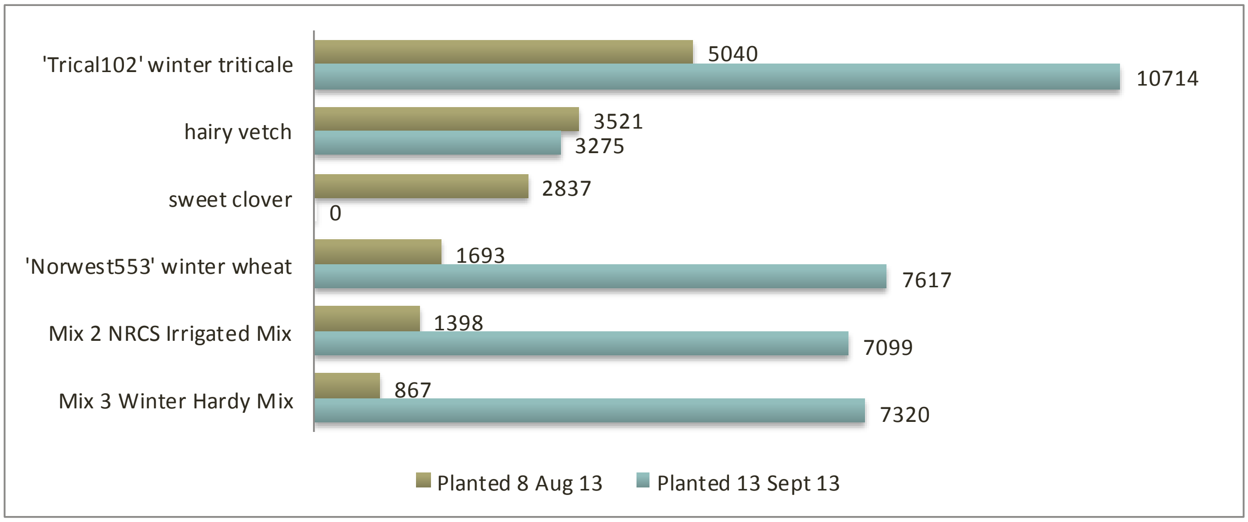


Figure 3. Comparison of biomass production of over-wintering cover crops planted on August 14 and September 12, 2013 near Othello at the time of sampling on May 19, 2014.

## Spring Biomass Production

Cover crops planted on March 14 were generally taller and produced more biomass than the cover crops planted on April 3 at the time of sampling on May 20. This is logical, considering the March-planted cover crops had more time to grow. A colder spring may have resulted in smaller differences. Results from 2014 show planting spring cover crops as soon as the ground can be worked may be beneficial if the goal is to produce maximum cover crop biomass prior to planting a late spring crop.

The March-planted cover crops that produced the most biomass were, in order: the Cool and Warm Season 6 Species Mix, spring barley, the Cool Season 3 Species Mix, the NRCS Irrigated Mix, oil seed radish, and spring wheat (Table 5 and Figure 4). The Cool and Warm 6 Species Mix plots were primarily comprised of yellow mustard, oat and spring pea. Plots with the Cool Season 3 Species Mix were primarily comprised of oat, and the NRCS Irrigated Mix plots were primarily comprised of spring triticale, yellow mustard and oil seed radish.

All of the March-planted cover crops were tall enough to harvest, but only about half of the April-planted cover crops were tall enough to harvest. The other plots were less than 6” tall at the time of sampling.

Table 5. Comparison of height and biomass production of the 16 top-performing spring cover crops planted on March 14 and April 3, 2014 near Othello at the time of sampling on May 20, 2014.

| | | Planting Date | | | |
|---|---|---|---|---|---|
| | | 3/14/14 | | 4/3/14 | |
| Variety | Common Name | Height (in) | Biomass (DM lb/ac) | Height (in) | Biomass (DM lb/ac) |
| | Mix 7 Cool and Warm Season 6 Species Mix | 20 | 3530 a[1/] | 12 | 1049 ab |
| | spring barley | 21 | 3190 ab | 14 | 1506 a |
| | Mix 6 Cool Season 3 Species Mix | 25 | 2865 abc | 14 | 1179 ab |
| | Mix 2 NRCS Irrigated Mix | 24 | 2850 abc | 8 | 929 bc |
| daikon type | oil seed radish | 22 | 2728 abcd | 10 | 868 bc |
| | spring wheat | 16 | 2725 abcd | 10 | 1197 ab |
| | Mix 8 Diana's Cool and Warm 9 Species Mix | 21 | 2356 abcd | 7 | 925 bc |
| | Mix 5 Cool Season 2 Species Mix | 12 | 2347 abcd | 8 | 1080 ab |
| | Mix 1 NRCS Dryland Mix | 16 | 2040 abcd | 13 | 986 bc |
| Martigena | yellow mustard | 19 | 1967 abcd | 6 | 1333 ab |
| Monida | oat | 12 | 1851 abcd | 8 | 913 bc |
| Banner | spring pea | 19 | 1767 bcd | 8 | 510 cd |
| Nemat | arugula | 18 | 1675 bcd | 6 | 479 cd |
| Wintmalt | winter barley | 10 | 1337 cd | 10 | 583 cd |
| Norwest553 | winter wheat | 14 | 1071 d | 9 | 212 de |
| 1269 | Austrian winter pea | 12 | 1057 d | 5 | . |

1/ Means within the same column followed by the same letter are not significantly different with Tukey HSD means comparisons at $\alpha = 0.05$.

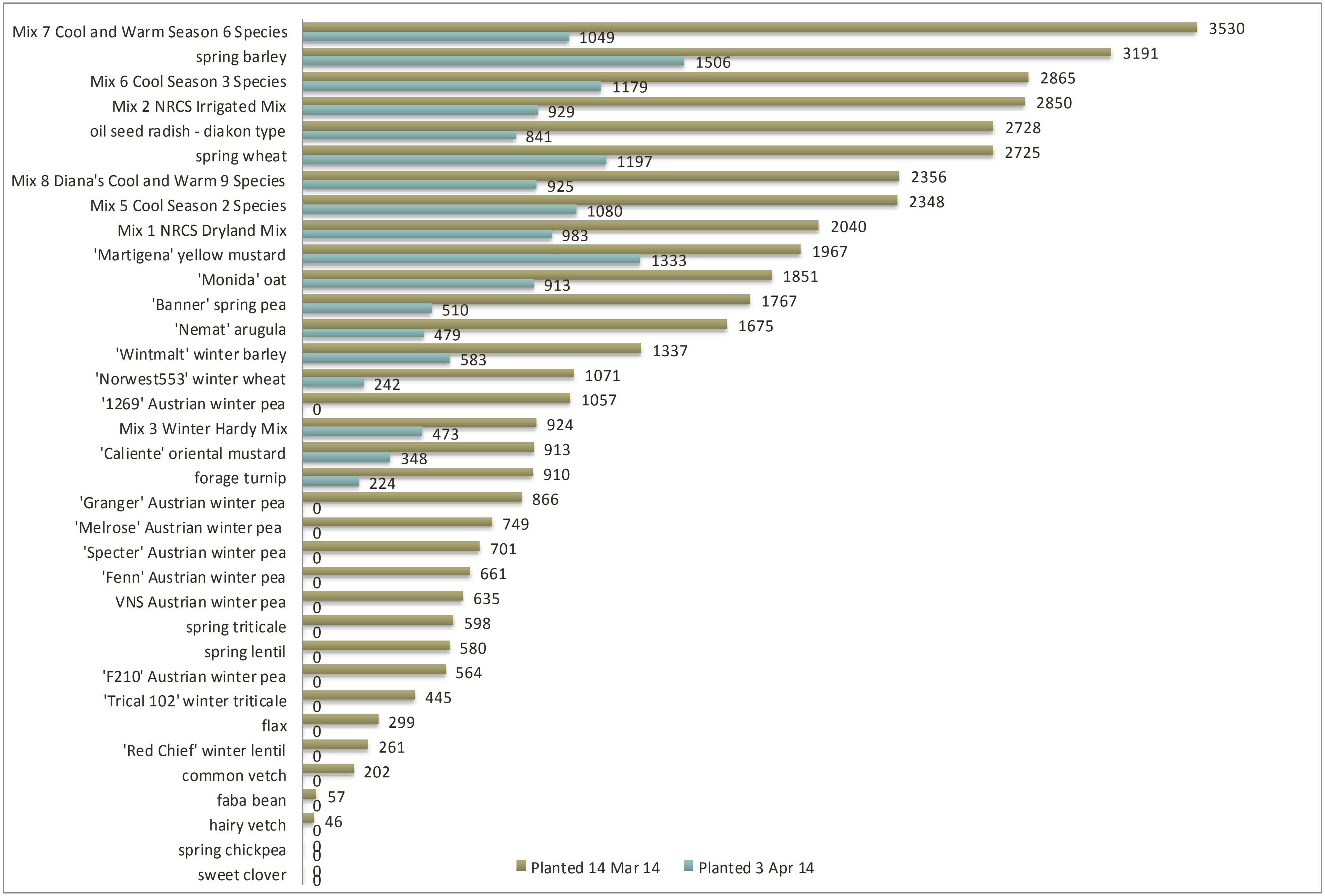


Figure 4. Comparison of dry matter biomass produced by cover crops planted on March 14, 2014 and April 3 near Othello at the time of sampling on May 20, 2014.

## CONCLUSIONS

This study demonstrates the necessity for planting cover crops in early August in the Columbia Basin if the goal is to maximize biomass production prior to late fall incorporation. Cover crops planted on August 8 produced substantially more biomass than cover crops planted on September 12. Conversely, winter-hardy varieties of cover crops produced more biomass and had higher percent cover in the spring when they were planted in September. Winter-hardy cover crops should therefore be planted later in the fall if the goal is to have an over-wintering cover crop. Spring cover crops should be planted as soon as the soil can be worked to maximize biomass production prior to the late spring planting of a commodity crop. Cover crops in this study planted on March 14 produced about 3 times more biomass than cover crops planted on April 3.

The August-planted cover crops with the most biomass were the mixes, oriental mustard, yellow mustard, oat and sorghum-sudangrass. The overwintering cover crops with the most biomass were winter triticale, winter wheat and hairy vetch, and the March-planted cover crops with the most biomass were the mixes, spring barley, oil seed radish and spring wheat.

Mixes in this study generally produced more biomass than the individual species, even though the seeding density of the mixes was often lower. Mix biomass was often comprised of one to three dominant species, and the others were absent or negligible. If the seeding density of only the dominant species was considered, the seeding density was even lower. It will be worth-while evaluating mixes containing the dominant species in this study: mustards, oil seed radish, oats, barley, and triticale (or millet if the cover crop is planted during the warm season) at low seeding rates in other studies or on-farm trials.

Biomass production is important, even when a cover crop is selected for a specific function. A mustard cover crop grown for its bio-fumigation properties or a legume cover crop grown for its nitrogen contribution is more likely to perform its intended function if it produces maximum amounts of biomass. Biomass production can be optimized by selecting the ideal cultivar and planting date.

## ACKNOWLEDGEMENTS

We would like to thank Clearwater Seed for providing most of the seed for this study. We also thank McKay Seed, High Performance Seed, Spectrum Crop Development, Dr. Rebecca McGee (USDA-ARS) and Erik Landry (WSU) for providing additional seed. We thank John Steinbock (WSU Othello Experiment Station Manager) for preparing, maintaining and irrigating our plots, Dallas Spellman (Pullman PMC Farmer) for helping us plant the plots, fix the broken drill, harvest biomass and collect data, and Liz Keith (Soil Conservationist, Ephrata FO) and Richard Fleenor (Plant Materials Specialist) for helping us harvest biomass and collect data.