AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
FUNDING CYCLE 2013 – 2015

TITLE: *Sinapis alba*: A Multipurpose Rotation Crop for the Willamette Valley

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SUMMARY:

Willamette Valley agriculturalists need rotation crops, especially on soils that have few alternatives. The well-publicized conflict over canola is one manifestation of this unmet need for crops that diversify cropping enterprises. *Sinapis alba*, known by the common names yellow or white mustard, is a potential oilseed feedstock crop that will not cross with *Brassica* spp. vegetable crops. Other cultivated mustards are members of the genus *Brassica* and may potentially cross with *Brassica* spp. vegetables or canola. Because of this distinction, *S. alba* is not regulated by current ODA administrative rules nor by recent (2013) Oregon legislation prohibiting canola production in the Willamette Valley.

Sinapis alba is a flexible potential rotation crop as it can be grown for multiple purposes depending on market conditions – condiment, oil, bio-pesticide, and a seed crop for propagation for cover crops. Seed from *S. alba* is the ingredient in the condiment yellow mustard and serves as a water-binding agent in the production of processed meats and meat products. Grown as a cover crop, *S. alba* has demonstrated that it can reduce weed populations in vegetable crop production, vineyards, and in other applications. As demand grows for pesticide replacement products such as *S. alba* that can act as a fumigant in suppression of weeds, there will be an increased need for seed to plant these cover crops. The Willamette Valley has long been a premier seed production region and the area's seed growers could produce the seed needed to supply the market for natural alternatives to chemical weed control agents.

OBJECTIVES:

1. Determine the biological effects of applied nitrogen (N) on seed yield and yield components of *Sinapis alba*.
2. Ascertain the impact of applied nitrogen on carbon partitioning in *Sinapis alba*.
3. Identify the optimum nitrogen management practices for production of *Sinapis alba* in the Willamette Valley. Develop recommendations for *Sinapis alba* seed production based on research results and disseminate this information to seed growers and industry practitioners.

PROCEDURES:

Objective 1. Seed Yield and Yield Components

The study consisted of two field trials at OSU's Hyslop Farm: Trial 1 was planted in March 2013 and Trial 2 was planted in March 2014. IdaGold, a yellow flowered cultivar of *Sinapis alba*, was sown to examine the effects of applied nitrogen on seed yield and yield components. The experimental design was a

randomized complete block with nitrogen application plots randomly arranged within four blocks. Nitrogen treatments were 0, 50, 100, 150, and 200 lbs/acre and these treatments were applied post-planting by using an Orbit-air applicator. Baseline soil samples were taken in each year prior to planting to characterize soil nutrient status. A blanket application of sulfur was applied to all plots in order to remove this nutrient and its potential impacts from crop responses.

Detailed measurements of seed yield components were made on plant samples taken from each plot prior to seed harvest. These seed yield components included: weight of harvested seed, number of seed produced per pod, the number of pods per plant, and the number of branches per plant. The plots were harvested by using a plot combine and seed yield was determined on the cleaned seed.

Objective 2. Carbon Partitioning

The goal in this objective was to learn how nitrogen applications affect the preferential partitioning of carbon in *Sinapis alba* plants. Several characteristics were measured to determine whether carbon was more likely to be moved to the seed or to vegetative organs of the plant such as leaves and stems with increased nitrogen levels applied to the system. These characteristics included plant nitrogen and carbon concentrations, oil and protein concentration in the seed, harvest index (ratio of seed yield to total plant weight), leaf area index (ratio of leaf area to ground area), and nitrogen use efficiency (ratio of seed yield to total nitrogen available).

Plant carbon and nitrogen concentrations were ascertained during vegetative or rosette (BBCH scale 30) and reproductive or full flowering (BBCH scale 65) developmental stages by use of a LECO CNS analyzer. Seed oil and protein concentration were determined by using NMR (nuclear magnetic resonance) spectroscopy on harvested seed. Leaf area index was ascertained by using a leaf area meter at the rosette and full flowering stages. Soil samples were taken to measure the total nitrogen available in the soil while total above-ground dry weight was obtained near harvest to calculate harvest index.

Objective 3. Dissemination of Research Results

One of the expected benefits of this study was the identification of optimum nitrogen management application rates for the production of *Sinapis alba* in the Willamette Valley, and the rapid dissemination of these results to the crop production and scientific communities. Research results and photos from the field trials were posted periodically on OSU's Seed Production Blog site (http://blogs.oregonstate.edu/seedproduction/) for public viewing. Results will also be published in refereed journals and in practitioner-oriented publications. Seed growers and other industry practitioners had an opportunity to view and comment on the results and recommendations produced by the study at OSU Field Days, and at various OSU Extension meetings.

SIGNIFICANT ACCOMPLISHMENTS:

Seed yield over the two years of the study ranged from a low of 963 lbs/acre with no nitrogen to a high of 2295 lbs/acre with 200 lbs N/acre (Table 1). Nitrogen increased seed yield by up to 76%. Seed oil content ranged from 26 to 28%, a little more than half of the oil content of canola but more than the 20% typical for soybeans. Oil yield ranged up to 604 lbs/acre. The time from planting in March to seed harvest in July was 162 days so this is a short-season crop. Rainfall during the crop season from planting to harvest was 23% below normal in 2013 and was 36% above normal in 2014.

Table 1. Nitrogen application rate effects on seed yield of *Sinapis alba* at Hyslop Farm, Corvallis.

Nitrogen rate	2013	2014	Mean
lbs/acre	---------- lbs/acre ----------		
0	1363 a†	963 a	1163
50	1555 b	1271 b	1413
100	1575 bc	1588 c	1582
150	1725 c	1741 d	1733
200	2295 d	1792 d	2043

† Means within years followed by the same letter are not different.

The seed yield improvement attributable to N application primarily resulted from increases in two seed yield components: seed number per unit area and seed weight. Nitrogen increased seed number by up to 62% over the control and seed weight was increased with N by up to 4%. Additionally, the number of branches and pods per plant were increased by N application.

Plant height was increased by an average 107% at the rosette stage and by up to 66% at flower emergence with N. Nitrogen increased leaf area index by 202% at the rosette stage and by up to 155% at flower emergence. Plant biomass more than doubled at the highest N rate.

The increase in plant height, leaf area, and biomass by N application improved the plants' ability to capture solar energy and carbon in the photosynthetic process. Consequently, the mustard plant was able to partition more carbon to seed (increased seed number and seed weight), thereby increasing seed yield. Carbon content in plant tissues ranged from 374 g/kg to 428 g/kg and was mostly unaffected by N rate. Tissue N content ranged from 18.8 g/kg to 64.7 g/kg and varied with nitrogen application rate with the highest concentrations observed with the highest N rates.

No black leg disease was observed in yellow mustard despite being grown in epidemic conditions.

Research findings were presented at OSU's Hyslop Farm Field Day in May 2013 and again in May 2014. Results were also submitted for publication in OSU's Seed Production Research Report and will be submitted for publication to the journal Field Crops Research in 2015.

BENEFITS & IMPACT:

Results to date suggest that gross income from the crop ranges from $600 to $800 per acre. These values compare favorably with current gross incomes for several Willamette Valley crops including annual ryegrass seed crops ($617/acre), wheat ($870/acre), radish seed ($577/acre), and meadowfoam ($651/acre). *Sinapis alba* is a low input crop, the primary costs of production are associated with seeding and establishment, nitrogen fertilizer, and harvest.

ADDITIONAL FUNDING RECEIVED:

No additional funding was received.

FUTURE FUNDING:

No requests for future funding are anticipated.