EFFECTS OF NITROGEN FERTILIZER ON SEED YIELD AND YIELD COMPONENTS IN YELLOW MUSTARD

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Introduction

Yellow mustard (*Sinapis alba* L.) is a new multipurpose rotation oilseed crop for Willamette Valley agriculturalists, especially non-irrigated operations. Yellow mustard can also be used to produce condiment mustard, as a green manure crop, and as a biopesticide. Although yellow mustard seed production is relatively new to the Willamette Valley, Oregon's north-central counties have been producing mustard seed for more than a decade.

The primary source of contention over large-scale *Brassica* oilseed production in the Willamette Valley is the risk of cross-pollination with high-value vegetable seed crops. However, yellow mustard is a distant relative of the *Brassica* species and is not a compatible cross with any specialty seed crops (Lelivelt et al., 1993; Hawkins et al., 1996; Vaughn, 1997; Brown et al., 2005; Quinn, 2010). Therefore, *S. alba* is not included in the current Oregon legislative regulation of canola (*B. napus*) production.

The objectives of this study were to (1) determine the relationship of nitrogen (N) fertilizer to seed yield and yield components of yellow mustard, and (2) examine how N fertilizer affects plant structure, lodging, and leaf area.

Methods

This field experiment utilized the 'IdaGold' yellow mustard cultivar. It was planted on March 11, 2013 at the Hyslop Crop Science Research Farm near Corvallis, OR, in a randomized complete block design with four replications. A single preplant herbicide (Teflon®) application was employed to control germinating weed seeds; no pesticide applications were made during the growing season. On April 4, an Orbit-air spreader was utilized to apply urea fertilizer at four treatment rates (50, 100, 150, and 200 lb N/acre). Control plots were not treated.

Plant growth, development, and lodging rates were tracked weekly throughout the growing season. Two adjacent one-square-foot quadrats were sampled from each plot on April 30, when the majority of the plants had reached the rosette stage, but prior to stem elongation. Ten plants were randomly selected from each sample for height and leaf area measurements. One-sided leaf area measurements were obtained with the LI-3100 leaf area meter. This procedure was repeated on May 20, when 90% of the plants had bolted and attained early inflorescence emergence.

Two weeks prior to harvest, two one-square-foot subsamples were collected from each plot. Above - ground biomass and seed yield components were recorded for these subsamples. Wet weight, dry weight, and the total number of plants per quadrat were determined. Plant height and further component analyses (branches per plant, pods per branch, and seeds per pod) were conducted utilizing ten random, representative plants per subsample.

From each plot, the center sections (6 feet x 50 feet) were swathed on July 16 and combined on July 23. Harvest index, clean-out, total seed yield, and thousand-seed weights were determined.

The following measurements will be conducted in 2014 and the data presented in the *2014 Seed Production Research Report*: carbon:nitrogen ratio of biomass sampled at the rosette and inflorescence emergence stages, seed protein, and seed oil content for each treatment.

Results and Discussion

<u>Vegetative measurements</u>

Nitrogen fertilizer treatments influenced yellow mustard characteristics at varying degrees of significance. Due to warm weather during the 2013 growing season, mustard plants grew at a greater rate than anticipated or previously observed. Lodging was present only with the two highest N rates—150 and 200 lb N/acre. However, even at these rates, the typical negative effects of lodging (reduced pollination, increased harvest difficulty, and reduced yield) were not observed.

At the rosette stage, treatments receiving N were taller than the control (Figure 1). Measurements conducted at inflorescence emergence allow for greater differentiation in height among treatments, with the greatest height observed in 150 and 200 lb N/acre plots. When measured at harvest, the average plant height was only about 7% greater than at inflorescence emergence, indicating that yellow mustard reaches nearly full mature height by inflorescence emergence. Plant height at harvest was influenced incrementally by the amount of N applied, with the greatest height attained at the highest N rate.

Above-ground biomass measurements illustrated that plots not receiving N fertilizer (control plots) consistently produced significantly less vigorous stands at the rosette and inflorescence emergence stages (Figure 2). At the rosette stage, the 100 lb N/acre treatment generated more biomass than did the 50 and 150 lb N/acre treatments. However, measurements at inflorescence emergence showed that the 150 lb N/acre rate yielded significantly more biomass than both the 50 and 100 lb N/acre rates. At the rosette stage, the 200 lb N/acre treatment was similar in biomass to the 50, 100, and 150 lb N/acre rates. At inflorescence emergence, the 200 lb N/acre treatment was similar to the 150 lb N/acre rate.

Due to midseason precipitation, control plots accumulated sufficient biomass by harvest and subsequently were not statistically different from plots receiving 50 or 100 lb N/acre. Interestingly, above-ground biomass at harvest with the 200 lb N/acre rate differed only from that in the control plots and plots receiving 50 lb N/acre.

As expected, N fertilizers notably influenced yellow mustard leaf area, a measurement of plant photosynthetic capacity (Figure 3). Typically, increasing N fertilizer rates resulted in an increase in average leaf area of 5.4% to 37.9% between rosette stage and inflorescence emergence, with only the 100 lb N/acre treatment experiencing a 2% decrease in leaf area. The control treatment experienced a 70% increase in leaf area from rosette to inflorescence emergence.

At both rosette and inflorescence emergence, control plots maintained significantly lower leaf area, and they were the last to reach canopy closure. At the rosette stage, there were no differences in leaf area between the 50 and 100 lb N/acre rates, nor among the 100, 150, and 200 lb N/acre rates. However, at inflorescence emergence, leaf area was greatest with 150 and 200 lb N/acre rates.

Yield components

Yellow mustard seed yield components are categorized into number of branches (main stem, primary, and secondary), total number of pods per branch type, and total quantity of seeds per branch type. N had a substantial influence on all yield components, beginning with branching structure (Table 1). Plots receiving 200 lb N/acre had significantly greater total branch count compared to both the control plots and the plots

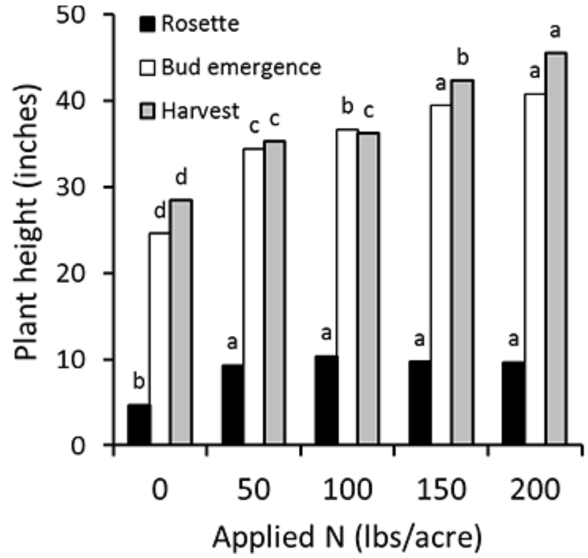

Figure 1. Effect of N fertilizer on yellow mustard plant height at rosette, inflorescence, and harvest. Means within growth stages or harvest are not statistically significant ($P = 0.05$) if followed by the same letter.

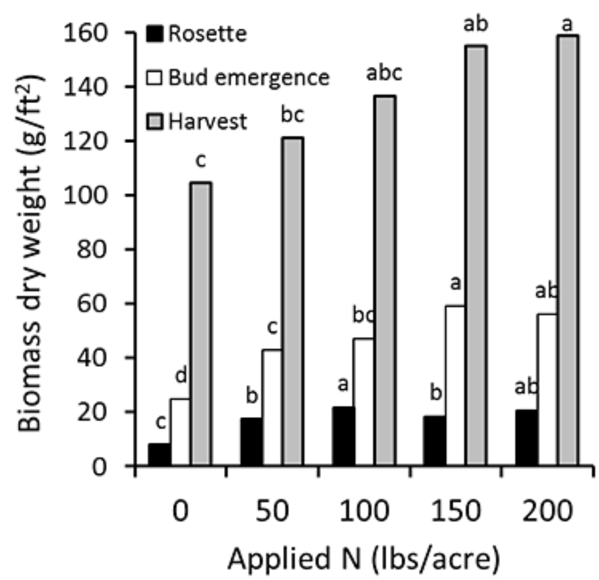

Figure 2. Effect of N fertilizer on yellow mustard above-ground biomass at rosette, inflorescence emergence, and harvest. Means within growth stages or harvest are not statistically significant ($P = 0.05$) if followed by the same letter.

receiving 50 lb N/acre. With a greater number of branches at the higher N rates, plants receiving 150 and 200 lb N/acre surpassed the control treatment in the number of main stem and primary pods produced (Table 1), as well as the number of seeds produced per main stem and primary pod (Table 2). Applications of 200 lb N/acre significantly increased the number of secondary branches per plant above that seen with the control, 50, and 100 lb N/acre treatments. However, N fertilizer did not generate significant differences in secondary pod production nor in the quantity of secondary seeds produced per pod.

A similar trend was observed when comparing average main seed mass across N fertilizer rates (Table 2). The control plots produced the lowest seed mass on main stems (although the control, 50 lb N/acre, and 100 lb N/acre treatments were not significantly different). Seeds produced on main stems with the 150 and 200 lb N/acre rates attained the greatest mass; the 200 lb N/acre rate far surpassed other rates in terms of primary seed mass—32% greater than the 150 lb N/acre treatment and 177% greater than the control.

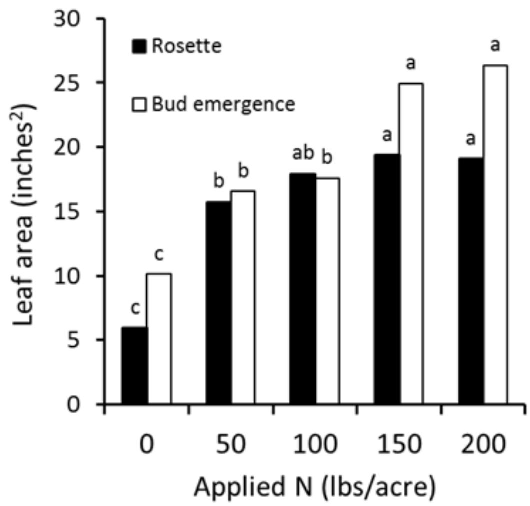

Figure 1. Effect of N fertilizer on yellow mustard leaf area at the rosette and inflorescence emergence growth stages. Means within growth stages are not statistically significant (*P* = 0.05) if followed by the same letter.

Table 1. Effect of applied N on the number of plant branches and pods produced by yellow mustard.[1]

Applied nitrogen	Branches[2]			Pods[3]			
	Total	1°	2°	Total	Main	1°	2°
(lb N/acre)	(number/plant)			(number/plant)			
0	3.2 b	2.0 b	0.2 b	56.9 c	36.3 c	20.3 c	0.4 ab
50	3.3 b	2.2 b	0.1 b	58.3 c	38.7 c	19.5 c	0.1 b
100	3.6 ab	2.4 ab	0.2 b	67.9 bc	40.7 bc	26.0 bc	1.2 ab
150	3.8 ab	2.5 ab	0.3 ab	78.4 ab	45.3 ab	32.2 ab	0.8 ab
200	4.3 a	2.8 a	0.5 a	87.8 a	47.7 a	38.6 a	1.5 a

[1]Means within each column are not statistically significant by Fisher's LSD (*P* = 0.05) if followed by the same letter.
[2]Total = total number of branches; 1° = primary branches; 2° = secondary branches
[3]Total = total number of pods; main = main stem; 1° = primary branches; 2° = secondary branches

Table 2. Effect of applied N on seed number and seed mass harvested from main stems, primary branches, and secondary branches in yellow mustard.[1]

Applied nitrogen	Seed number[2]				Seed mass[2]	
	Total	Main	1°	2°	Main	1°
(lb N/acre)	(number/plant)				(g/plant)	
0	205.3 d	135.0 d	68.7 c	1.6 a	0.84 d	0.43 d
50	248.2 cd	169.7 c	78.1 c	4.4 a	1.14 c	0.52 cd
100	295.1 bc	183.1 bc	107.5 bc	4.4 a	1.22 bc	0.71 bc
150	336.8 ab	202.5 ab	131.1 ab	3.1 a	1.41 ab	0.90 b
200	400.4 a	222.1 a	172.6 a	6.7 a	1.58 a	1.19 a

[1]Means within each column are not statistically significant by Fisher's LSD (*P* = 0.05) if followed by the same letter.
[2]Total = total number of seeds; main = main stem; 1° = primary branches; 2° = secondary branches

Seed yield

Considering the strong influence of N on yield components, it is no surprise that N fertilizers also had a complex but significant influence on seed yield in terms of seed number and seed weight (Table 3). The 200 lb N/acre rate produced the highest seed yield of 2,295 lb/acre, resulting primarily from the overall quantity of seeds produced. The control yielded 1,363 lb/acre. In 2013, the general relationship between applied N fertilizer and yellow mustard seed yield was that yield increased with increasing N.

This study addresses N fertilizer application rates as well as yellow mustard growth and developmental patterns for optimum seed yield under Willamette Valley environmental conditions and illustrates the potential of this crop to emerge as a successful multimarket, low-input, rotation crop option.

References

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Table 3. Effect of applied N on seed weight and seed yield in yellow mustard.[1]

Applied nitrogen	Seed weight[2]	Seed yield
(lb N/a)	(mg)	(lb/a)
0	6.923 bc	1,363 d
50	6.825 c	1,555 c
100	6.835 bc	1,575 bc
150	7.042 ab	1,725 b
200	7.192 a	2,295 a

[1]Means presented within each column are not statistically significant by Fisher's LSD (P= 0.05) if followed by the same letter.

[2]Seed weight (mg) was calculated from thousand-seed-weight measurements.