

Determining optimum agronomic practices to maximize productivity of canola-quality Oriental mustard (*Brassica juncea*).

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Statement of problem

Few crop species are suitable to Northern Idaho growers to include in rotation with small grain cereals. *Brassica* crops such as winter and spring canola and rapeseed have long been included in this region, albeit on a relatively small acreage basis. Similarly yellow mustard (*Sinapis alba*) has recently been proven to be a valuable rotation crop. It has been shown that wheat yields after canola, rapeseed and yellow mustard can be favorably high compared to monoculture cereal production. These crops are high in plant biomass which adds to the soil organic matter and improves water holding capacity. In addition, these crops break disease cycles and it has been suggested that they produce allelochemicals that further reduce soil-borne diseases.

Justification

Over the past 10 years, a number of new winter and spring canola, spring rapeseed, and yellow mustard cultivars have been released and are now grown commercially in Northern Idaho. Several studies have been conducted over this period to examine optimum growing conditions including herbicide efficacy studies, effects of variable nitrogen and other nutrients, insect damage and efficacy studies, etc., and these have greatly added to the yield potential and sustainability of including these crops in rotation with wheat and barley.

Recent traditional breeding efforts in Canada and Australia have resulted in the development of oriental mustard (*B. juncea*) having canola-quality seed oil and seed-meal glucosinolates. The University of Idaho obtained some of these breeding lines and field tested two of them in this study to assess local adaptability. It is highly likely that the USDA will grant 'canola status' to these new canola type mustards within the next few years. This could increase the acreage of canola in the region, with greater production in the dryer areas. In addition, greater flexibility in rotation options would be available with additional crop species other than the canola species available at present.

Unlike their *Brassica* and other mustard relatives, oriental mustard crops are new to this area and as yet there has been no research directed towards determining optimum nitrogen management and seeding rates for maximum crop productivity and seed quality. This proposal will determine optimum agronomic practices to maximize productivity of canola-quality oriental mustard *Brassica juncea*, so that when this status is granted we will have prior knowledge on how to best grow these new canola lines under Pacific Northwest conditions.

The aim of this study is to determine the effect of variable nitrogen rate and seeding rate on productivity and quality of canola-quality oriental mustard cultivars in the Pacific Northwest.

Results

The effects of varying available nitrogen rates (50, 75, 100, 125, and 150 lb/available N/acre) and seeding rate (3 rates) of two canola-quality *Brassica juncea* cultivars (Arid and Dahinda) and the condiment oriental mustard cultivars 'Pacific Gold' and 'Kodiak' was determined at two locations two locations and two planting dates at each location in 2004.

Prior to planting, soil samples were taken to determine base nitrogen level. Nitrogen treatments were added such that total available nitrogen was 50, 75, 100, 125, and 150 lbs/N/acre. The experimental design of the complete trial at each site was a strip-split-plot design with four replicates (i.e. 4 cultivars x 5 nitrogen levels x 3 seed rates x 3 replicates = 180 plots/site/seeding date). Plant growth was monitored throughout the growing season and variables recorded included plant stand counts, flower start date, and plant height at maturity. At harvest, seed from each plot was harvested and the seed weighed. A sub-sample from each plot was removed, and the seed used to determine oil content and seed size.

Averaged over all planting dates, sites, nitrogen application rates and seeding rates Pacific Gold produced 1,693 lb/acre while Kodiak yield was significantly reduced at 1,374 (Table 1). Average seed yield of the canola-quality cultivars was 1,034 lbs/acre, which was significantly less than either of the condiment mustard types. Indeed the canola-quality cultivar yields were 25% and 38% lower than the yield potential of Kodiak and Pacific Gold, respectively. Highest seed oil content was obtained from Pacific Gold, while Arid had significantly lower seed oil content than the other cultivars. Arid seedling emergence was poor compared to the other cultivars and this resulted in a significantly reduced seedling stand counts. Both canola-quality cultivars flowered one day earlier than the condiment cultivars and were shorter in plant height than Kodiak or Pacific Gold.

Table 1. Seed yield, plant stand counts, days from planting to 50% bloom, and plant height of four cultivars averaged over all treatments.

Cultivar	Seed yield	Oil Content	Plant stand	Days to Flower	Plant height
	-- lb/acre --	---- % ---	- Count/2m -	--- days ---	-- cm --
Pacific Gold	1,693 ^a	33.6 ^a	30.7 ^a	60.3 ^a	151 ^b
Kodiak	1,374 ^b	29.8 ^d	31.5 ^a	60.4 ^a	156 ^a
Arid	1,007 ^d	32.1 ^c	27.4 ^b	59.9 ^b	143 ^c
Dahinda	1,061 ^c	32.7 ^b	31.7 ^a	59.2 ^c	146 ^c
Mean	1,284	32.1	30.3	60.0	149
LSD 5%	18	0.13	0.79	0.18	1.00

Means within columns with different superscript letter are significant (P<0.05).

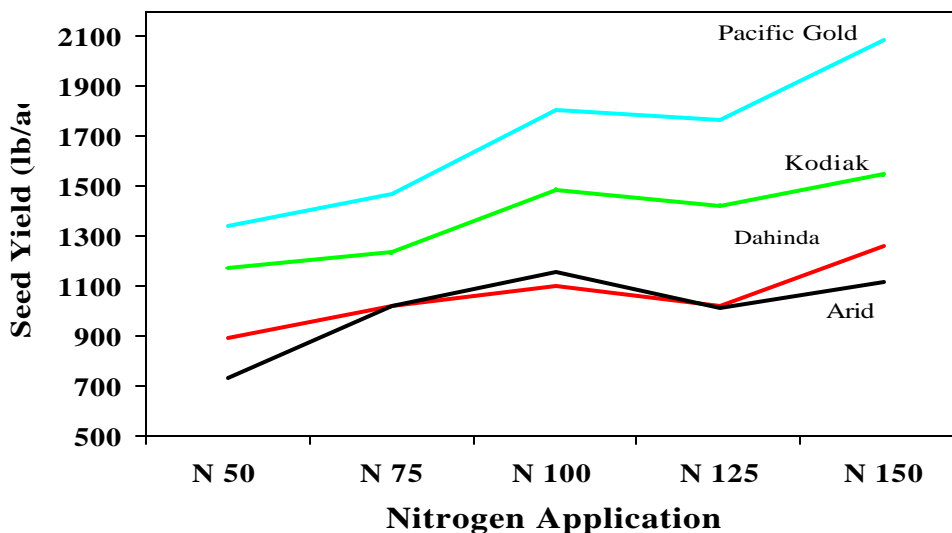
Increased nitrogen application had a significant impact on seed yield (Table 2). The relationship between nitrogen applications and seed yield was significantly linear for all cultivars. Pacific Gold, however, had a greater nitrogen response compared to Kodiak, Arid or Dahinda (Figure 1). Increasing nitrogen application rate by 1 lb/acre resulted in 7.1 lb/acre increase in Pacific Gold seed yield while 1 lb/acre increase in nitrogen application related to only a 3.7, 3.0, and 2.9 lb/acre seed increase in Kodiak, Arid and Dahinda, respectively. Seed oil content was linearly related to nitrogen application in that increased nitrogen application caused a decrease in seed oil content. As both Pacific Gold and Kodiak are designated as condiment oriental and brown mustard, respectively, lower oil content is considered desirable over high oil content. However, the reverse would not be true for the canola-quality mustard types as high oil content would be desirable over low content. Increasing available nitrogen had no effect on seedling stand counts. As would have been expected, increased nitrogen application resulted in taller plants.

Table 2. Seed yield, plant stand counts, days from planting to 50% bloom, and plant height after application of five nitrogen rates averaged over all treatments.

Nitrogen Rate Applied	Seed yield	Oil Content	Plant stand	Days to Flower	Plant height
	-- lb/acre --	--- % ---	- Count/2m -	--- days ---	-- cm --
0 lb N	1,034 ^d	32.6 ^a	30.5	60.4 ^a	134 ^b
25 lb N	1,186 ^{cd}	32.6 ^{ab}	31.8	59.4 ^d	140 ^b
50lb N	1,386 ^{ab}	31.9 ^{bc}	30.4	59.8 ^c	155 ^a
75lb N	1,302 ^{bc}	31.7 ^c	29.0	60.0 ^{bc}	155 ^a
100lb N	1,500 ^a	31.5 ^c	29.8	60.1 ^{ab}	159 ^a
Mean	1,284	32.1	30.3	59.9	149
LSD 5%	20	0.15	n.s.	0.21	1.12

Means within columns with different superscript letter are significant (P<0.05).

Figure 1. Yield response four cultivars to increased nitrogen.



Significant yield loss was observed when seed rate was reduced from 4.5 lb/acre to 3 lb/acre (Table 3). There was no significant yield increase associated with seeding rates higher than 4.5 lb/acre. As expected, higher seeding rates were associated with increasing seedling stand counts. Plants from the higher seeding rate treatments flowered earlier than the 5.0 lb/acre rate and the highest seeding rate was on average 3 cm shorter. This is most likely related to greater inter-plant competition at the higher seeding rates.

Table 3. Seed yield, plant stand counts, days from planting to 50% bloom, and plant height of three seeding rates averaged over all treatments.

Seeding rate	Seed yield	Oil Content	Plant stand	Days to Flower	Plant height
	-- lb/acre --	--- % ---	- Count/2m -	--- days ---	-- cm --
5.0 lb/acre	1,225 ^b	31.9	21.7 ^c	60.1 ^a	150 ^a
7.7 lb/acre	1,300 ^a	32.1	28.6 ^b	59.9 ^b	150 ^a
10.3 lb/acre	1,327 ^a	32.1	40.6 ^a	59.8 ^b	147 ^b
Mean	1,284	32.1	30.3	59.9	149
LSD 5%	16	n.s.	0.69	0.15	0.87

Means within columns with different superscript letter are significant (P<0.05).

Early planting seed yields were significantly higher for both cultivars compared to planting 14 days later (Table 4). Averaged over all cultivars, seed yield from the early plantings produced 1,546 lbs/acre while later planting yields were 34% lower. The canola-quality cultivars were particularly sensitive to later planting dates. Later planting was related to significantly higher seedling stand counts and lower oil content. The former is likely due to higher soil temperatures at later planting which resulted in higher seedling emergence, while the later is most likely related to greater heat and drought stress of the later plantings, which had fewer days from bloom to maturity compared to the early plantings. As expected, the later planting date had significantly shorter period to flowering than the early plant date.

Table 4. Seed yield, plant stand counts, days from planting to 50% bloom, and plant height from early and late planting averaged over all treatments.

Planting date	Seed yield	Oil Content	Plant stand	Days to Flower	Plant height
	--- lb/acre ---	--- % ---	- Count/2m -	--- days ---	-- cm --
Early	1,546 ^a	33.1 ^a	26.2 ^b	64 ^a	145
Late	1,017 ^b	31.0 ^b	34.4 ^a	56 ^b	153
Mean	1,284	32.1	30.3	60	149
LSD 5%	13	0.09	0.56	0.22	0.71

Means within columns with different superscript letter are significant (P<0.05).

Potential benefits and impacts

Given the wide diversity of environments that exist in the Pacific Northwest, it will be necessary to utilize all canola producing species if a sound canola industry is to be developed. This is the first time the newly developed canola-quality *B. juncea* cultivars

have been evaluated in the region. Their performance in these trials was lower than the condiment types grown for comparison. However, industry and grower interest in Pacific Gold in northern Idaho has escalated dramatically since its release in 2001, and current interest is evident by the high demand to purchase certified seed this year. Most of this interest has stemmed from the high yield potential of this cultivar throughout the region. The true potential of canola-quality mustard cultivars may be a few years from realization but will likely attract the most attention in the dryland regions where canola is not successful. This is the first research that has investigated the effects of planting date, seeding rate or nitrogen on productivity of *B. juncea*. It is difficult to make strong recommendations or conclusions based on a single year of results and it is hoped to continue this type of agronomic research in future years. With further years of experimentation this information will be available to maximize productivity and grower profitability in growing mustard crops.