

## FERTILIZER PLACEMENT IN ANNUAL CROP DIRECT-SEEDED CANOLA

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### Abstract

The effect of fertilizer amount and placement on stand establishment, plant growth, and yield in direct-seeded fall canola following spring wheat was evaluated in a field near Pendleton, Oregon. 'Ericka' canola was seeded on September 25. Comparisons were made among starter fertilizer (100 lb/acre of 16-20-0-14) placed with the seed, below and to the side of seed, no starter applied at seeding, and placing the full complement of fertilizer (100 lb/acre of 16-20-0-14 plus 160 lb/acre of 46-0-0) below and to the side of seed. These factors had a significant impact on yield with nearly a two-fold difference between the best and worst treatments. Placing the full complement of fertilizer to the side and below the seed provided the best stand establishment, winter survival, accumulated dry matter, and yield. The worst canola yield resulted from applying all the fertilizer in the spring, rather than at the time of seeding.

### Key Words

Canola, no-till, direct-seed, stand establishment, seeding, fertilizer

### Introduction

Annual crop direct-seed systems in the inland Pacific Northwest (PNW) region, where wheat/fallow and wheat/pea are the traditional production systems, would benefit if a broadleaf crop such as canola (*Brassica napus* L.) could be rotated with cereal crops (Brown et al. 2001). Conventionally tilled canola can be grown, but these systems are not sustainable and therefore conservation systems such as direct seed are needed. Although winter canola yields two times spring canola

(Wysocki et al. 1992), adequate soil water is not always present at the optimum seeding time and therefore stand establishment is difficult, especially in a direct-seed or minimum tillage system. This research was conducted to address this issue and determine the influence of fertilizer amount and placement on canola stand establishment, plant growth, and yield in a PNW annual crop direct-seed system.

### Materials and Methods

'Ericka' canola was seeded on the Pendleton Agricultural Research Center at the rate of 8.2 lb/acre on September 25, 2000 into flailed spring wheat stubble using a direct-seed hoe-type plot drill. Four treatments were sown in 12-ft by 50-ft plots in a randomized complete block experiment with four replications. All treatments received equal amounts of N (nitrogen), P<sub>2</sub>O<sub>5</sub> (phosphorous pentoxide), and S (sulfur), but varied in fertilizer form, placement, timing, and method of application. The four treatments investigated included the following:

1. Starter fertilizer (100 lb/acre of 16-20-0-14) placed with the seed plus 74 lb of N per acre (solution 32 formulation) applied on March 20, 2001 with a spoke-wheel applicator.
2. Starter fertilizer (100 lb/acre of 16-20-0-14) placed below and beside the seed plus 74 lb of N per acre (solution 32 formulation) applied on March 20, 2001 with a spoke-wheel applicator.

3. No starter fertilizer applied at seeding. Spoke-wheel application of 90, 20, and 14 lb/acre of N, P<sub>2</sub>O<sub>5</sub>, and S, respectively, on March 20, 2001.
4. Starter fertilizer plus urea (100 lb/acre of 16-20-0-14 and 160 lb/acre of 46-0-0) placed below and beside the seed.

Seed and fertilizer placement were determined from 2- by 2- by 4-in-deep soil cores sectioned into 0.4-in increments. Stand observations were taken on October 20, 2000 and March 7, 2001. Above-ground dry matter production was measured on

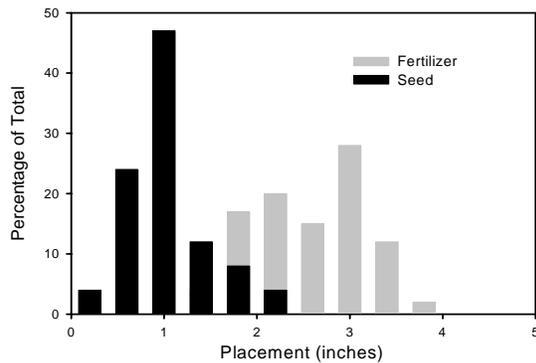


Figure 1. Vertical distribution of seed and fertilizer in canola plots near Pendleton, Oregon in 2000.

April 4, 2001 and seed yield was determined at harvest with a plot combine.

## Results

Figure 1 shows the distribution of seed and fertilizer where the full complement of fertilizer (starter plus urea) was placed below the seed. Although the mean seed depth was 1.1 in, seed depth ranged from 0.2 to 2.8 in. Mean fertilizer depth (2.4 in) was over 1.25 in deeper than mean seed depth; however, fertilizer was found at depths ranging from 1.75 in to 3.75 in.

Table 1 shows stand observations on October 20 and March 7, winter survival, above-ground dry matter accumulation on April 4 prior to bolting, and seed yield. Stand establishment, winter survival fraction (stand on March 7 divided by stand on October 20), plant growth, and yield were superior with the full complement of fertilizer (starter plus urea) compared to no fertilizer applied at seeding. Starter fertilizer applied at seeding improved winter survival and seed yield compared to no fertilizer applied at seeding. There were no statistically significant differences in stand establishment, winter survival, accumulated dry matter, or seed yield for starter fertilizer placed with the seed, or beside and below the seed.

Table 1. Effect of fertilizer amount and placement on stand establishment and dry matter production of Canola in April, 2001, Agricultural Research Center, Pendleton, Oregon.

Treatment	Plant stand		Winter survival <sup>1</sup> fraction	Above-ground dry matter on April 4		Seed yield lb/acre
	Oct. 20 plants/ft <sup>2</sup>	Mar. 7 plants/ft <sup>2</sup>		g/plant	lb/acre	
1. Starter <sup>2</sup> with seed	3.8 b <sup>3</sup>	3.2 bc	0.86 a	0.38 ab	92 b	852 ab
2. Starter below seed	5.0 b	4.9 b	1.01 a	0.29 b	78 b	783 b
3. No starter	5.6 b	2.1 c	0.37 b	0.10 b	14 b	517 c
4. Starter plus urea <sup>4</sup> below seed	8.0 a	8.4 a	1.10 a	0.49 a	406 a	900 a

<sup>1</sup> Winter survival = plant stand on Mar. 7 divided by stand on Oct. 20.

<sup>2</sup> Starter (16-20-0) applied at the rate of 100 lb/acre.

<sup>3</sup> Numbers within a column followed by the same letter are not statistically different by LSD test (P = 0.05).

<sup>4</sup> Urea (46-0-0) applied at the rate of 160 lb/acre.

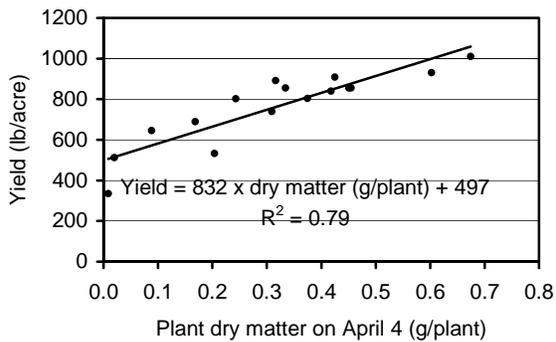


Figure 2. Canola yield at Pendleton, Oregon in 2001 as influenced by above-ground canola plant dry matter on April 4, 2001.

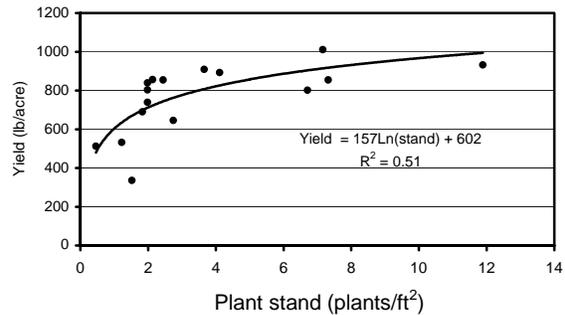


Figure 3. Effect of canola plant stand on yield at Pendleton, Oregon in 2001.

Data plotted in Figure 2 show the importance of early plant size on yield. Treatments that had large plants in April produced the highest yields. A linear regression fit to the early plant growth and yield data had an R<sup>2</sup> (coefficient of determination) value of 0.79. This indicates that 79 percent of the variation in yield was accounted for in early plant growth. Plant stand also influenced yield (Fig. 3). Yield

increased from 450 lb/acre to 800 lb/acre as stand increased from 1 plant/ft<sup>2</sup> to approximately 4 plants/ft<sup>2</sup>. Plant densities of more than 4 plants/ft<sup>2</sup> did not increase yield significantly. The logarithmic equation that best fit these data was determined to be:

$$\text{Yield} = 157 (\text{Ln}(\text{stand})) + 602$$

where stand is in units of plants/ft<sup>2</sup> and yield is expressed in lb/acre. The coefficient of determination (R<sup>2</sup>) was 0.51.

Accumulated dry matter per acre is a function of stand and plant size. Increases in stand and/or plant size increase accumulated above-ground dry matter. Figure 4 shows the logarithmic relationship found between accumulated dry matter and seed yield per acre. At dry matter levels below 75 lb/acre, yield decreased dramatically as dry matter decreased. At dry matter levels above 100 lb/acre, increased levels of dry matter increased yield slightly.

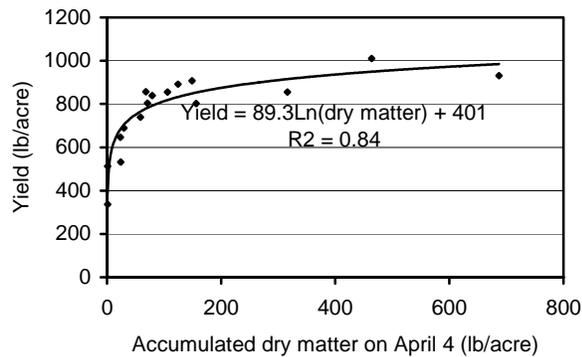


Figure 4. Influence of accumulated dry matter on canola yield at Pendleton, Oregon in 2001.

The logarithmic equation that best fit these data was determined to be:

$$\text{Yield} = 89.3(\text{Ln}(\text{dry matter})) + 401$$

where dry matter is the above-ground oven-dried plant material in lb/acre and yield is expressed in lb/acre.

The coefficient of determination (R<sup>2</sup>) for this regression equation was 0.84, indicating that 84 percent of the variation in yield can be accounted for by the early above-ground dry matter production.

Observations in this experiment are supported by canola growth and nutrient uptake data taken in past growing seasons at the Agricultural Research Center near Pendleton, Oregon (Table 2). Of the total amount of nutrients in the above-ground plant material, over one-half of the nitrogen and roughly one-third of the sulfur and phosphorus are in the plant by the spring rosette stage of growth. It therefore is essential to have these nutrients available to the plant early in its development.

### Summary

Placement and timing of fertilizer in annual crop direct-seed canola following wheat near Pendleton, Oregon greatly impacted stand establishment and plant size. These factors had a significant impact on yield with nearly a two-fold difference between the best and worst treatments. Placing the full complement of fertilizer to the side and below the seed provided the best stand establishment, winter survival, accumulated dry matter, and yield. The worst canola yield resulted from applying all the fertilizer in the spring, rather than at the time of seeding. Future research is planned to determine optimum vertical and horizontal separation of canola seed and fertilizer for direct-seeded winter canola.

Table 2. Winter canola dry matter and nutrient uptake, Pendleton, Oregon in 1998-1999 growing season.

Date	Stage	DM <sup>1</sup> lb/ac	N <sup>2</sup> %	N lb/ac	S <sup>3</sup> %	S lb/ac	P <sup>4</sup> %	P lb/ac	B <sup>5</sup> ppm	B lb/ac
9/11/98	Sowing		0	0	0	0	0	0	0	0
11/25/98	Winter rosette	2,407	4.86	121	0.36	9	0.57	14	27	0.07
2/26/99	Spring rosette	2,719	4.39	124	0.53	15	0.51	14	38	0.11
3/26/99	Bolting	4,534	4.01	189	0.45	22	0.49	23	44	0.21
4/8/99	First bloom	6,954	2.55	187	0.36	27	0.41	30	41	0.29
4/22/99	Early bloom	9,470	2.38	236	0.33	33	0.40	39	44	0.43
5/12/99	Full bloom	12,212	1.56	197	0.32	41	0.35	44	31	0.39
6/10/99	Pod filling	15,376	1.10	175	0.29	47	0.28	44	31	0.50
7/9/99	Harvest	12,620	1.21	153	0.32	40	0.32	41	28	0.35
	Straw at harvest	9,219	0.56	51	0.30	28	0.09	8	33	0.30
	Seed at harvest	3,401	3.00	102	0.37	13	0.96	33	13	0.04

<sup>1</sup>DM = dry matter in lb/acre.

<sup>2</sup>N = nitrogen.

<sup>3</sup>S = sulfur.

<sup>4</sup>P = phosphorous.

<sup>5</sup>B = boron.

### References

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