# Uniform Plant Stands Promote Pod Set and Boost Seed Yield in Canola

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## Introduction

Canola (*Brassica napus* L.) is an economically important oilseed crop in many parts of the world. The seed yield of canola is often limited by poor plant establishment. This is a serious issue in short season growing regions, such as western Canada, where crop plants usually have a limited time to adapt and compensate for yield losses due to poor or non-uniform plant establishment. It is unknown how the uniformity of canola plant stands affect pod set and seed yield. In this study, we determined the impacts of uniformity of plant stands on pod formation, seed set, and seed yield of canola.

## Materials & methods

The experiment was carried out at 16 site-years across the major canola growing area of western Canada from 2010 to 2012 (**Tab.1**). At each site-year, the cultivar 'InVigor ® 5440' was planted under five uniform (20, 40, 60, 80 and 100 plants $m^{-2}$) and four non-uniform stands (40, 60 and 80 plants $m^{-2}$) using a randomized complete block design with four replicates. The non-uniform stands were created by planting at 100 plants $m^{-2}$ and then manually removing some of the plants to cause gaps of various lengths within each plant row (**Fig. 1**).

## Results & discussion

Across the 16 site-years, there were significant treatment x site-year interactions for most of the variables evaluated, but some treatment effects were similar among a number of site-years. To better determine the nature of those interactions in a quantitative manner, the Nonmetric Multidimensional Scaling (NMS) test was used to group site-years into "high-yielding" and "low-yielding" sites (**Fig. 2**). There was a significant relationship between stand uniformity and seed yield (**Fig. 2**). At both high-yielding and low-yielding sites; uniform plant establishment increased seed yields significantly compared with non-uniform stands at the same plant density.

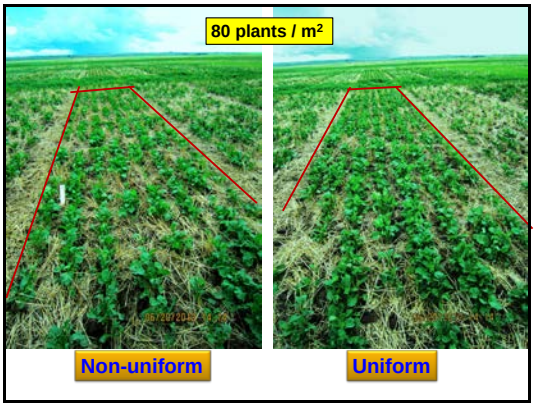


**Fig.** 1. Canola plots of non-uniform (left) and uniform (right) plant stands at 80 plants $m^{-2}$. Non-uniform plant stands are often caused by many factors, including environmental conditions and agronomic practices (Photo taken at Swift Current in 2013).

**Tab. 1**. Canola stand uniformity project in western Canada (16 site-years)

| Year | Site | Soil type | Soil property | | | |
|---|---|---|---|---|---|---|
| | | | N-P-K-S (kg ha$^{-1}$) | Texture (%) sand:clay:silt | pH | Organic matter (%) |
| 2010 | Swift Current | Silt loam | 8.6-35.6-325.7-53.3 | 31:50:18 | 6.5 | 3 |
| 2010 | Melfort | Clay loam | 11-54-540-6 | clay loam | 8.1 | 6.6 |
| 2010 | Carman | Sandy | 6.7-20-170-69.4 | 82:7:11 | 5.9 | N/A |
| 2010 | Lacombe | Silt clay | 31-31-503-259 | 43:33:24 | 7.2 | 9.4 |
| 2010 | Brandon | Silt loam | 6-23-371-5 | 42:24:33 | 7.5 | 4.6 |
| 2011 | Swift Current | Silt loam | 8.4-39.2-491.3-53.3 | 31:50:18 | 6.5 | 3 |
| 2011 | Carman | Sandy | 23-16-262-89 | 74:11:15 | 5.5 | 3.9 |
| 2011 | Morden | Loam-clay | 11-56-588-21 | N/A | N/A | N/A |
| 2011 | Melfort | Clay loam | 32-67-600-10 | loam | 7.2 | 9.1 |
| 2011 | Lacombe | Silt clay | 44-50-324-32 | 18:48:54 | 6.8 | 12.3 |
| 2011 | Indian Head | Heavy clay | 19.9-16.4-194.5-13.5 | Clay | N/A | N/A |
| 2012 | Swift Current | Silt loam | 4.4-28.7-317.5-7.5 | 31:50:18 | 6.5 | 3 |
| 2012 | Melfort | Clay loam | 20.6-48-540-44 | clay loam | 7.1 | 5.9 |
| 2012 | Carman | Sandy | 29-8-85-29 | 81:5:15 | 7.1 | N/A |
| 2012 | Morden | Loam-clay | N/A | N/A | N/A | N/A |
| 2012 | Lacombe | Silt clay | 42-28-373-14 | 22:42:36 | 6.2 | 10.5 |

The differences in seed yield between uniform and non-uniform stands at low plant densities was much greater than at high plant densities, at both high-yielding and low-yielding sites (**Fig. 2**). In particular, a yield difference of up to 48% was detected between uniform and non-uniform treatments when plant density was 20 plants m$^{-2}$ at low-yielding sites.

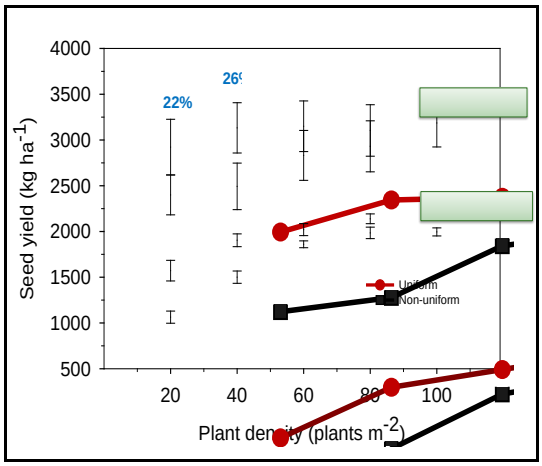


**Fig. 2**. Canola stand uniformity and seed yield (averaging across 16 site-years)

There was a linear relationship between canola seed yield and the number of fertile pods per m$^2$ in both uniform ($P$ = 0.002) and non-uniform ($P$ = 0.018) stands (**Fig. 3**). On average, seed yield increased by 168 g ha$^{-1}$ with each additional pod. The number of fertile pods is the most important yield component in canola; more fertile pods per unit area lead to higher seed yield. This relationship was altered by plant uniformity; an evenly distributed plant community alters the distribution of pods within the canopy profile and promotes more synchronous pod formation and seed development.

Non-uniform plant stands may have increased intraspecific competition within the plant community, which reduces the distribution of optical radiation, causes nutrient deficiencies, and limits the development of fertile pods.

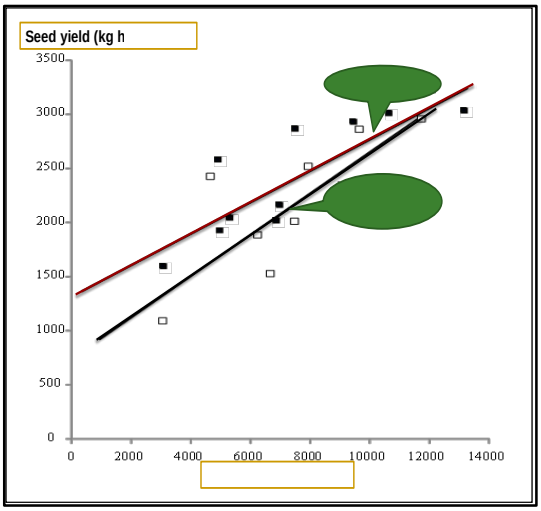


**Fig. 3**. Canola seed yield is a function of pods per square meter

## Conclusions

Averaged across multiple sites-years, uniform plant stands increased seed yield by 6 to 22% at high-yielding sites and 8 to 48% at low-yielding sites, compared to non-uniform plant stands. Uniform plant stands optimized the use of available resources, leading to more fertile pods per plant. Across the 16 site-years, plant establishment consistently played a key role in increasing canola seed yield. The achievement of uniform plant stands may be one of the most important agronomic factors required to close the yield gap between the current level of canola productivity and its full potential.

## Acknowledgements

This research was supported by Canola Clusters of Agriculture and Agri-Food Canada. We thank Lee Poppy at Swift Current, Colleen Kirkham and Dan Cross at Melfort, Larry Michielsen, Patty Reid, Elizabeth Sroka and Jennifer Zuidhof at Lacombe, Derek Lewis at Winnipeg, Mark Sandercock at Morden, and Randy Shiplack at Indian Head, for their technical assistance and contributions to this work.