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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.

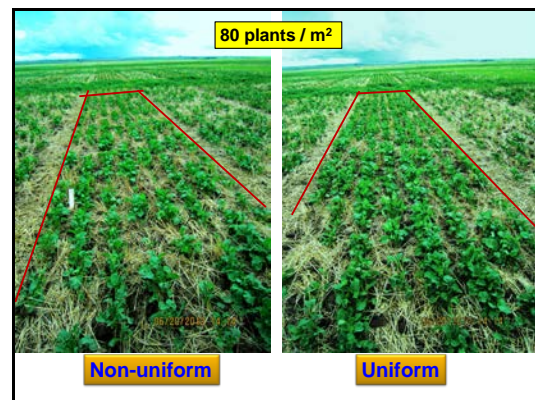


Fig. 1. Canola plots of non-uniform (left) and uniform (right) plant stands at 80 plants m⁻². Non-uniform plant stands are often caused by many factors, including environmental conditions and agronomic practices (Photo taken at Swift Current in 2013).

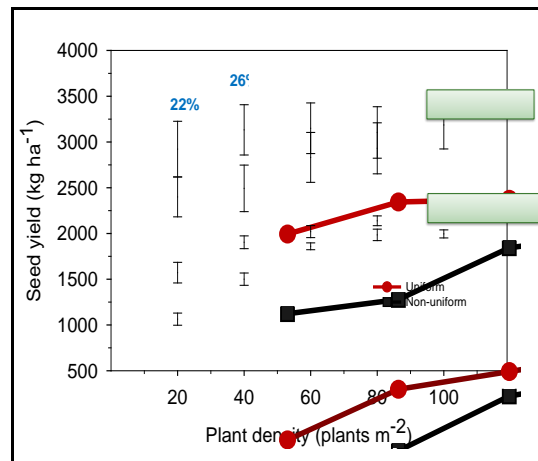
Tab. 1. Canola stand uniformity project in western Canada (16 site-years)

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.

There was a linear relationship between canola seed yield and the number of fertile pods per m² 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.

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

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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.

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.

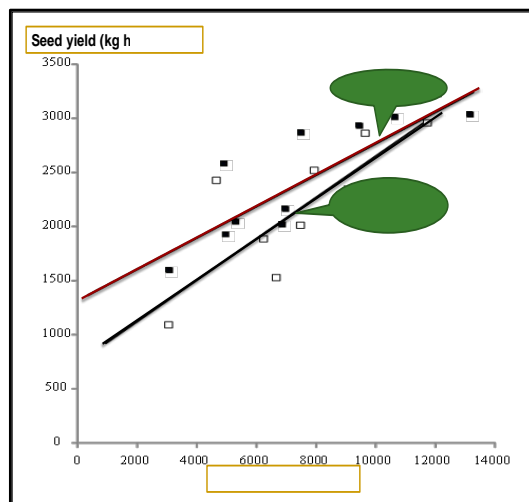


Fig. 3. Canola seed yield is a function of pods per square meter

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