Eastern Canada Oilseeds Development Alliance

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Activity 15 Factsheet

Effects of Plant Population on Stress Tolerance and Seed Quality of Spring Canola

Objectives

The overall objectives of this activity are to 1) determine, in a series of field trials, how reduced plant populations affect physiological responses of spring canola to abiotic stresses – primarily heat stress and water stress – in the Ontario growing environment; and 2) quantify effects of canola plant population on seed quality (primarily free fatty acid content).

Methodology

Field trials were carried out over three seasons (2013 to 2015) to test the effects of seeding rate on yield, seed quality and stress tolerance of spring canola in Ontario. The seeding rates were a low rate (50 seeds m^{-2}), a typical rate (100 m^{-2}) and a high rate (200 m^{-2}). At one location in two years, seeding rates were tested in combination with rain-fed and irrigated treatments, to test the effects of seeding rate in the presence and absence of water stress. A greenhouse experiment was also used to test the hypothesis that at low plant populations, more highly branched plants would be less susceptible to yield loss caused by an acute, transient water stress occurring during early flowering. Plants were grown at either a high density (90 m^{-2}) or a low density (30 m^{-2}), and subjected to either control conditions (well watered) or to a drought stress treatment, for four treatment combinations in a 2 x 2 factorial.

Results

Field Trials. In 2013, growing conditions were not ideal for the experiment, lacking stress conditions. At low populations, there was an increase in brown seed content and green seed. The effects of seeding rate on susceptibility to Swede midge damage were tested at one location. None of the insecticide treatments affected yield or Swede midge damage ratings. The seeding rate treatment effects on yield were similar to those reported for the above experiment, but with even stronger statistical separation. Yields were 3.87, 3.67 and 3.30 Mg / ha for the 200, 100 and 50 plants per m^2 seeding rates, respectively. Consistent with our hypothesis, Swede midge damage ratings tended to be highest at highest seeding rates.

In 2014 the seeding rate experiment was performed at three locations. Lower seeding rates resulted in higher green seed counts, consistent with less uniform maturity on more highly branched plants. Reduced seeding rates resulted in a significantly increased fraction of the yield being borne on the branch racemes (smaller fraction of yield on main racemes), as was also seen in 2013. Plant height tended to decrease as seeding rate increased. In 2014 we began investigating interactions of irrigation and seeding rate. Because of the well-distributed precipitation in 2014, it was not possible to apply a significant amount of irrigation water. Consistent with our hypothesis, we observed significantly lower soil water content at the 100-cm depth (only) for the lower seeding rate compared to the high seeding rate. However, this difference was only apparent on two measuring dates around mid-season (42 and 49 DAP). In 2015 the irrigation/seeding rate study was repeated. Analysis of the yield, yield distribution and seed quality data showed no main effect of irrigation treatment on any measured parameters. The Elora location was the only location to show a significant yield penalty at the high (200 m^{-2}) seeding rate. At the Melancthon location (lower yielding), the highest seeding produced highest yields.

Greenhouse Trials. On an area basis, yields in the greenhouse trial were extremely high (e.g., 625 g m^{-2} = 6.25 Mg ha^{-1}). The seeding rate treatment strongly affected pod distribution between the main raceme and the branches, but the overall yield was not affected by seeding rate. This demonstrates the extensive ability of the crop to compensate for low plant populations under high yielding conditions. The water stress treatment greatly reduced yields, primarily by reducing pod set on the branches; main raceme pod numbers were not strongly affected. We did not find a statistical interaction between seeding rate and water stress on yield. Thus, in this experiment there was not compelling evidence that the crop was more resilient to the stress at the lower population. However, numerically, at a plant population of 90 m^{-2} the water stress treatment reduced yield by 25.4%, but at the lower plant population the stress reduced yield by just 16.4% below the highest yielding treatment. This suggests the lower plant population may afford some protection against yield loss under water stress. In 2015 a second greenhouse experiment further investigated the cause of the extremely high yields observed in the first experiment. The objective was to grow plants at increasing levels of interplant competition to identify yield levels under conditions emulating a continuous canopy. The seed yield in the absence of border effects was 6.2 Mg ha^{-1}, or about twice a typical field yield. Pots on the outer edge of the grid yielded 40% higher than this; the increase was attributable entirely to increased seed yield on branch racemes, as main racemes were unaffected. The increased yield on branches was due to the increased branch number and associated increased pod number, not seeds per pod or seed size. A buffer 0.48 m (two pots) wide was sufficient to fully eliminate border effects. These results demonstrated that even under full-canopy interplant light competition conditions, the yield potential of this commercial hybrid exceeds 6.2 Mg / ha; also, under these ultra-high-yielding conditions, the yield component entirely responsible for the yield increase was the pod number on branch racemes; pod numbers on main racemes were "saturated" under these conditions and could not increase further.

We found that under ultra high yielding conditions, pod numbers (and seed yield) on main racemes was "saturated", and all additional yield derived from increased numbers of branch racemes and increased numbers of pods on branch racemes. Seeding rate had the expected effects on plant height (shorter plants at higher seeding rates) and seed distribution (a much greater fraction of total yield was borne on the main racemes at higher seeding rates). However, despite the hypothesized potential benefits of low plant populations, we never observed a case where the low seeding rate out-yielded the normal rate. A higher than normal seeding rate was sometimes beneficial when yield potential was generally low; under high yielding conditions, yield was generally insensitive to seeding rate, and in one high-yielding trial the high rate yielded significantly lower than the normal rate. It was found that despite the very high yield potential and very large plant size in some Ontario canola crops, there is no demonstrated advantage, and possibly some disadvantage, to reducing seeding rates below the current typical rate of 100 viable seeds m^{-2}. A greenhouse experiment designed to maximize the potential benefit of a low seeding rate failed to convincingly demonstrate that a reduced plant population could enhance tolerance to a soil water deficit. In combination, the field and greenhouse experiments provided no evidence to argue for seeding rates below those currently commonly used in Ontario.

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