Effect of an insecticide and fungicide seed treatment on canola production and yield under varying levels of precipitation

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Abstract

The effect of an insecticide/fungicide seed treatment on the performance and yield of winter canola (*Brassica napus* L.) was compared at 24 locations in 2002 throughout the southern United States. Canola seed of three winter-type varieties, 'Abilene', 'Plainsman' and 'Wichita' were either untreated or treated with a combination of the insecticide imidacloprid and fungicides thiram and metalaxyl. Imidacloprid is systemic and mainly targeted aphids on seedling plants. Fungicides prevented damping off and seedling blights. Treatments were planted in a randomized complete block design at 24 locations as part of the National Winter Canola Variety Trial. Precipitation both natural and irrigation from 1 July through 1 December 2002 was used to classify test locations as high, medium and low precipitation sites. Low precipitation conditions substantially reduced canola yields irrespective of seed treatments. The seed treatment prevented prevent loss of stand and grain yield in the high (>370 mm) and medium (370 – 270 mm) precipitation regimes. However, at the 8 locations receiving less than 270 mm of autumn precipitation, an application of the seed treatment yielded did not significantly affect yield regardless of canola variety. Use of the seed treatment provided a clear benefit in wetter environments where autumn precipitation levels can normally be expected to exceed 270 mm.

Key words: Canola, *Brassica napus*, imidacloprid, seed treatment, precipitation

Introduction

Canola-quality oilseed rape, *Brassica napus* L., production in the United States currently is concentrated in the northern Great Plains along the Canadian border. In this area spring-type canolas are grown in the summer. In much of the rest of the U. S. winter-type canolas planted in autumn except in the Gulf coast and coastal plain region of the southeastern U.S. where facultative spring-types grown in the winter perform best (Raymer et al., 1990). New winter-type canola cultivars with improved cold tolerance and yield potential have increased the interest in growing winter canola in the mid-South, Midwestern and southern Great Plains regions. Three recently released winter-type cultivars with wide adaptation to this region include 'Abilene' (Rife et al., 2003), 'Plainsman' (Rife et al., 2000) and 'Wichita' (Rife et al., 2001).

In autumn-planted canola aphids are the most important insect damaging seedling stands in the southern U. S. (Buntin & Raymer, 1994, Buntin, 1995). Primary aphid species are the turnip aphid, *Lipaphis erysimi*, green peach aphid, *Myzus persicae*, and cabbage aphid *Brevicoryne brassicae*. Feeding injury by turnip and cabbage aphids during the seedling and rosette stage can distort and permanently stunt plant growth and make plant more susceptible to winterkill. Feeding by green peach aphid usually causes little obvious symptoms of plant injury. Imidacloprid can suppress aphids on canola seedlings for several weeks after planting (Buntin et al., 1998). Imidacloprid is a neonicotinoid insecticide that is systemic in seedling for 2-3 weeks after planting. Fungicide seed treatments usually are recommended for canola to prevent seedling losses due to damping off and seedling blights caused by *Pythium* spp., *Fusarium* spp., *Phytophthora* spp., and *Rhizoctonia solani*. Two fungicides widely sued for this purpose are thiram and metalaxyl. Insecticide seed treatments also are available to prevent insect damage to seedling canola.

The National winter canola variety test is conducted and numerous locations throughout the U. S. In the 2002-2003 growing season, this test was used to compare the effect of a seed treatment of imidacloprid, thiram and metalaxyl on growth, development and yield of three cultivars of winter canola. The effect of the seed treatment on canola performance also was related to varying levels of autumn precipitation.

Materials and Methods

Certified seed lots of 'Abilene', 'Plainsman', and 'Wichita' were divided with half being treated and half remaining untreated (Rife et al., 2000; Rife et al., 2001; Rife et al., 2003). Five kg of seed was treated with imidacloprid (Gaucho 600), thiram (Thiram 42S), and metalaxyl (Allegience FL) at the rate of 20.5, 5.0 and 0.5 fl. oz per 100 lbs of seed, respectively. ProIzed Purple seed colorant and Dyna Coat were added to a water slurry for application to each seed batch using and Hege seed treater. After the seed and slurry was completely mixed and when the seed was almost dry, 7.8 g Magnabritener was applied dry to the seed. Untreated seed was not treated with the pesticides.

Treated and untreated seed was distributed to 24 test sites in 14 states in conjunction with the National Winter Canola Variety Trials (Rife et al., 2004). Autumn precipitation and growing degree days (GDD) were calculated for each location. Precipitation including all precipitation and irrigation for that location received between July 1, 2002 and December 31, 2002.

Accumulated GDD represent the time period for the 56 days after planting using a baseline temperature of 5 °C.

At each location the three cultivars with and without the seed treatment plus 28 other untreated entries were planted in a randomized complete block design with three replications (Rife et al. 2004). The other entries were excluded from further analysis. Seed was planted in plots measuring 9.3 m^2 at the rate of 3.5 kg per ha in 18 - 20 cm rows using a small plot planter. Canola was managed using local recommendations for fertility and weed control. No other pesticides were applied except at some locations were an insecticide was applied to all plots at early bloom to control cabbage seedpod weevil, *Ceutorhynchus obstrictus* (Marsham).

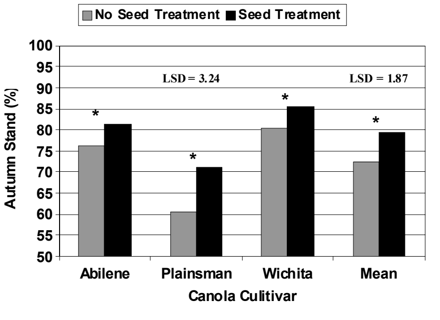
Plots were rated or sampled for percentage fall stand, percentage winter survival, date of 50% bloom, maturity date, final plant height, percent lodging at maturity, and pod shattering. Plots were harvested using small-plot combine and seed weight, test weight and moisture content were measured. Grain yields were adjusted to 8.5% moisture content. Subsamples of seed were analyzed for total grain oil content by the canola oil quality laboratory at the University of Idaho.

Data from all locations were analyzed using ANOVA. Treatment sources of error were location, replicates, cultivar, Gaucho seed treatment, and their interactions. Yield also was compared among locations based on three levels of precipitation, <269 mm, 270 - 370 mm, and >371 mm. When main effect for cultivar was significant LSD ($\alpha < 0.05$) were used for separation of means.

Results

Stand and Winter Survival: Fall stand establishment was improved by 10% when the seed treatment was used. Establishment of Abilene and Wichita were improved by 7% and Plainsman was improved by 18%. Significant differences were detected for location, cultivar, seed treatment, location×cultivar, location×seed treatment, cultivar×seed treatment, and location×cultivar×seed treatment. Reduced establishment of Plainsman caused much of this interaction, presumably because the Plainsman seed lot was not as vigorous as the other two cultivars. The seed treatment increased the establishment of all cultivars Plainsman more than Abilene and Wichita, but stand of the Plainsman treated seed was still less the establishment of untreated Abilene or Wichita (Fig. 1).

Thirteen of the 24 locations reported 100% survival for all treatments. The seed treatment did not increase survival of any specific cultivar but significantly increase in winter survival when averaged over all cultivars (Fig. 1). At the 11 locations where differential winterkill occurred, the seed treatment resulted in a 4.3% increase in survival. The seed treatment did not reduced winter survival at any location.



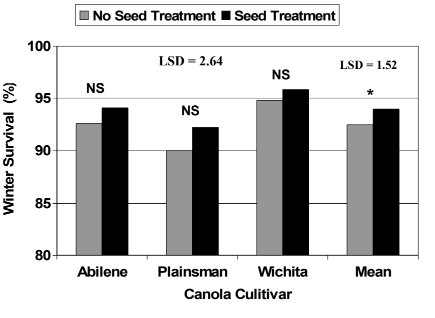


Fig. 1. Effect of seed treatment on autumn stand (left) and winter survival (right) of three canola cultivars averaged over 24 locations.

Bloom and Maturity Dates: Bloom and maturity dates were significant different among locations, cultivars, and location×cultivar interaction. The seed treatment did not significantly affect 50% bloom date or maturity date ($P > 0.05$, data not shown).

Plant Height, Lodging and Pod Shattering: Final plant height and pod shattering were not significantly affected by cultivar and seed treatment. Both parameters varied significantly among locations but cultivar and treatment interactions were not significant. Lodging when averaged among cultivars was significantly reduced by 2.3% in the seed-treated entries. This reduction ranged from 1.6% for Abilene to 3.4% for Wichita but differences within cultivars were not significant.

Grain Yield, Test Weight and Oil Content: Differences in yield were associated with autumn precipitation levels (Fig. 2). At the 8 locations that received more than 371 mm precipitation, yields averaged 307 kg/ha more with the seed treatment than without the seed treatment. Differences among all three cultivars also were significant. At locations receiving between 270 and 370 mm of precipitation, the canola with the seed treatment yielded 216 kg/ha more than untreated canola when averaged over all cultivars and locations. Yields among the three cultivars also were greater with the seed treatment but this difference was significant only for Wichita. However, at the 8 locations receiving less than 270 mm of autumn precipitation, an application of the seed treatment yielded did not significantly affect yield within cultivars or when averaged over all cultivars and locations. Cultivar×seed treatment interactions were not detected. Grain bulk density (=test weight) oil content were not significantly affected by cultivar and seed treatment.

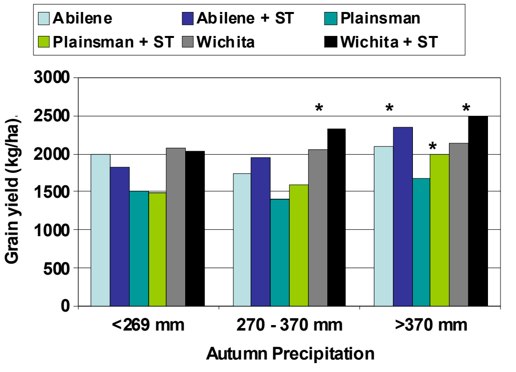


Fig. 2. Effect of seed treatment (ST) on grain yield of three canola cultivars at three levels of autumn precipitation. *significant seed treatment effect within cultivar.

Discussion

Diseases causing damping off and seedling blight generally infect plants during or shortly after emergence. Thiram generally controls damping off and seedling blights including *Fusarium* spp., *Phytophthora* spp., and *Rhizoctonia solani*. Metalaxyl also provides control of *Pythium* spp. Fungicide seed treatments can minimize seedling diseases and usually prevent seedling mortality (Rimmer & Buchwaldt, 1995). Imidacloprid is a neonicotinoid insecticide that when applied to seed is taken up and provide systemic insect control for two weeks or more after planting.

Seedling diseases and insects were not sampled in this study. Therefore significant differences between canola with and without the seed treatment in stand establishment, winter mortality, lodging, grain yield and test weight must be inferred by the known occurrence and range of target pests. Presumably the seed treatments caused differences in canola by preventing seedling mortality and injury from seedling diseases and insects, mainly aphids. Seedling diseases mostly cause plant mortality and because canola can compensate for large differences in plant density, fungicide seed treatments usually do not affect yield unless stand differences are extreme (Rimmer & Buchwaldt, 1995).

Conversely, the systemic activity of imidacloprid can initially reduce aphid numbers in autumn, which can remain low throughout the winter until aphid flight activity resumes in the spring. Feeding injury especially turnip aphid during seedling and rosette stages can permanently stunt and retard normal canola growth and development (Buntin & Raymer, 1994; Buntin, 1995). These points suggest that seed treatment differences in stand may have been due to combination of insect and disease control, however seed treatment differences in winter mortality, lodging, grain yield and test weight that occur later in the season presumably would have been mostly caused by differences in insect control.

Low precipitation conditions clearly reduced canola yields irrespective of seed treatments. An important finding of this study is the differences in effect of the seed treatment on yield under different levels of precipitation. Dry condition presumably would limit seedling diseases thereby reducing the benefit of a fungicide seed treatment. Dry conditions also may have limited aphid activity. Low precipitation also may have reduced the uptake of imidacloprid thereby limiting its systemic activity. Nevertheless use of the seed treatment consistently prevented significant yield loss in all canola cultivars. Use of the seed treatment provided a clear benefit in wetter environments where autumn precipitation levels can normally be expected to exceed 270 mm.

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