Disease Management Strategies for Ascochyta Blight of Chickpea.

C. Armstrong-Cho[1], G. Chongo[2], Y. Gan[3], T. Wolf[4], T. Hogg[5] and S. Banniza[1]

[1] Crop Development Centre, University of Saskatchewan, 51 Campus Drive, Saskatoon SK, S7N 5A8
[2] present address, Bayer CropScience , Site 600, Box 117, R.R. #6, Saskatoon SK S7K 3J9
[3] Agriculture and Agri-Food Canada, Semiarid Prairie Agricultural Research Centre, Box 1030 Airport Road, Swift Current, SK, S9H 3X2
[4] Agriculture and Agri-Food Canada, Saskatoon Research Centre, 107 Science Place, Saskatoon SK, S7N 0X2
[5] Canada-Saskatchewan Irrigation Diversification Centre, Prairie Farm Rehabilitation Administration, Agriculture and Agri-Food Canada, Outlook SK, S0L 2N0

Key Words: fungicides, *Ascochyta rabiei*, nozzles, carrier volume

Abstract

Management of chickpea ascochyta blight is a difficult task that requires ongoing attention and utilization of all possible techniques. Starting with clean seed of a resistant cultivar is critical, but even with this sound foundation, fungicide application is often necessary. Optimizing fungicide application strategies in chickpea is essential to protect the crop while simultaneously keeping costs as low as possible. Field experiments showed that early application of fungicide is crucial, and often additional applications were necessary for effective disease management. Of the product sequences tested, those including two strobilurin applications and two other applications during the season gave superior disease control in several cases, but this did not always confer higher yields. Nozzle type had no effect on disease development or yield in any of the field site-years. Similarly in the laboratory study, nozzle types had no effect on the amount of spray coverage or the degree of spray penetration into the crop canopy. A similar laboratory study comparing carrier volumes showed that using a higher carrier volume (>100 L ha^{-1}) improves penetration of a fern leaf-type canopy, but offered no benefit in a unifoliate canopy. In the field, increasing carrier volume did not improve disease control when disease pressure was low to moderate. In some cases under high disease pressure, higher carrier volumes were important for achieving disease control.

Introduction

Ascochyta blight of chickpea (*Cicer arietinum* L.) is a fungal disease caused by *Ascochyta rabiei* (Pass.) Labrousse (teleomorph: *Didymella rabiei* (Kovachevski) Arx.). The pathogen can completely destroy a chickpea crop when weather conditions are favourable for disease development. High inoculum levels and a shift of the fungal population to more aggressive isolates (Vail et al., 2004) has made disease management even more challenging. Some resistance in chickpea varieties to ascochyta blight is available, but at present, disease management is dependent on timely and efficient use of fungicides. Our program has investigated several aspects of fungicide application in order to help producers address the challenges of managing this disease, and to provide information on newly registered products. Field trials were conducted to evaluate various application timings, fungicide products and sequences of different products. The use of appropriate application technology could also aid in effective management of ascochyta blight. Different sizes of spray droplets and different carrier volumes can influence the amount of spray coverage on crop plants (Knoche, 1994), which could in turn influence fungicide efficacy. Laboratory trials were conducted to compare the deposition and penetration of spray in chickpea canopies when applied using a range of nozzle types and carrier volumes. Corresponding field trials were conducted to investigate the effect of different nozzle types and carrier volumes on disease development.

Experimental Work

1. Application Timing

Field experiments were established with kabuli (CDC Yuma, CDC Chico, Amit, or Sanford) and desi (Myles) chickpea varieties from 2002 to 2004. Trials were conducted at Saskatoon and in commercial fields located near Elrose and Zealandia (2002), Dinsmore and Demaine (2003) and Kyle (2004). Due to drought conditions at Elrose and Zealandia in 2002, and at Dinsmore and Demaine in 2003, disease development was absent or extremely low. Moderate disease levels (20-50% in control plots) developed at Saskatoon in 2003. Disease levels in 2004 were moderate in desis, and high (over 50% in control plots) in kabulis at Saskatoon and in producer’s fields at Kyle. Data from Saskatoon in 2002 was not useable due to spray contamination and poor emergence.

The efficacy of different application timings were compared by applying single, double and triple applications of Bravo, and rotations of Headline with Bravo or with Lance applied at pre-, early, mid-, late flower and/or at podding. Results showed that application of either Bravo or Headline at the pre-flower stage significantly reduced disease severity over a wide range of disease pressures. Applying Bravo or Headline later, at early flowering, resulted in significantly more disease that was comparable to disease severity levels observed in untreated check plots (Fig. 1). In some cases, treatments with pre-flower application of fungicide had 20-30% higher yields than treatments where applications commenced at early flower (data not shown). The timing and product used in subsequent applications was of lesser importance, but these additional applications were often necessary for effective disease management. Three applications of fungicide were often more effective than two applications at reducing disease levels and increasing yield.

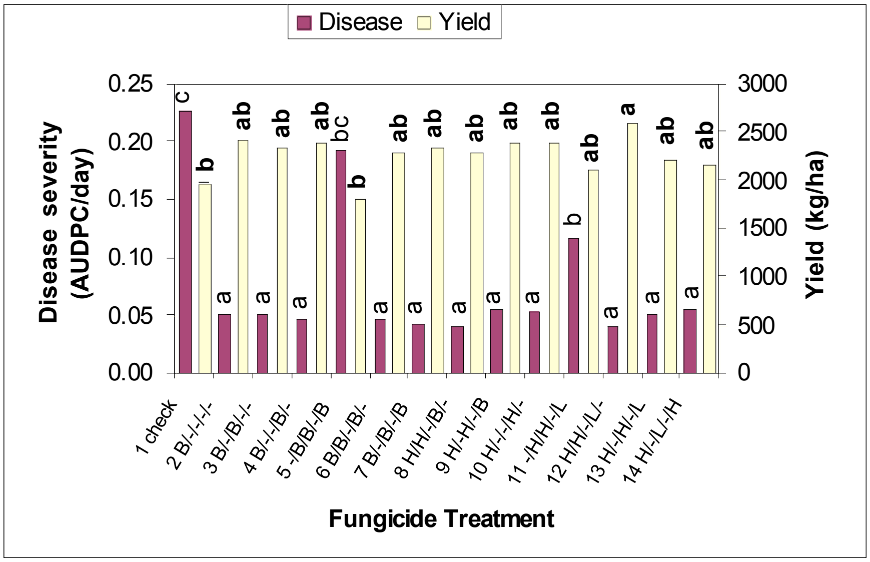

Figure 1. Effect of different fungicide application timing on ascochyta blight severity and yield at moderate disease pressure. 2003 field plots of CDC Yuma (kabuli) chickpea at Saskatoon (44% disease in controls) with Bravo (B), Headline (H) and Lance (L) applied at pre-/early/mid/late flower/podding. AUDPC/day = area under the disease progress curve per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

2. Fungicide Product Sequence

Experiments to determine the most efficacious fungicide sequence compared various combinations of Bravo, Quadris, Bravo/Quadris tank-mix, Dithane DG Rainsheild at low and high rates, Headline, and Lance, applied at seedling, pre-, early-, mid-, or late flower. Dithane is not registered on chickpea in Canada, but was included in the trial because it is used in Australia. Field trials were conducted using both desi (Myles) and kabuli (CDC Yuma) cultivars at Saskatoon and Swift Current from 2002-2004. Disease levels were high at Swift Current in 2002, but in 2003, the Swift Current trial suffered from drought and disease severity very low (<10% in control plots). Moderate disease levels (20-50% in control plots) developed at Saskatoon in 2003. Despite cool conditions during the spring and late summer, disease levels in 2004 were moderate in desis, and high (over 50% in control plots) in kabulis at both sites.

Results from product sequence trials confirmed that application of fungicide at the pre-flower stage was important for good control of ascochyta blight. As in the application timing trial, three applications of fungicide were often more effective than two applications at reducing disease levels and increasing yield.

There were few differences among treatments under low disease pressure. At moderate to high disease pressure, applying Dithane at a low concentration at pre-flower followed by Bravo at early flower and Quadris or Headline at late flower resulted in high disease levels and low yields. The inclusion of two strobilurin applications in the sequence of products had a significant effect on reducing disease levels at moderate disease pressure, and on reducing disease and seed infection at high disease pressure. Although fungicide sequences including two strobilurin applications and two other applications gave superior disease control in several cases, this did not always result in higher yields (Fig. 2). The various treatments including two strobilirin applications gave equivalent results regardless of the timing of the strobilurin applications and the other products used. Calendar application of Dithane at a low rate lead to high seed infection levels under high disease pressure, and was not as effective as using Dithane at a high rate or in combination with Headline under moderate to high disease pressure (data not shown).

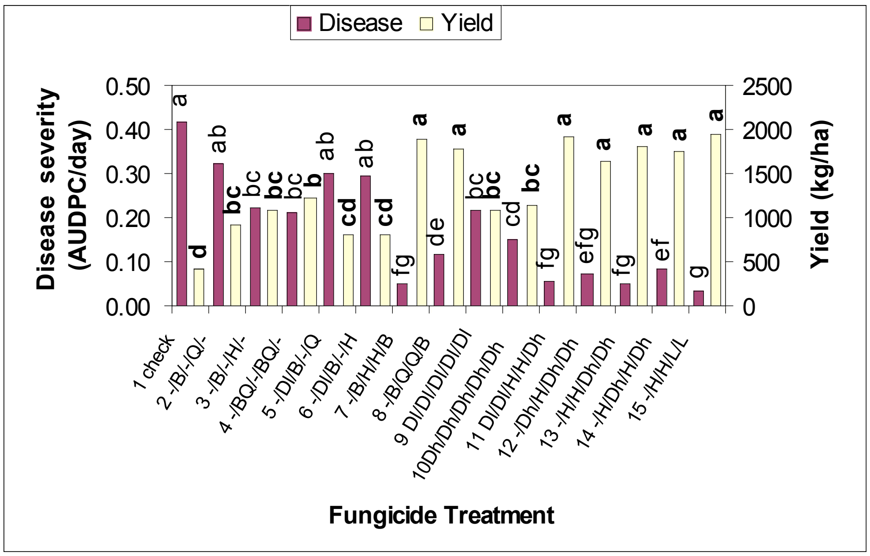

Figure 2. Effect of different fungicide product sequences on ascochyta blight severity and yield at high disease pressure (97% disease in controls). 2002 field plots of CDC Yuma (kabuli) chickpea at Swift Current with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L) applied at seedling stage/pre-/early/mid/late flower. AUDPC/day = area under the disease progress curve per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

3. Nozzle Type

The effect of varying spray droplet size from fine to coarse on disease control was investigated in field trials using three different nozzle types sprayed onto the chickpea cultivars Myles (fern leaf) and Sanford (unifoliate). Nozzles used were a Lurmark Twin Cap delivering a fine spray from two XR8001 tips (‘Twin’), a flat fan nozzle (TeeJet XR8002) delivering medium droplets (‘Standard’), and a Venturi Air Bubble Jet 11002 with course droplet size (‘Venturi’). Fungicides were applied using a carrier volume of 200 L ha^{-1} applied at 275 kPa of pressure.

The field study was conducted at 3 sites (Saskatoon, Outlook and Scott) in 2001 and at Saskatoon and Outlook in 2002 and 2003. In 2001, ascochyta blight levels were very low in most parts of Saskatchewan as a result of severe drought conditions, but disease development was moderate to high in irrigated plots at Outlook. Disease levels were extremely high at both sites in 2002, and ranged from low to high in 2003. Nozzle type, and thus spray droplet size, had no effect on ascochyta blight development (Fig. 3) or yield (data not shown) irrespective of the severity of ascochyta blight and the chickpea cultivar.

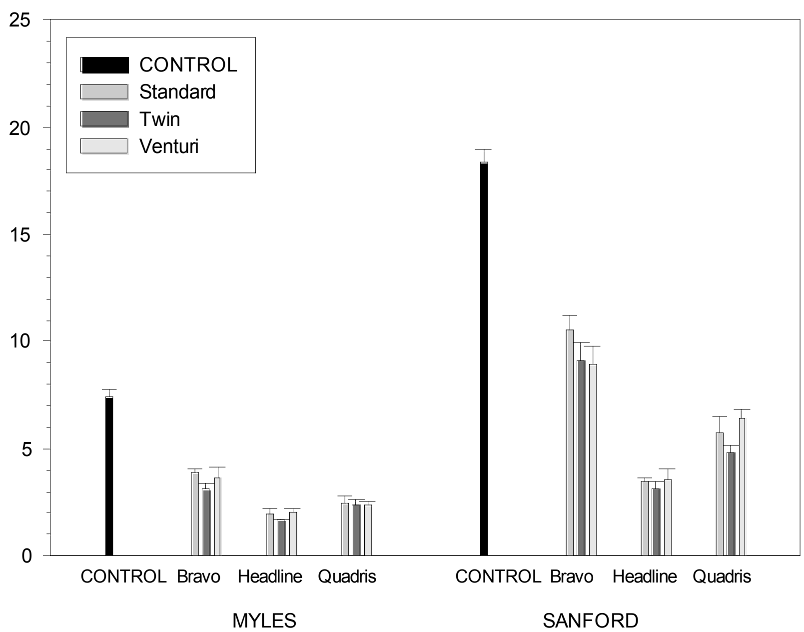

Figure 3. Area Under the Disease Progress Curve (AUDPC) at Saskatoon in 2003 evaluating the effect of three nozzle types used to apply fungicides. Disease severity in control plots reached 45% in Myles and 91% in Sanford.

The three different nozzle types were also used in the laboratory to compare spray deposition patterns and penetration of spray into a simulated crop canopy. Plant canopies with different architectures were simulated by arranging pots of either Myles or Sanford in rows at a typical field density. A track sprayer was used to spray the canopy with a fluorescent dye solution. The amount of dye solution deposited onto different plant parts at different heights in the canopy was determined using fluorescence spectrophotometry. Nozzle types had no effect on the amount of spray coverage or the degree of spray penetration into the crop canopy, irrespective of the canopy architecture of the target plants.

4. Carrier Volume

Field studies were conducted from 2001 to 2003 to compare the efficacy of different carrier volumes (100 L ha^{-1}, 200 L ha^{-1} and 300 L ha^{-1}) for ascochyta control in chickpea. There were two studies conducted, the first of which had several fungicides applied on the fern leaf type kabuli cultivar (cv.)'CDC Yuma' (trial A). The second trial employed one fungicide treatment (Bravo 500 followed by Quadris) applied to the fern type desi cv. 'Myles' and the unifoliate kabuli cv. 'Sanford' to assess the effect of carrier volume on different canopy structures characteristic for the two different leaf types (trial B). Both trials had two applications of fungicide during the season applied with conventional flat fan nozzles (TeeJet XR8002) with medium droplet size. In 2001, trial A was conducted at 6 sites (Saskatoon, Outlook, Scott, Redvers, Indian Head and Swift Current) and trial B was conducted at 4 sites (Saskatoon, Scott, Indian Head, and Swift Current). Two sites were used for both trials in 2002 and 2003 (Saskatoon and Outlook). A range of disease pressures were observed over the three-year period of the field studies. In 2001, ascochyta blight levels were very low in most parts of Saskatchewan as a result of severe drought conditions, but disease development was moderate to high in irrigated plots at Outlook. Disease levels were extremely high at both sites in 2002, and ranged from low to high in 2003.

Carrier volume did not have a significant effect on disease development when disease pressure was low to moderate (data not shown). In cases where disease pressure was high, however, the better fungicide coverage obtained by using higher carrier volumes reduced disease development significantly (Fig. 4). This was primarily observed when increasing the carrier volume from 100 to 200 L whereas a further increase to 300 L only improved disease control and reduced yield loss in some situations. Under high disease pressure, however, two fungicide applications were insufficient to protect the crop, thereby obscuring the effect of carrier volume. An effect of higher carrier volumes in reducing disease development was only observable in some cases where the more resistant cultivar Myles and systemic fungicides were used. The effect of higher carrier volumes on yield could not be observed, since very high disease levels resulted in significant yield losses. Due to the high susceptibility of the unifoliate cultivar Sanford, and the inability of two fungicide applications to manage the disease in several site-years, we were unable to evaluate the effect of increasing carrier volume in a unifoliate versus a fern-leaf chickpea canopy.

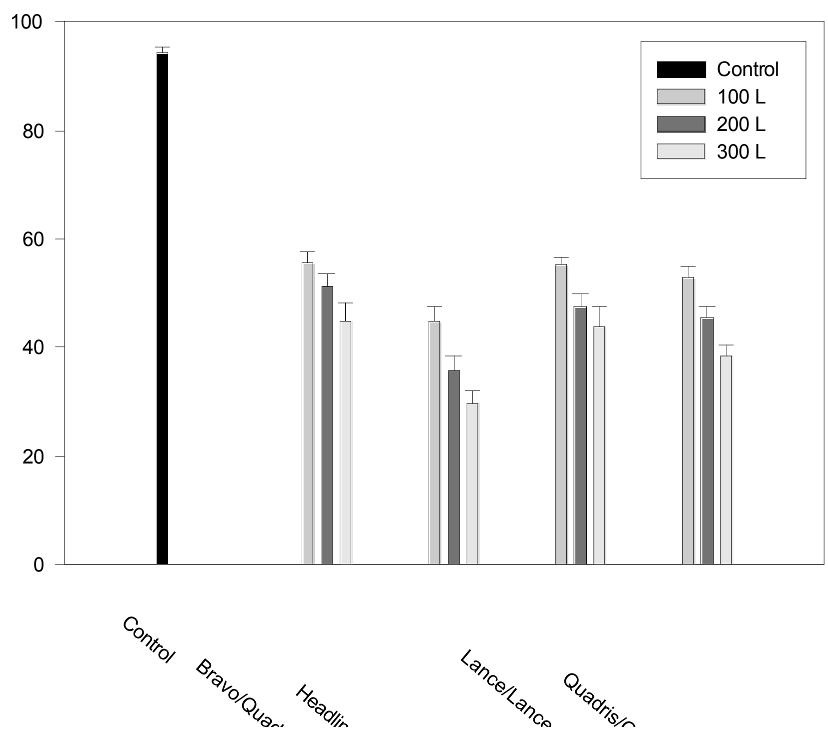

Figure 4. Ascochyta blight severity on the kabuli cultivar CDC Yuma sprayed with various fungicide products at three carrier volumes (L ha^{-1}) at Saskatoon and Outlook in 2002.

The three carrier volumes were also evaluated in a laboratory study by examining the deposition of spray solution in fern leaf and unifoliate chickpea canopies as described above. The laboratory study showed that using a higher carrier volume (>100 L ha^{-1}) improves penetration of a fern leaf-type canopy, but offered no benefit in a unifoliate canopy.

Conclusions

The full range of disease management techniques are required for growing a successful chickpea crop. Clean seed of resistant varieties and carefully planned crop rotation is very important. Producers need to continue to be diligent in checking their chickpea crops for early signs of disease. Early control of the disease at the pre-flower stage with fungicides, regardless of follow-up applications, is crucial for success under a range of disease pressures. In these studies, the use of two strobilurin products in a sequence of four applications was effective at reducing disease levels at moderate disease pressure, and reducing disease and seed infection at high disease pressure. Although these fungicide sequences gave superior disease control in several cases, this did not always result in higher yields. The use of different nozzle types to create different sizes of spray droplets had no effect on disease development in the field, and had no effect on deposition and penetration of spray in indoor studies. An increase from 100 L ha^{-1} to 200 L ha^{-1} carrier volume can significantly improve ascochyta blight control in chickpea, and will ensure the highest efficacy of fungicides applied in this crop.

Acknowledgments

We are grateful to Cal McDonald, Gerry Stuber, Teri Ife, Brian Caldwell, Guy Lafond, Eric Johnson and their crews for their work on these trials. Cooperation of producers Brad McDonald, Doug McDonald, Jim Winny, Darren Hopkins, Lloyd Affleck, Shaun Dyrland and Aaron Beattie was critical for completion of the application timing trials. Thank you to Scott Ife, Megan England, Mark Thompson, Firew Seyoum, Patrick Thomson, Allan MacDonald, Clint Ringdal, and Don David. We also acknowledge support from BASF, Syngenta, and Bayer Cropscience. Funding provided by the Agriculture Development Fund and Saskatchewan Pulse Growers is gratefully acknowledged.

References

Knoche, M., 1994. Effect of droplet size and carrier volume on performance of foliage-applied herbicides. Crop Prot. 13,163-178.

Vail, S., Chongo, G., and Banniza, S. 2004. Pathogenic variability of *Ascochyta rabiei* populations on chickpea in Saskatchewan. Can. J. Plant Pathol. 26(2): 229 (Abstr.).