Field isolates of *Leptosphaeria maculans* from Western Australia overcome a single dominant resistance gene in *Brassica napus* cv. *Surpass 400*

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Abstract

In 2001, in experimental field rows of cultivar (cv.) *Surpass 400* at Mount Barker in Western Australia, a small proportion of the lower stem lesions observed were ‘typical’ of those observed in susceptible cultivars but containing fewer pycnidia. Approximately 80% of isolates obtained from those plants with stem lesions showing pycnidia induced a hypersensitive response on cv. *Surpass 400* cotyledons. The remaining 20% of isolates developed characteristic disease lesions with pycnidia on cv. *Surpass 400* cotyledons. These isolates were able to infect cv. *Surpass 400* such that characteristic blackleg cotyledon necrotic lesions and crown cankers in the field with pycnidia developed, confirming the ability of these isolates to overcome the single dominant resistance gene present in cv. *Surpass 400*.

Keywords: Blackleg disease, canola, oilseed, resistance breakdown

Introduction

The cultivar (cv.) *Surpass 400* was released Australia-wide in 2000 as the most resistant cultivar to *L. maculans*. The resistance gene in this cultivar originated from *B. rapa* ssp. *sylvestris* (Crouch *et al.* 1994). Normally, inoculated plants of cv. *Surpass 400* display a typical resistant hypersensitive reaction characterised by small dark brown necrotic local lesions on the cotyledons, leaves and stems. Resistance to *L. maculans* in cv. *Surpass 400* is considered to be controlled by a single dominant gene (Li and Cowling 2003).

Breakdown of resistance determined by a single dominant gene has been reported in various crop-pathogen relationships. Some aggressive isolates of *L. maculans* have been shown to overcome the single dominant gene resistance of *B. juncea* (Purwantara *et al.* 1998). There is also circumstantial evidence for the loss of field polygenic resistance to blackleg in Australian canola varieties after some years in cultivation (Salisbury and Ballinger 1993).

This investigation aimed to determine the pathogenicity of isolates of *L. maculans* from cv. *Surpass 400* and other older isolates, initially on cultivars *Surpass 400* and *Westar*, then on a wider range of canola cultivars.

Materials and methods

Fresh cv. *Surpass 400* residues with crown lesions were obtained from fully mature plants at Mt Barker in 2001. Isolates were obtained from plants with crown lesions that contained pycnidia and were compared with two older isolates.

In an initial experiment, plants of cv. *Surpass 400* and highly susceptible cv. *Westar* were used. Fifteen seeds of each cultivar were sown in 14 × 9 × 5 cm pots in a phytotron room with plants watered daily to field capacity. Seven-day old seedlings were thinned out to 10 plants per pot and inoculated with 1 × 10\(^6\) per mL of spore suspension using a hand sprayer. Cotyledon disease severity was scored on a 0–9 scale 14 days after inoculation.

For a subsequent experiment, three isolates from cv. *Surpass 400* were selected based on their ability to attack cv. *Surpass 400* cotyledons in the initial experiment described above. Two older isolates were also used as a comparison to the virulence of these cv. *Surpass 400* isolates. Seeds were sown as described above. Droplets of 1 × 10\(^6\) spore suspension were deposited on cotyledons of 7-day old seedlings and the inoculated plants placed in a growth room as in the initial experiment. Cotyledon disease severity was scored as in the initial experiment. Seedlings were transplanted into the field to allow the disease to develop under natural conditions.
conditions. Two weeks before harvest, the extent of both external and internal crown canker development was assessed on a 0–5 scale using the method of Ballinger and Salisbury (1996), where scores of 0, 1, 2, 3, 4, respectively, represent 0, 1–25, 26–50, 51–75, 76–100% of the crown cross-section infected and showing typical brown/black discoloration. A score of 5 indicated the plant had died prior to assessment from severe crown canker development.

Data from both experiments was analysed using ANOVA with Genstat.

Results

In the initial experiment, all isolates caused severe cotyledon disease symptoms on the susceptible cv. Westar. Approximately 80% of the isolates from cv. Surpass 400 and older comparison isolates induced a hypersensitive response on cv. Surpass 400 cotyledons. However, the remaining 20% of isolates from cv. Surpass 400 developed characteristic disease lesions with pycnidia on cv. Surpass 400 cotyledons.

In the second experiment, virulence of isolates from cv. Surpass 400 was significant on a range of B. napus cultivars, both on cotyledons and on the stems. Cultivar Westar showed a susceptible response to all the isolates and developed extensive cotyledon tissue collapse and severe crown cankers. Cultivar Surpass 400 showed a hypersensitive reaction on cotyledons and stems (including crown region) to the two older isolates. However cv. Surpass 400 showed characteristic blackleg cotyledon lesions and crown cankers to the new virulent isolates taken from cv. Surpass 400.

Discussion

Cultivar Surpass 400 was released in Australia in 2000 as the most resistant cultivar to L. maculans, and typically still shows outstanding resistance in the field. On cotyledons, this cultivar shows a hypersensitive response to infection, which is considered to be controlled by a single dominant gene (Li and Cowling 2003). However, under the conditions of our study, some isolates obtained from mature plants of cv. Surpass 400 failed to induce the hypersensitive response normally accompanying infection with L. maculans isolates, instead forming typical cotyledon lesions and crown cankers containing pycnidia characteristic of a susceptible disease reaction. It is clear that these isolates have overcome the dominant gene resistance previously displayed by this cultivar.

These strains of L. maculans capable of overcoming a single dominant gene were obtained in the field in Western Australia approximately one year after commercial release of cv. Surpass 400. There are similarities to the breakdown of single dominant gene resistance blackleg disease in France, where a field experiment showed that the resistance in lines carrying single dominant gene resistance broke down after only three years (that is, two selection cycles of L. maculans populations on stem residues). Both their and our results are cause for concern as larger areas of cultivars having a single dominant resistant gene are being sown throughout Australia. It remains to be seen if the resistance-breaking isolates in Australia have sufficient fitness to compete in the general L. maculans population, but experience in France suggests that this is highly likely.

In conclusion, our study suggests the need to re-evaluate widespread reliance in Australia towards the deployment of single dominant gene-based resistance to blackleg.

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References


