Blackspot Survival in Soil and Stubble and Aerial Dissemination through the Season

D.M. Peck [1], G.K.McDonald[1] and J.A. Davidson[2]

[1]Department of Plant Science, Adelaide University, Glen Osmond SA.
[2]South Australian Research and Development Institute, Adelaide, SA.

Abstract

The amount of blackspot surviving on stubble and in soil in a long-term rotation trial at Turretfield, SA was determined over 4 consecutive seasons using a seedling bioassay. Infection from stubble was initially high but dropped to low levels after one year, while infection from soil inoculum declined slowly over 3 years. Hence soil-borne blackspot pathogens are an effective inoculum source for a longer period than stubble inoculum. Aerial inoculum was monitored over three seasons using 'trap' plants of 2-week old seedlings cv. Alma placed in the field at weekly intervals. The amount of inoculum varied greatly between years and sites, but in each season the aerial inoculum diminished rapidly after 70-80 mm of rainfall had been recorded. If this finding is reproducible across a range of sites it will aid in time of sowing decisions.

KEY WORDS

Mycosphaerella pinodes, Phoma medicaginis var. pinodella, inoculum, Pisum sativum, time of sowing.

Introduction

Field peas are the major pulse crop in South Australia, but between 1983 and 1995 pea yields declined in many areas of South Australia (6). The fungal disease blackspot (*Mycosphaerella pinodes* and *Phoma medicaginis* var. *pinodella*) has been identified as a probable major contributor to the yield decline syndrome (3). It is the major disease of field peas in Australia and causes ongoing yield losses (2,3,8). Blackspot survives between successive pea crops on infected pea stubble and in soil for a number of years (1,10). Ascospores are released from stubble with opening rains and disseminate with rainfall splash and wind (1,5). With successive rainfall events the amount of aerial inoculum diminishes. Soil-borne spores are also splashed onto plants during rainfall, or the pathogens may infect the base of the stem causing foot rot (5).

Blackspot infection can be reduced if pea crops are sown after the initial peak of aerial inoculum has diminished (1,3,4). However, any potential yield benefits from reduced disease can be lost if sowing is postponed for too long since flowering and grain filling may be delayed until the hotter drier months (4,7). The amount of aerial inoculum was monitored over 3 years to identify the timing of the initial inoculum peak to assist with recommendations for sowing dates for peas.

The ability of the blackspot pathogens to survive for several years in soils has lead to the recommendation that rotation intervals between pea crops should be increased to enable time for the soil pathogen populations to degrade. The recommended break ranges from 3 to 6 years. In 1996, we established a pea rotation trial to determine the effects of 3, 4 or 5-year rotation cycles on survival of pathogens, infection and yield of a following pea crop. The cycle will be completed in 2001. From 1997 we have used a bioassay technique to monitor the survival of blackspot in soil and stubble in this trial.

Materials and Methods

A rotation trial was established in 1996 at Turretfield, South Australia (45 kms north of Adelaide) in which peas are to be grown every 3, 4 or 5 years. For the initial pea crop in each rotation, blackspot inoculum was introduced via infected barley seeds (9). Disease-free plots were also established with regular spraying of fungicide (2 l/ha Bravo and 0.5 l/ha Bavistin). At the end of each season all treatments were split for stubble management; pea stubble was either left *in situ* or raked off.

‘Trap’ plants were used to monitor the amount of aerial blackspot inoculum at the field site from April to November for 1998 and 1999 and from April to September in 2000. A pot of twelve 2-week-old pea-seedlings (cv. Alma) were placed in each corner of the pea rotation trial each week. After 1 week the potted seedlings were returned to the glasshouse and were replaced in the field with a new set. A second site at Charlick Research Farm (50 kms south of Adelaide) was similarly monitored in 1998 from May until November. Trays containing twenty trap-plants were placed either adjacent or 400metres from last years pea stubble. The trays were replaced each week by a new set of seedlings. After 14 days incubation in the glasshouse the number of blackspot lesions on each leaf was counted. Temperature, rainfall and solar radiation were recorded and related to the amount of blackspot lesions.

Soil (0-10 cm) and stubble samples were collected in the autumn of each year from every treatment in the rotation trial. A seedling bioassay was used to determine the amount of blackspot inoculum present in these samples. Pots (12.5cm) were half filled with sterilised potting mix and then topped up with either soil from the plots (soil bioassay), or with a mixture of potting mix and stubble (stubble bioassay). Four pots of four plants cv. Alma were used for each field plot sampled. After four weeks growth the total length of lesions on the basal stem was recorded. The lesions were plated onto quarter strength PDA to confirm the presence of blackspot pathogens.

Results

Blackspot lesions developed on the ‘trap’ plants in weeks that rainfall was recorded. The number of lesions varied from year to year. Two distinct peaks of inoculum were recorded; an initial peak in autumn and a second peak in spring (Fig 1). Following the initial autumn peak the incidence of blackspot lesions was low despite regular rainfall events. The date by which the initial peak was exhausted varied from the second week of May to the first week of July (Figs. 1&2), however the inoculum was exhausted after 70-80 mm of rainfall was recorded from 1 April (Fig. 3). The timing of the spring peak varied from September through to November (Fig. 1) and was extremely late at Charlick where only a small rise in lesions was detected in November (Fig. 2). The seedlings placed 400m away from the pea stubble had approximately half the infection of the seedlings immediately adjacent to the stubble (Fig. 2).

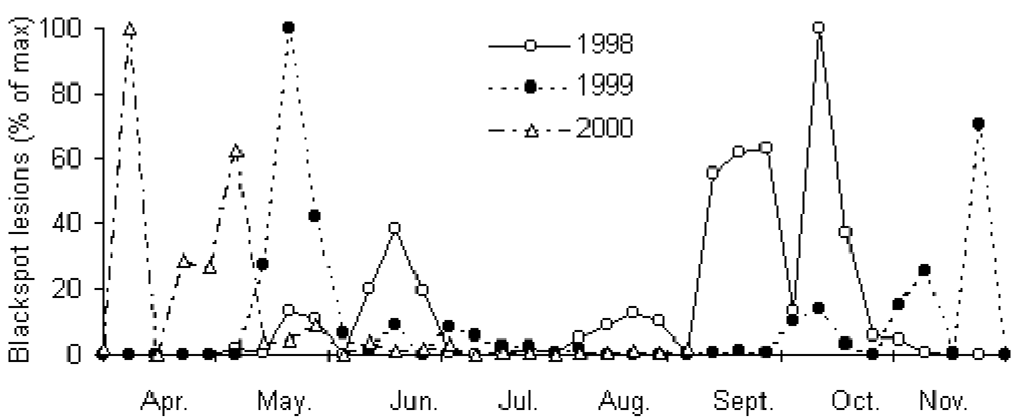

Figure 1. Number of blackspot lesions on ‘trap’ pea plants placed at Turretfield for 1 week from April to November. Each year is plotted as a percentage of the maximum number recorded in one week. Maximum number was 120, 390 and 1260 lesions for 1998, 1999 and 2000 respectively.

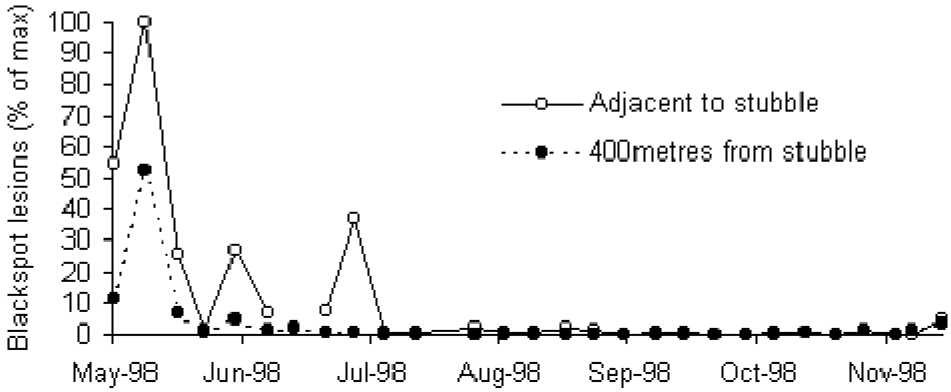

Figure 2. Number of blackspot lesions on ‘trap’ pea plants placed at Charlick 1998 for 1 week from May to November. Seedlings were placed adjacent to stubble or 400m away from stubble. Each line is plotted as the percentage of the maximum number recorded in one week. Maximum numbers were 123 and 65 lesions for adjacent to stubble and 400m away respectively.

Pea stubble from the rotation trial infected a high number of pea seedlings with blackspot in the first year after a pea crop (Fig. 4). Two years after a pea crop the number of plants colonised with blackspot from pea stubble was low. The survival of blackspot in soil (Fig. 5) was greater, and significant levels of infection occurred from soil in which peas had been grown 3 and 4 years previously. The amount of blackspot resulting from soil collected in 2000 is lower than previous years, even in samples that had grown a pea crop in 1999.

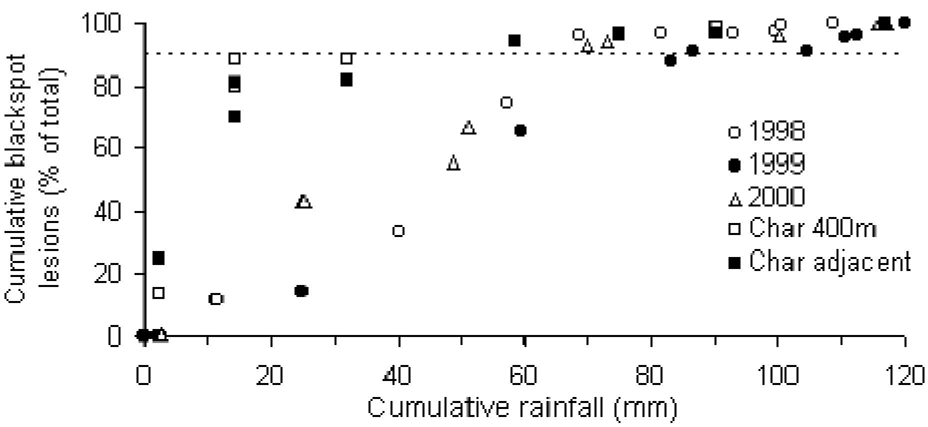

Figure 3. Relationship between rainfall and cumulative blackspot lesions (percent of total) for first 120mm of rainfall from 1 April

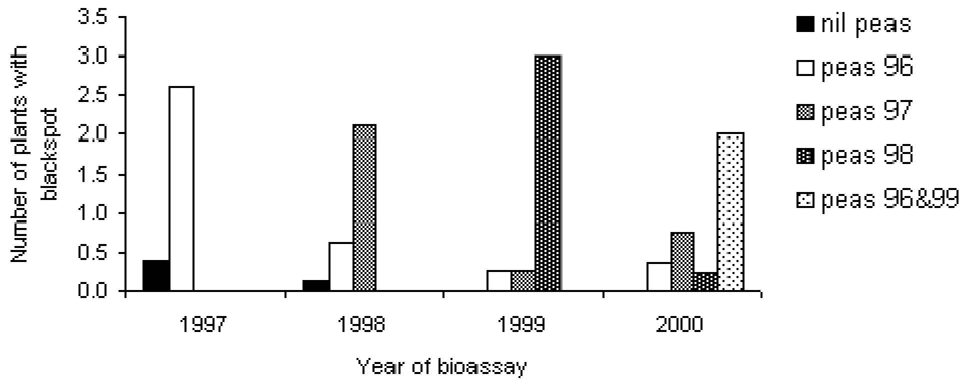

Figure 4. Number of plants out of 4 colonised with blackspot in bioassay of stubble samples taken in autumn 1997-2000 from a pea/cereals rotation trial

Figure 5. Number of plants out of 4 colonised with blackspot in bioassay of soil samples taken in autumn 1997, 1998 and 2000 from a pea/cereals rotation trial

DISCUSSION

There are 2 distinct peaks in aerial inoculum of blackspot, one in late autumn to early winter from pea stubble and the second in spring from the current pea crop. The low levels of aerial blackspot inoculum that occurred in winter supports previous findings (1,3,4) that delaying sowing of peas past autumn reduces blackspot infection. The date by which the initial peak of inoculum had passed varied from second week of May to first week of July. However, over 3 years at Turretfield with different aerial blackspot pressure, 90% of inoculum was dispersed when 70- 80 mm of rainfall had fallen. At Charlick the exhaustion of the inoculum occurred at a faster rate and very few spores were released after 30 mm of rain. The effect of April-June rainfall on spore release was consistent from year to year. This suggests that growers can reduce blackspot risk by planting peas after receiving 70- 80 mm of rainfall rather than planting to a sowing date. In seasons with an early break, growers could sow earlier and avoid the risk of lower yields associated with spring drought. This rainfall result needs to be validated at a wide range of sites and seasons before it can be recommended to growers.

The second peak of spore release in spring varies between sites and seasons and was not detected at Charlick in 1998. It is likely that this peak is related to the senescence of the pea crop, which encourages production of ascospores (5). Continued monitoring into December may have detected this second peak at Charlick.

Proximity to pea stubbles was found to be an important factor in the disease incidence. When seedlings were placed immediately adjacent to pea stubble at Charlick the incidence of blackspot lesions was double that of seedlings placed 400m away. The number of lesions recorded in the trap plants at Turretfield in 2000 was much higher than in previous years. In 2000 the stubble from a commercial pea crop was closer than in previous years. This supports other recommendations to avoid sowing pea crops adjacent to last season's pea stubble.

This study indicates that 1-year-old pea stubble is an important source of inoculum, pathogens survive in the soil for a longer period. The soil blackspot levels decline slowly with time, which indicates that long rotations are needed to reduce blackspot levels in subsequent pea crops. When the fieldwork is completed in 2001, we will have a measure on how much blackspot occurs in the soil 3, 4 and 5 years after a pea crop and it’s effect on blackspot epidemics and yield in subsequent pea crops.

CONCLUSIONS

Blackspot survives long term in soil while stubble is an effective source of inoculum at the end of the first fallow. Results from our site indicate that 90% of initial aerial inoculum is used up when 70 – 80 mm of rainfall has been recorded after 1 April.

ACKNOWLEDGMENTS

The work was funded by Grains Research and Development Corporation and South Australian Grains Industry Trust Fund.

References

1. Bretag, T.W. 1991 PhD thesis University La Trobe, Victoria, Australia.

2. Bretag T.W., Price T.V., and Keane P.J. 1995. *Aust. J. Exp. Ag* **35**,531-536

3. Davidson, J.A. and Ramsey, M.D. 2000. *Aust. J. Agric. Res*. **51**, 347-354.

4. Heenan D.P. 1994. *Aust. J. Exp. Ag*. **34**, 1137-1142

5. Lawyer A.S. 1985. In: Compendium of Pea Diseases (Ed. D.J. Hagedorn) (The American Phtopathology Society, St Paul, Minnesota) pp 11-15

6. Peck, D. M. and McDonald, G.K. 1998. *Proceedings 9th Australian Agronomy Conference*. Wagga Wagga, 531-532.

7. Ridge P.E. and Pye D.L. 1985. *Field Crop Res*. **12**,339-346

8. Siddique K.H.M. and Sykes J. 1997. *Aust. J. Exp. Ag* **37**, 103-111

9. Tivoli, B., Bees, C., Lemarchand, E. and Masson, E. (1996). *Annals of Applied Biology* **129**, 207-216.

10. Wallen V.R., Wong S.I. and Jeun J. 1967. *Can. J. Bot*. **45**, 2243-2247