Changes in Distribution of A-Group and B-Group *Leptosphaeria maculans* (Stem Canker)

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INTRODUCTION

Populations of *L. maculans*, causing stem canker (blackleg), can be divided into at least two main groups, which have been described by a number of terms, including A-group and B-group (Johnson & Lewis, 1994; Williams & Fitt, 1999). However, the most serious stem base canker is associated with A-group; therefore, the A-group is considered more damaging than the B-group (Johnson & Lewis, 1994). The distribution of the two groups of *L. maculans* differs between geographical locations (Fig. 1). In Australia, the A-group is the predominant group (Ballinger & Salisbury, 1996). However, in Poland, the B-group is the main group (Jedryczka *et al*., 2000). In China, only the B-group has been identified to date (West *et al*., 2000). In Western Europe, both A-group and B-group are present (West *et al*., 2001). Recently, A-group *L. maculans* has spread into Mexico and caused 70% yield loss in cauliflower production (Moreno-Rico *et al*., 2002). In Canada, with the increase in area of oilseed rape grown, the proportion of the A-group *L. maculans* has gradually increased in western Canada in the last decade (West *et al*., 2001). In Poland, where B-group is predominant, the proportion of the A-group has been increasing recently (Jedryczka *et al*., 2000).

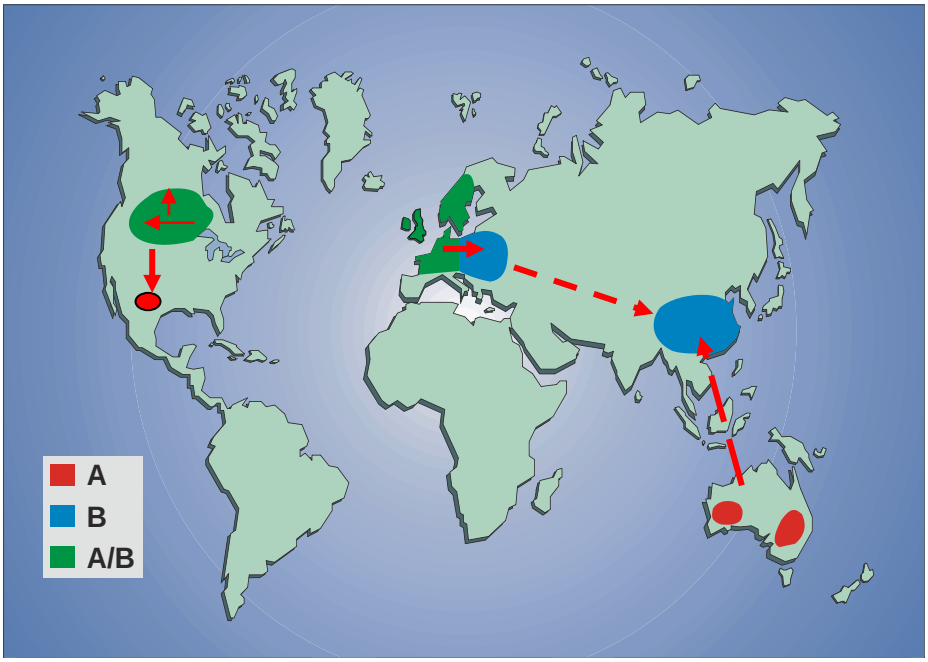

Fig. 1 Worldwide distribution of A-group and B-group *Leptosphaeria maculans* (solid arrows showing the direction of spread of A-group; dotted arrows showing the direction of potential spread of A-group *L. maculans*).

The distribution of the two groups not only differs between regions but also differs between seasons and between different positions on the oilseed rape stem. In France, the proportion of A-group isolates collected in the autumn was greater than that at harvest (Penaud *et al*., 1999). In Germany and the UK, A-group isolates were obtained predominantly from stem bases and a greater proportion of B-group isolates was obtained from upper stem lesions (Thürwächter *et al*., 1999; West *et al*., 2002). In the UK, both A-group and B-group *L. maculans* are present, but the A-group is more damaging than the B-group. To control the disease effectively, there is a need to study the changes in proportions of A-group and B-group isolates, both within and between seasons.

MATERIALS AND METHODS

Seasonal changes in proportions of A-group and B-group *L. maculans* in winter oilseed rape crops and on their debris were investigated in 1999/2000, 2000/2001 and 2001/2002 experiments without fungicide treatments at Rothamsted, southern England. During the growing seasons, changes in proportions of A-group and B-group were investigated by visual assessments of leaf lesion appearance (large pale lesions with abundant pycnidia were classified as A-group and small dark lesions with few or no pycnidia as B-group) and by isolation from leaf lesions, stem base cankers (both cortex and pith) and upper stem lesions. After harvest, changes in proportions of A-group and B-group *L. maculans* on oilseed rape debris were examined by growth of cultures from ascospores that were ejected from pseudothecia on stem base and upper stem debris at different times in the three seasons. Single ascospore isolations were done from naturally infected oilseed rape debris collected from Poland and China from 1999 to 2001.

RESULTS

Changes in proportions of A-group and B-group infections on leaves

The ratio of B-group to A-group infections on leaves differed between months of sampling ($P < 0.001$) and between seasons ($P < 0.001$). In the autumn/winter of both 1999/2000 and 2000/2001, most (75%) leaf lesions assessed were classified as A-group. In 2001/2002, the proportion of B-group lesions was higher than that in the two previous seasons. In October 2001, 48% of lesions were classified as B-group, compared with 23% of lesions classified as B-group in October and November 2000. In 1999/2000 and 2000/2001, 213 out of 220 large pale lesions produced A-group colonies and 157 out of 184 small dark lesions produced B-group colonies. The correlation between the classification by visual symptoms and that obtained by isolation from leaf lesions was better for A-group than for B-group *L. maculans*. Both large pale lesions and small dark lesions occasionally produced both A-group and B-group *L. maculans* isolates.

Changes in proportions of A-group and B-group mycelium on stem base and upper stem tissues

In 1999/2000 and 2000/2001, there were differences in the ratio of B-group to A-group isolates obtained between stem bases and upper stems ($P < 0.05$, 11df), but not

between seasons or months of isolation. There were considerably more A-group than B-group isolates obtained from the stem bases in both seasons, but the proportion of B-group isolates was larger in 2001 (35%) than in 2000 (26%). In both 2000 and 2001, the proportions of B-group isolates obtained from upper stem tissues (40-60%) were much greater than at the stem base (20-25%), although the numbers of isolates obtained were smaller. When isolations were made from tissues across the stem base, A-group isolates were obtained from samples taken from the cortex (71%) and pith (91%), while B-group isolates were rarely obtained from pith tissues (9%), but were more frequently isolated from the cortex (29%). B-group isolates were more frequently isolated from symptomless stem tissue (74%) 10 cm above ground.

Changes in proportions of ascospores of A-group and B-group *L. maculans* obtained from oilseed rape debris

The ratio of B-group to A-group isolates obtained from ascospores differed between stem bases and upper stems ($P < 0.001$), between seasons ($P < 0.001$) and between months of isolation ($P < 0.001$). In the three seasons, the proportions of B-group ascospores released from stem base pieces was generally <10% (and sometimes 0%) and there was no evidence that this proportion changed with time during the autumn/winter period (October to March). However, the proportion of B-group ascospores released from upper stem pieces increased with time and was generally >50% from November onwards. In most cases, all the single ascospore cultures obtained from a single stem piece (0.5 × 1.0 × 0.5 cm) belonged to the same group. Of 372 stem base and upper stem pieces, only 6.5% produced both A-group and B-group ascospore isolates. All single ascospore cultures obtained from oilseed rape debris collected from China were B-group *L. maculans*. The majority (98%) of single ascospore isolates obtained from oilseed rape debris collected from Poland belonged to the B-group, only two stems out of 150 produced A-group isolates.

DISCUSSION

Results of the three experiments have shown that relative proportions of A-group and B-group *L. maculans* change, both on winter oilseed rape crops during their growing season (parasitic growth) and on stem debris after harvest during saprophytic growth (survival, reproductive phase). After harvest, B-group colonised upper stems more effectively and more B-group isolates were obtained from upper stem debris (West *et al*., 2002), suggesting that B-group may be a more effective saprophyte than A-group *L. maculans*. During the growing season, the differences between stem bases and upper stems in proportions of the two groups isolated reflect the relative economic importance of the two groups in Europe (West *et al*., 2001). Previous studies suggest that stem base cankers, rather than stem lesions, are associated with the greatest yield losses from phoma stem canker (Zhou *et al*., 1999). More A-group than B-group *L. maculans* isolates were obtained from the pith tissues of green stems, suggesting that the A-group can penetrate living stem base tissues more effectively than the B-group. This may be one reason why A-group is more damaging than B-group *L. maculans* (Johnson & Lewis, 1994).

These results suggest that for effective control of severe stem canker epidemics globally there is a need to prevent the spread of A-group *L. maculans* to new areas in the world (Fig. 1). In China, the biggest oilseed rape producer in the world, only the B-group has been identified (West *et al*., 2000). However, there is the potential for the

A-group to spread into China with the increasing world trade. Concerning the cases in Mexico, Canada and Poland, it is necessary to develop strategies to prevent the A-group from spreading into areas where it is not already present.

AKNOWLEDGEMENTS

We thank the Perry Foundation, UK Department of the Environment, Food and Rural Affairs, Biotechnology and Biological Sciences Research Council and the China Scholarship Council for supporting the work. We thank M Jedryczka for supplying oilseed rape debris from Poland.

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