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Status of *Ascochyta rabiei* of chickpea in the Mediterranean basin

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SUMMARY - *Ascochyta rabiei* (Pass.) Lab. is one of the most important pathogens of *Cicer arietinum* L. in most Mediterranean areas, where it can cause extremely severe yield losses, particularly when chickpeas are winter-sown. The fungus survives on seeds and on plant debris and its the perfect state on overwintered chickpea straw has been reported. *A. rabiei* shows a fairly high degree of morphologic and pathologic variability. Since 1963, observations on the behaviour of chickpea varieties, both in field and under controlled environmental conditions with artificial inoculations, have shown the existence of physiologic specialization. In Syria, Lebanon and Italy six races were identified. Race 6, to which all the differentials are susceptible, seems to be rather common. International cooperation is needed to define a suitable set of differential varieties and to standardize the testing techniques. Surveys on the race situation and distribution in the major growing areas of chickpeas in the Mediterranean countries should be intensified. On these bases breeding programmes for resistance could achieve reliable results. Seed multiplication schemes including seed-health testing are strongly recommended in order to prevent the spread of ascochyta blight.

RESUME - *"Aschochyta rabiei du pois chiche dans le bassin méditerranéen"*. Aschochyta rabiei *(Pass.) Lab. est l'un des plus importants pathogènes du pois chiche* (Cicer arietinum *L.) dans la plus grande partie des zones méditerranéennes interessées par la culture, où il peut provoquer de très graves dégâts surtout en semis d'hiver. Le champignon peut survivre sur les graines et sur les résidus de culture. Sur ces derniers la forme parfaite peut apparaître si les conditions climatiques sont favorables.* A. rabiei *montre un degré élevé de variabilité morphologique et pathologique. Des observations, conduites à partir de 1963, sur le comportement de plusieurs variétés au champ ou en conditions contrôlées, ont montré l'existence d'une spécialisation pathologique. En Syrie, au Liban et en Italie, 6 races ont été identifiées. La race 6, capable d'attaquer toutes les variétés différentielles, semble être la plus fréquente. La coopération internationale est indispensable pour établir une série de variétés différentielles communes et standardiser les techniques des essais. Pour prévenir la diffusion de la maladie provoquée par* A. rabiei, *des programmes de production de semence comprenant l'analyse sanitaire des graines sont à recommander.*

Introduction

The results obtained in winter sowing trials in several Mediterranean countries have shown that, at least in the low or medium elevation areas, chickpea (*Cicer arietinum* L.) can give satisfactory yields because the plant can make a better use of soil moisture, compared to the traditionally more common spring sowing (Saxena, 1984). The drawback of winter sowing is the increased risk of more severe epiphytotics of ascochyta blight (Hawtin and Singh, 1984). Thus, the shift to early sowing dates implies the availability of varieties resistant to ascochyta blight. One of the prerequisites to breeding for durable resistance is the good knowledge of the causal agent, particularly in what concerns its pathological specialization.

The purpose of this paper is to deal with the situation in the Mediterranean area, define the current knowledge of ascochyta blight, and to stress the need for further international cooperation in this field.

The causal agent

Ascochyta rabiei (Pass.) Labrousse is the most frequently used name for the causal agent of ascochyta blight although some workers do not agree (Khune and Kapoor, 1980). The debate is mostly based on the low percentage of bicellular picnidiospores produced by the fungus. The more frequent reports on the existence of the perfect state of the fungus, *Mycosphaerella rabiei* (Pass.) Kovachevski, first observed in Bulgaria, will probably impose a larger use of the name of the teleomorph in the near future, in agreement with the rules of the international botanical code. The name of the anamorph is nevertheless still used by such an authoritative source as the Commonwealth Mycological Institute and will be used throughout this paper.

In the Mediterranean region, the perfect state of the pathogen was observed in Greece (Zachos *et al.*, 1963), in Syria (Haware, 1987) and in Spain (Jimenez-Diaz *et al.*, 1987). According to Trapero-Casas and Kaiser (1987), production of mature ascospores by perithecia formed on overwintering plant debris can take place even under mild temperature (up to 15 °C. The role of the teleomorph in the epidemiology needs to be intensively studied as also its contribution to the morphologic and pathologic variability of the fungus through recombination.

The presence of the pathogen has been reported from Portugal across most Mediterranean areas eastwards to the Indian subcontinent. Within the Mediterranean basin and the close surroundings the following countries are concerned: Algeria, Bulgaria, Cyprus, Egypt, France, Greece, Iraq, Jordan, Italy, Israel, Lebanon, Morocco, Spain, Syria, Tunisia and Turkey. Some other reports concern scattered areas in all the continents including Australia (CMI, 1986; Nene and Reddy, 1987).

A. rabiei overwinters in plant debris at the soil surface or beneath the top soil layer (a few centimeters) and on seeds. The latter is probably the most efficient way of survival and spread (Haware *et al.*, 1986). In Italy, the author observed particularly severe outbreaks of ascochyta blight in experimental plots where chickpea had not been cultivated for decades before. The plots were also situated far away from any chickpea field, so that contaminated seeds were the only possible source of inoculum.

The disease

A. rabiei attacks all the above ground parts of the host. Early infections, mostly from contaminated seeds, can cause damping-off of the seedlings. The fungus causes necrotic spots on leaves leading to more or less severe defoliation. Under most Mediterranean climatic conditions, however, the most devastating symptoms occur on stem and branches comprising elongated brownish lesions, often becoming necrotic, and girdling. In the latter case the parts above the lesions wilt and breaking of stem or branches follows.

Infections on pods occur frequently. Through the pod wall, infection or contamination of seeds can result. Seeds, however, can also be contaminated during threshing.

Under favourable climatic conditions, picnidia are formed abundantly on the lesions, often in concentric ring patterns. Spore masses oozing from picnidia can be spread by rain. When wind is present, the dispersal is even more intense. According to Weltzien and Kaack (1984), the best conditions for a rapid epiphytotic are temperature between 9 and 24 °C and wetness periods of 10 hours or more. Such conditions can easily be met during a large part of the cultivation cycle of chickpea around the Mediterranean. The moisture requirements for epiphytotics can be assured by night dew even in a relatively dry season.

The host-pathogen relationship:resistance and race specialization

There appear to be no reports of *A. rabiei* affecting naturally plants other than the genus *Cicer*. Kaiser (1973) reported mild symptoms after artificial inoculations on cowpea (*Vigna sinensis* Endl.) and bean (*Phaseolus vulgaris* L.). At the International Center for Agricultural Research in the Dry Areas (ICARDA), infection was observed on the above mentioned hosts and on pea (*Pisum sativum* L.) in greenhouse experiments with artificial inoculation (Nene and Reddy, 1987). Singh *et al.* (1981) tested 13 accessions of seven *Cicer* species. The reactions of different accessions within the same species were different, which emphasizes the need for further studies. Some accessions of wild chickpea species have been tested both in the field and under controlled environmental conditions in Italy. The first results show susceptibility of *C. reticulatum* Ladizinsky towards an isolate of *A. rabiei* (Crinò, personal communication).

Within the genus and within different lines of *C. arietinum, A. rabiei* shows an extended degree of pathogenic variability. The first report suggesting race specialization came from India, where, in 1963, the cv C-12/34 lost its resistance (Nene and Reddy, 1987). Other studies confirmed the results and extended the knowledge on the variability of *A. rabiei* (Aujla, 1964; Grewal, 1984; Vir and Grewal, 1974).

With regard to the race situation of the pathogen in the Mediterranean basin, relevant information has come through the Chickpea International Ascochyta Blight Nursery, started by ICARDA in 1978 to evaluate sources of resistance. The data from several countries over the years showed differential reactions in some lines. Observations on ICARDA lines and local landraces in Italy (Crinò *et al.*, 1985; Porta-Puglia *et al.*, 1985) encouraged further research on race specialization. The results obtained on 50 isolates from different Italian locations show a high level of variability and give evidence of a large race specialization (Porta-Puglia *et al.*, 1986 and 1987). Six "pathogenic groups" or races have been identified by artificial inoculation on a set of six differential varieties. Reddy and Kabbabeh (1985), experimenting at ICARDA on isolates from Syria and Lebanon, were also able to distinguish among six races. The two groups of workers operated with similar techniques, nevertheless the results are not totally similar. It is not easy to define which part of the difference is due to the fungal isolates and which due to diversity in the choice of differentials, disease rating scales and other minor sources of variation. The results, however, are not diverging and lead to the conclusion that at least six races are present, one of which attacks all the differentials. Moreover, this race proved to be the most frequent among the populations examined by both groups of workers.

Control

Control of *A. rabiei* must begin with the use of healthy or efficiently treated seeds. This precaution should be applied to all stages of plant breeding, including germplasm exchange.

Several fungicides were reported as effective (Kaiser *et al.*, 1973). The mixture of tridemorph (11%) and maneb (36%) seems to strongly reduce the inoculum (Nene and Reddy, 1987). Seed dressing with thiabendazole was reported as effective and without phytotoxic effect (ICARDA, 1983). Foliar sprays to be applied according to a schedule are, at present, uneconomical. More studies are needed on chemical control to ascertain the efficiency of the more recent active ingredients. At this point it is useful to underline that field experiments concernig a fungus with such a strong epidemic pressure must be designed taking into account the interplot interference. The interference results from a situation where "influx" (spores moving into the plot) and "exodus" (spores moving out from it) are not in equilibrium. As an effect of that situation, a treatment can either be under or overestimated according to the level of disease on the adjacent plots (James, 1979).

Probably, the best way of managing the disease is to combine the choice of varieties possessing a fair degree of field resistance with the use of healthy or treated seeds, obtained through seed production schemes including seed health testing. A few foliar applications of fungicides at critical development stages of chickpea should also be economically acceptable and should complete the strategy.

Cultural practices as crop rotation and burying the crop residues to a depth of 10 cm at least (Kaiser, 1973) can also contribute to the control of ascochyta blight, by reducing the amount of soil-borne inoculum.

The role of international cooperation

International cooperation plays a paramount role in promoting the knowledge of ascochyta blight and fostering resistance breeding. ICARDA has a large germplasm collection and has supplied basic information on the behaviour of germplasm accessions under different environmental condition in the Mediterranean countries and elsewhere. Sources of useful field resistance have been identified and interesting varieties have been released as a consequence of this work (Singh, 1984). Wild species related to chickpea have also been collected. They are promising for their eventual use in resistance breeding through gene manipulation. All this has been achieved through active cooperation of international and national institutions in several countries. This meeting, held under the aegis of the Internantional Center for Advanced Mediterranean Agronomic Studies, the Commission of the European Communities and ICARDA, clearly underlines the trend towards more cooperation. Another example is the recently signed agreement between ICARDA and Italian research institutions, with financial support from the Italian Governement, concerning a research project on combined resistance to ascochyta blight and fusarium wilt.

The above mentioned programme also foresees a survey on the race situation of *A. rabiei* in some Mediterranean areas. In fact, race identification is a typical case in which only international cooperation can achieve the best results. Preliminary work can be done independently by workers in different countries and institutions, and this is even desirable; however, at the end, the choice of an appropriate set of differentials and the standardisation of the techniques should be internationally accepted in order to allow the comparison of the results. Going into more detail, according to our experience in Italy, we feel that more work should be done to develop lines for the specific purpose of their use as differentials. It is common to observe, that all the plants in an available variety do not show homogenous response to some isolates of *A. rabiei*, and in all probability this may arise from the genetic variability of the host, as the inoculations are done with colonies of the fungus obtained from single-spore isolates and performed under standardized environmental conditions.

Should all the above conditions be fulfilled, a further step could be the comparison of results obtained in different laboratories with the same isolate, to be exchanged and tested under strict quarantine conditions. The agreement in results obtained by different workers will verify the method and give reliability to extensive surveys on the race situation in time and space.

In general, a more interdisciplinary approach to host-pathogen relationship is needed. It should cover evolutianary, plant pathology and biochemical aspects along with extensive epidemiological observations. As a matter of fact, our knowledge of the genetical bases of resistance of chickpea to ascochyta blight is still poor. Even if a gene-for-gene pattern, more or less complex, should be expected in most host-pathogen relationship (Ellingboe, 1986), we do not have conclusive evidence in so-far-as *A. rabiei* is concerned.

Conclusions

The tasks to be afforded jointly by chickpea pathologists and breeders against ascochyta blight are multifold and heavy. International cooperation provides the opportunity to face them efficiently and economically, avoiding duplicate work. Two results can be expected from these common efforts. On one hand, some theoretical aspects of the host-parasite relationship could be elucidated. On the other hand, economic benefits can be expected in the Mediterranean basin through an increase of yields in the areas in which the chickpea is still important and the enhancement of the crop where its decreasing popularity has deprived the farmers of a legume potentially useful in crop rotation.

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