CP-574

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RECENT ADVANCES IN FUNGAL DISEASES OF CHICKPEA AND PIGEONPEA

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Abstract

Fungal disease problems of chickpea and pigeonpea in India have been properly identified and their distribution and importance determined. Fusarium wilt, dry root rot, ascochyta blight, botrytis grey mold, and collar rot are the major diseases affecting chickpea. In pigeonpea, fusarium wilt, phytophthora blight, and alternaria blight are important diseases. In the case of chickpea wilt, much progress has been made in both understanding the problem and its management through resistant varieties. Progress on dry root rot is limited to identification of a few field tolerant sources. Though work on ascochyta blight has been going on for several years, progress on its management has not been satisfactory mainly due to lack of stable resistance sources. Effective seed dressing and foliar fungicides have been identified but there are limitations in their use. A few field- tolerant lines have been identified and some information on pathogenic variability and genetics of resistance has been obtained. Some effective seed dressing and foliar fungicides have been found effective in controlling botrytis grey mold. In pigeonpea, excellent progress has been made in the management of wilt, especially through host-plant resistance. The progress on the management of phytophthora blight through host-plant resistance has been limited mainly because of frequent change in the virulence of the pathogen. Some field-tolerant lines have been identified and seed dressing and foliar sprays with metalaxyl were found to provide good control. Good progress has been made in the management of alternaria blight through utilisation of host-plant resistance.

In future, for effective management of dry root rot, collar rot, and foliar diseases such as ascochyta blight and botrytis grey mold in chickpea, it is necessary to pursue an integrated approach as higher levels of genetic resistance are not available in the available germplasm. In addition, it may be worthwhile to undertake work on germplasm enhancement for these diseases. In pigeonpea, development of varieties with multiple disease resistance needs better attention.

Introduction

Research on chickpea (*Cicer arietinum* L.) and pigeonpea (*Cajanus cajan* (L.) Millsp.) diseases has recently been reviewed (Nene and Reddy, 1987, Reddy, *et al.,* 1990). In this paper, we highlight the advances made on major fungal diseases during the past 15 years and briefly outline the strategies for future research.

Major diseases and their distribution

Chickpea

Fusarium wilt (*Fusarium oxysporum* Schlecht. emend Snyd. & Hans. f. sp. *ciceri* (Padwick) Snyd. & Hans.), dry root rot (*Rhizoctonia bataticola* (Taub.) Butler = *Macrophomina phaseolina* [Tassi] Goid), collar rot (*Sclerotium rolfsii* Sacc.), ascochyta blight (*Ascochyta rabiei* [Pass.] Labr.). botrytis grey mold (*Botrytis cinerea* Pers. ex. Fr.), and alternaria blight (*Alternaria alternata* (Fr.) Kiessler) are the major fungal diseases of chickpea in India. Black root rot (*F. solani* (Mart.) Sacc.), wet root rot (*R. solani* Kuhn), rust (*Uromyces cicerisarietini* (Grogn.) joez & Beyer), *stemphylium* blight (*Stemphylium sarciniforme* (Cav.) Wilts). and sclerotinia stem rot (*Sclerotinia sclerotiorum* (Lib.) deBary) are of minor importance. Soil-borne diseases - wilt and root rots - are relatively more serious in chickpea-producing regions located between 0 and 30 ° N and S latitudes. The chickpea-growing season in these areas is relatively short, dry, and warm, resulting in low yields. The dry and warm conditions also favour wilt and root rot incidence. The foliar diseases, ascochyta blight, grey mold and alternaria blight are problems at higher latitudes (between 35 and 45° N and S) where the crop-growing season is relatively longer, cooler, and wetter. The productivity of chickpeas in these areas is high. In between , there is a transition zone (25-30° N and S) where both soil-borne and foliar diseases can be serious in certain seasons. Winter rains are common during the chickpea growing season in higher latitudes. They are useful in increasing chickpea yields but, unfortunately, they also encourage build up of foliar diseases. Thus in the most productive regions, the conditions for good chickpea crop and build up of foliar diseases are similar and, unless foliar diseases are managed well, it is difficult to increase chickpea yields.

Pigeonpea

Fusarium wilt (*Fusarium udum* Butler). phytophthora blight (*Phytophthora drechsleri* tucker *f. sp. cajani* (Pal *et al.* Kannaiyan *et. al.*), alternaria blight (*A. alternata* and *A. tenuissima* (Kunze ex. pers.) Wiltshire), stem canker and root rot (*R. bataticola* = *M. phaseolina*) are the major fungal diseases of pigeonpea in India. Wilt is prevalent throughout the country but it is relatively more serious in vertisols in central parts. Phytophthora blight is serious when fields are subjected to waterlogging. The disease is relatively more serious in alfisols and in short-duration pigeonpeas. The close spacing advocated for short- duration pigeonpeas seems to encourage disease build up. Phytophthora blight management is essential for the success of short-duration pigeonpeas. Alternaria blight is specifically serious in pre-rabi/late sown pigeonpeas in northeastern India and its management is essential for the spread of this productive system. Though macrophomina stem canker phase is prevalent throughout the country it is of minor importance at present. The root rot phase was found to be a major problem in summer-sown pigeonpeas at ICRISAT Center, especially in Vertisols. Occurrence of more than one of these diseases in the same field is also common. Currently, minor diseases such as cercospora leaf spots and bacterial leaf spot(*Xanthomonas comperstris cajani* Kulkarni *et al.,* Dye *et al.*) may become serious in short-duration pigeonpeas as the

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Sachan, J.N. (ed). 1992. New Frontiers in Pulses Research and Development: proceedings of National Symposium, 10-12 Nov. 1989, Directorate of Pulses Research, Kanpur 208 024 pp. 194-201

agronomic practices followed for this crop (closer spacing and irrigation) favour them.

Recent advances

Chickpea

Solving the mystery of the so-called wilt complex can be considered as a major achievement (Nene *et al.*, 1978). The different causes of mortality have been identified. Both fungi and viruses were found to be involved. Different pathogens produce specific symptoms. The fungi involved are F. *oxysporum* f. sp. *ciceri* (fusarium wilt), *R. bataticola* (dry root rot), *S. rolfsii* (collar rot). *F. solani.* (black root rot). *R. solani* (wet root rot) and *Operculella padwickii* (foot rot). The viruses involved are a strain of pea(bean) leaf-roll virus (stunt), alfalfa mosaic virus (mosaic), cucumber mosaic virus (proliferation). and bean yellow mosaic virus (narrow leaf). The involvement of viruses in mortality of chickpeas has been the main cause of confusion. Their role was not realised earlier.

Good progress has been made in understanding the fusarium wilt problem and its management. The wilt pathogen is seed-borne (Haware et al., 1978). The fungus, in the absence of chickpea, survives in soil for more than 5 years (Haware et al., 1986). It exhibits physiologic specialisation, and four races have so far been reported from India (Haware and Nene, 1982). Effective laboratory and field inoculation techniques have been developed. (Nene *et al.*, 1981) and good progress has been made in the identification of resistance sources and development of high yielding and wilt-resistant varities. Lines such as ICC 2862, ICC 9023, ICC 9032, ICC 10803, ICC 11550, ICC 11551 with multilocational resistance to wilt have been identified. Effective sick plots have been developed at various centres in India such as ICRISAT, Badnapur, Berhampore, Dahod, Delhi, Dholi, Durgapura, Faizabad, Rahuri, Jabalpur, Kanpur, Hisar, Gurdaspur, Ludhiana, and Varanasi. Active work on resistance breeding is going on at all these centres. Inheritance of resistance to the disease has been understood.

Relatively less progress has been made on root rots. A laboratory paper towel-inoculation technique has been standardised for dry root rot (Nene *et al.*, 1981). Some of the wilt sick plots at the above centres have become multiple disease sick plots including dry root rot. Field tolerant lines such as ICC 14619, ICC 14631, ICC 14680, ICC 14681, ICC 14735, ICC 42762, ICC 14795, ICC 15023, ICC 15081, ICC 15090, ICC 15127, ICC 15109, ICC 15146 ICC 15166, ICC 15168, ICC 15233, and ICC 15236, have been identified. These lines show less than 20% mortality when the susceptible checks showed 100% incidence. These lines, despite heavy root necrosis, do not die till maturity. The susceptibility of chickpea to dry root rot was found to increase with age of the plant (S. K. Singh, unpublished).

Though work on ascochyta blight has

been going on for over 80 years, progress on managing the disease has not been satisfactory. Several effective seed dressing and foliar fungicides have been identified , but their application under field conditions has been neither feasible nor economical. It is now well established that the fungus *A. rabiei* is highly variable. Lines with resistance/tolerance in the vegetative stage are available, but none has resistance in both the vegetative and podding stages. Some information on the genetics of resistance to blight exists (Singh and Reddy, 1983; Singh and Reddy, 1989).

Compared with Ascochyta blight, very little work has been done on greymold. During the past 5 years, there have been reports on identification of lines field-tolerant to the disease (Rathi *et al.*, 1984: Shukla *et al.*, 1987: Sahu and Sah, 1988; Gurdip Singh, unpublished). However, it appears that the reactions of the lines depend very much on disease pressure. The lines ICC 1069, ICC 1913, ICC 3640, ICC 4954, ICC 6299, ICC 7111, which showed tolerance to the disease at Pantnagar (latitude 29°N)where the disease pressure is usually moderate, showed high susceptibility when tested at Rampur (latitude 27° N) in Nepal where the disease pressure is much higher. Whether this variation is due to different races or environmental factors needs to be investigated. Seed dressing and foliar fungicides effective against the disease have been found (Grewal and Laha, 1983; Singh and Bhan, 1986a, Singh and Kaur, unpublished), but, the economics of the use of foliar fungicides for management of the disease needs to be worked out. Singh and Bhan (1986b) reported four physiological races from northern Indian states. Observations made at ICRISAT also indicate variability in the pathogen. Field Observations have shown that kabuli types are less susceptible than desi types. Also the tall and compact types suffer less than the traditional bushy and spreading types.

The importance of alternaria blight, stemphylium blight, and sclerotinia stem rot has been recently recognised. As they occur along with the two major foliar diseases, ascochyta blight and botrytis grey mold, they are more or less shadowed by them.

Pigeonpea

Excellent progress has been made on the management of fusarium wilt. Effective sick plots have been developed at several centres in India for evaluating pigeonpeas for resistance to wilt and several good sources of resistance such as ICP 8863, ICP 9174 have been identified. A few resistant/tolerant and high-yielding varieties such as NPWR 15, BDN 1, Mukta, Sharda, C 11, Maruti, ICPL 87 have been developed. Quite a few lines such as ICPL 227, DA 12, BDN 31, ICPL 8357, PDA 86-1, PDA 85-1, and ICPL 87119 in the current coordinated trials have resistance to wilt. Active work on disease resistance is continuing at Annigeri, Berhampore, Jabalpur, Rahuri, Pudukkottai, ICRISAT, Gulbarga, Badanpur, Rahuri, Kanpur, and Dholi. The wilt pathogen was found to be seed-borne in tolerant cultivars (ICRISAT, 1987). It survives in soil for 3 years in the absence of pigeonpea (Kannaiyan *et al.,* 1981). The pathogen appears to be variable. The short-duration pigeonpeas suffer relatively less from wilt than the medium-and long-duration ones. Limited information is available on the influence of crop rotation and intercropping on wilt. Progress on the management of phytophthora blight has been limited, and relatively little research has been carried out on this problem. The pathogen appears to be highly variable. Reliable field and greenhouse inoculation techniques such as the drench inoculation, and diseased-debris methods have been developed. While high levels of resistance are available against some isolates, only field tolerance is available against others (Table 1). The susceptibility of pigeonpea to the disease decreased with age. Ridomil (R) seed dressing and two foliar sprays at 15-day interval after sowing were found to give good protection in short duration pigeonpeas under field conditions at ICRISAT center.

Several sources of resistance are available for alternaria blight (Kannaiyan *et al.,* 1986), and a few resistant cultivars

Table 1. Pigeonpea germplasm accessions field resistant(0-10% blight) or moderately resistant (11-30% blight) to phytophthora blight (PB), ICRISAT Center, Patancheru, 1987-89.

	Mortality due to PB (%)					
	Field test				Pot test	
Pigeonpea acession	1987[1]	1988[2]	1989[2]	Average	P2 isolate[1]	P3 isolate[1]
ICP 7200	13	17	40	23	2	71
ICP 7815	28	16	22	22	90	28
ICP 8564	3	8	19	10	2	90
ICP 8610	7	14	45	22	9	70
ICP 8692	13	21	14	16	5	73
ICP 8921	15	25	35	25	4	71
ICP 9046	13	25	38	25	0	83
ICP 9252	4	26	30	20	3	88
KPBR-80-1-4	32	27	16	25	0	73
KPBR-80-2-1	17	15	12	15	0	63
ICP 7119 (Susceptible toP2 and P3 Isolates)	95	98	95	96	100	100
ICP 2376 (Resistant to P2 but susceptible to P3 isolate)	98	98	97	98	0	100

1. Mean of 2-3 Unreplicate tests
2. Mean of 2-3 replicated tests

(W.B. 20 (105), DA11, DA12) have been bred. The reason for increased occurrence of alternaria blight in the pre-rabi season need to be understood. There has been hardly any work on macrophomina stem canker and root rot disease.

Good progress has been made in the identification of lines with multiple disease resistance(Nene, 1988). The line KBBR 80-2 is resistant/tolerant to wilt, phytophthora blight and sterility mosaic.

Future research strategies

Chickpea

Though good progress has been made on the management of fusarium wilt, the progress on the root rot diseases has been very limited. Wilt control cannot be fully utilised until root rot are also managed. It may be difficult to obtain high levels of resistance to the root rot fungi due to their wide host range. Emphasis should be on integrated management practices including field tolerance, use of fungicidal seed-dressing, and manipulation of agronomic practices such as sowing date, irrigation, seed bed preparation, etc. For example, collar rot may be managed by preparing seed beds free from undecomposed organic matter and sowing seed treated with fungicides such as Rizolex(R) when soil moisture is not unduly high and when temperatures are low (20°C). Also, desi varieties are less susceptible than the kabuli types. The use of short-duration varieties that can mature before the ambient temperatures rise over 30°C may also help in minimising the dry root rot problem. The effect of irrigation on wilt and root rots incidence needs to be investigated.

Concerted efforts should be made to better understand the epidemiology of ascochyta blight. It is particularly important to identify the primary sources of inoculum for epidemic build-up. The means by which the disease spreads rapidly over very large areas need to be understood. The extent of variability in *A. rabiei,* and its distribution, and the means by which the variability occurs, need to be further investigated. Further studies on genetics of resistance in chickpea to blight are needed for complete mapping of the resistance genes. Only then can the resistance breeding program be placed on a sound footing. Germplasm enhancement for blight resistance may prove fruitful. In the absence of complete information on the involvement of genes in blight resistance, intercrossing lines with different types of resistance and lines resistant to different races of *A. rabiei* can be undertaken.

In the past there has been hardly any work on the integrated management of the disease. Most efforts have been directed at the development of resistant varieties and fungicidal control. Effective seed dressing fungicides such as thiabendazole and calixin M (R) are now available. Application of one or two foliar sprays of chlorothalonil during the podding stage to tolerant cultivars has been found effective in the control of the disease. Development of effective systemic foliar fungicides with longer residual action could make this practice more economical and practical.

The experience in India and Nepal with extensive screening against botrytis grey mold indicates that it may be difficult to obtain higher levels of genetic resistance in the available chickpea germplasm. Though some lines do not show much damage on vegetative parts, they suffer severe flower infection resulting in no pod formation. In areas where the disease pressure is moderate, there appears to be good scope for integrated management of the disease. A field experiment at Pantnagar during the 1988/89 season indicated that the disease incidence was much lower in a tall and compact genotype(ICCL 87322) than in a bushy and spreading type (H 208) (Table 2). In both genotypes, there was a large increase in yield when inter-row spacing was increased from the normal 30 cm to 60 cm keeping the plant population constant. Germplasm enhancement and utilisation of related wilt species are also suggested as promising avenues to obtain resistance that could be used in the management of the disease.

Some of the strategies adopted for management of ascochyta blight and grey mold such as wider row spacing and use of tall and compact genotypes may also help in minimising other foliar diseases. For example, in Bangladesh, tall, compact genotypes suffer much less from stemphylium blight than do the traditional spreading genotypes. Search for sources of genetic resistance may prove fruitful. Kabuli types were found to suffer less from stemphylium blight in Bangladesh than did desi types. Foliar diseases generally become serious when the maximum temperatures are between 20 and 25° C. If we have short-duration varieties which can mature before the temperatures rise to these levels, foliar diseases can be avoided. This is possible with varities having cold tolerance.

Table 2. Influence of growth habit of chickpea genotypes and inter and intra-row spacing on botrytis grey mold severity and grain yield. Pantnagar, 1988/89.

Treatment	Disease Ratin on 1-9 scale[1]		Yield (kg ha $^{-1}$)
Sprayed with Ronilan (R)			
ICCL 87322 (30X10cm)	4.3	(1.5)[2]	3537
ICCL 87322 (60X5cm)	3.3	(1.2)	5179
H 208 (30X10cm)	6.7	(1.9)	2778
H 208 (60X5cm)	5.0	(1.6)	3065
No spray			
ICCL 87322 (30X10cm)			
ICCL 87322 (60X5cm)	5.0	(1.6)	3417
H 208 (30X10cm)	4.1	(1.4)	4462
H 208 (60X5cm)	8.0	(2.1)	1009
	7.1	(1.9)	1907
SE ±			
CV %	0.9	(0.2)	135
CD	15.8	(10.01)	4.3
(P=0.05)	1.6	(0.3)	254.0

1. Disease rating system in which 1 = No disease and 9 = plants killed.
2.Figures in parenthenses are loge values.

Pigeonpea

Though considerable progress has been made on some of the important disease such as wilt and phytophthora blight, much more needs to be done. In fusarium wilt, the ecology of the disease needs to be further understood. Though it is known that the incidence of the disease varies from one location to another and depends on soil type, the reasons for this are not understood. Delayed sowing reduces wilt incidence but again the reasons for this are not clear. The effects of irrigation and other agronomic factors such as intercropping, crop rotation and weed control on wilt incidence are also not fully understood. The variability in the pathogen, mechanism of resistance in the host and genetics of resistance need to be investigated. The reasons for loss in tolerance of the plant to wilt with age have not been experimentally established. Considerable scope exists for the management of wilt by integrating host resistance and cultural practices such as crop rotation, intercropping, sowing time, etc.

In phytophthora blight, there is a need to further understand the epidemiology of the disease and variability in the pathogen, and for identification of stable sources of resistance to the disease. Though it is clear that the pathogen can survive in the soil from one season to another, the mode in which it survives needs further investigation. Also there is no explanation for the appearance of the disease in a field where pigeonpea was not grown for the past several years. More work needs to be undertaken on foliar diseases caused by *Cercospora* and *Alternaria*, and root rot and stem canker caused by *M. phaseolina*.

Although control measures have been worked out for individual diseases, there has been insufficient emphasis on development of integrated control measures for combinations of the major diseases. This is important as the diseases commonly occur in combinations in the field. Sources of resistance to individual diseases and to several diseases are available and there is a need to make increased use of multiple disease resistance to develop cultivars with multiple disease resistance and high yield.

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