

Relationship between *Ascochyta* blight severity and yield loss in Chickpea and identification of resistant lines

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Summary. Two field experiments were conducted at ICARDA, Tel Hadya, Syria for three seasons (1982/83, 1983/84, and 1985/86) to study the relationship between *Ascochyta* blight severity and yield loss in chickpea and to identify disease resistant lines. The first experiment involved 20 germplasm lines representing a range of resistance and susceptibility. The second involved 19 germplasm lines with a low blight severity. In the first experiment, less than 10% yield loss was recorded in lines showing a rating of 2 to 4. Yield loss was 16% in lines with 5 rating, 26-27% in lines with 6 to 7 rating, and more than 80% in lines with 8 to 9 rating. In the second experiment, lines with a rating of 4 or less showed a maximum of 12% loss in yield, while susceptible line 'ILC 1929' with a 9 rating showed almost 100% yield loss. In both experiments, the yields of the susceptible lines were higher than the lines with less than 4 rating under disease free conditions.

Riassunto. CORRELAZIONE TRA L'INTENSITA' DELL'ASCOCHITOSI E LA PERDITA DI PRODUTTIVITA' NEL CECE E IDENTIFICAZIONE DI LINEE RESISTENTI. Due serie di ricerche di campo sono state condotte dall'ICARDA, Tel Hadya, Siria, per tre cicli colturali (1982/83, 1983/84 e 1985/86) al fine di analizzare le correlazioni tra l'intensita' dell'ascochitosi e la perdita di produttivita' nel Cece ed individuare linee resistenti. Nella prima serie di ricerche sono state considerate 20 linee di germoplasma a differente grado di suscettibilita' alla malattia; nella seconda 19 linee di germoplasma resistente. Nella prima serie di prove di campo e' stato constatato: una perdita di produttivita' inferiore al 10% nelle linee con una intensita' di malattia compresa tra l'indice 2 e 4 della scala adottata, il 16% nelle linee con indice 5, il 26-27% nelle linee con indice da 6 a 7, e piu' dell'80% nelle linee con indice da 8 a 9. Nella seconda serie di prove di campo le linee con indice 4 o inferiore, la perdita di produttivita' e' stata al massimo del 12%, a confronto della linea suscettibile 'ILC 1929' con un indice di 9 la quale ha presentato una perdita del 100%. In entrambe le prove e in condizioni di assenza di malattia la produttivita' delle linee suscettibili e' stata superiore a quella delle linee con un indice inferiore a 4.

Introduction

Ascochyta blight (*Ascochyta rabiei* |Pass. |Lab.) is the most destructive disease of chickpea (*Cicer arietinum* L.) in parts of the Indian subcontinent and the Mediterranean region. Though the disease has been known for over 75 years, little progress has been made on its control. In Pakistan the disease caused about 48% reduction in production during the 1978-79 and 1979-80 seasons (Malik and Tufail, 1984). Though some effective foliar fungicides have been identified, their application may not be practical and economical as a minimum of four sprays are required to control the

disease in a susceptible cultivar (Reddy and Singh, 1983). Therefore, the use of resistant cultivars is the most practical way to control this disease.

Several sources of resistance to blight based on disease severity alone have been reported (Aziz, 1962; Grewal and Vir, 1974; Kaiser, 1972; Singh *et al.*, 1981 and 1984; Reddy and Singh, 1984). Resistance sources based on both disease severity and yield loss response have not been identified. This paper reports the results of a study which examines the relationship between disease severity and yield loss and identifies resistant lines based on yield loss.

Materials and methods

Selection of the genotypes .

Experiment 1. Twenty chickpea lines were selected to show a range of reactions to blight during the vegetative and podding stages in a field screening of the world germplasm collection to determine the relationship between blight severity and yield loss (Reddy and Singh, 1984) (Table II). These included 17 kabuli types (characterized by large, ram-head-shaped and beige-colored seeds) and 3 desi types (characterized by small, angular, and colored seeds).

Experiment 2. Nineteen lines showing ratings of 4 or less on a 1-9 visual rating scale in a field screening of world germplasm collection were used to identify chickpea lines with little or no yield loss (Reddy and Singh, 1984) (Table IV). These included 13 kabuli types and 6 desi types. A Syrian local landrace, ILC 1929, was used as a susceptible check.

Experimental details . Two field experiments were conducted at ICARDA in each growing season of 1982/83, 1983/84, and 1985/86. A split-plot design was used with noninoculated and inoculated treatments in main plots and genotypes in subplot with three replications. Each subplot consisted of four rows 4 m long with inter-row spacings of 30 and intra-row spacings of 10 cm. Sowing was carried out during early December and harvesting in early July. The plots were inoculated by scattering blight-affected chickpea debris collected from the previous season one month after sowing. The noninoculated plots were sprayed with chlorothalonil (Bravo 500) (5 ml/L water, 500 L/ha) at 10- to 15-day intervals from one month after sowing until the end of May, when environmental conditions for blight development became unfavorable. In each growing season, sprinkler irrigation was used during the dry periods in April and May to encourage severe blight buildup. Irrigation was given for 2 h per day on all dry days during the vegetative stage until susceptible lines were killed, and again during podding stage for 15 days.

Data recording . Blight severity on vegetative parts and pod infection were recorded on a 9-point scale (Table I) at crop maturity. The extent of breaking of branches was scored visually. Percent pod infection was calculated by counting the total and the infected pods of five randomly selected plants from each plot at harvest. The highest score of either of these two observations was considered for categorization of lines in to

TABLE I. - A 9-point rating scale for scoring Ascochyta blight severity of Chickpea.

TABELLA I. - *Scala di valutazione dell'intensità di malattia nel Cece.*

Disease rating	Blight reaction category	Broken branches and infected pods (%)
1	I	0
2	HR	1-5
3	R	6-10
4	MR	11-15
5	T	16-40
6	MS	41-50
7	S	51-75
8	HS	76-100
9	HS	Plants Killed

I = immune
 HR = highly resistant
 R = resistant
 MR = moderately resistant
 T = tolerant
 MS = moderately susceptible
 S = susceptible
 HS = highly susceptible

different reaction groups. The yield data was also recorded by harvesting the entire plots at maturity. The percent yield loss due to blight was estimated using the following formula:

$$\% \text{ YL} = \frac{\text{YHP} - \text{YDP}}{\text{YHP}} \times 100$$

Where: YL = yield loss;
 YHP = yield in healthy plot; and
 YDP = yield in diseased plot.

Results

The blight developed uniformly during the three test seasons, as indicated by the death of the plants of the two susceptible lines ILC 263 and ILC 1929 (Tables II and III).

Experiment 1. The lines tested showed a range of susceptibility to blight during the vegetative and podding stages (Table II). Though no line was rated 1, for each of the 8 remaining

categories there was at least one representative line (Table III). A significant positive correlation ($r=0.8$) was recorded between disease severity the vegetative stage and pod infection. Negati

TABLE II. - *Ascochyta* blight severity and yield loss estimations (a) in a set of chickpea germplasm lines with a range of *ascochyta* blight susceptibility, ICARDA, Tel Hadya, Syria, 1982/83, 1983/84 and 1985/86.

TABELLA II. - *Intensità dell'ascochitosi e valutazione (a) della perdita di produttività nelle linee di germoplasma suscettibile, ICARDA, Tel Hadya, Siria, 1982/83, 1983/84 e 1985/86.*

Chickpea Germplasm line	Blight score on vegetative parts on a 1 - 9 scale	Pod infection (%)	Average yield (t/ha)		Yield loss/increase (%)
			Uninoculated	Inoculated	
ILC 183	2.6	26	2.0	2.0	0
ILC 194	3.0	42	2.1	2.0	- 5
ILC 196	2.3	15	1.5	1.3	- 13
ILC 201	2.2	10	1.6	1.8	+ 14
ILC 202	2.7	4	1.8	1.8	0
ILC 215	6.3	67	2.1	0.6	- 71
ILC 236	2.6	44	2.0	1.7	- 15
ILC 263	8.8	80	2.4	0.03	- 99
ILC 482	3.9	52	2.3	1.7	- 23
ILC 484	3.4	53	2.3	1.6	- 31
ILC 1695	3.1	46	1.8	1.6	- 19
ILC 1919	6.2	70	2.2	0.4	- 81
ILC 1929	9.0	82	2.2	0.02	- 99
ILC 2548	2.7	28	1.8	2.1	+ 14
ILC 3279	2.1	7	1.6	1.8	+ 9
ILC 3346	2.0	4	1.9	1.7	- 9
G 543	2.8	29	2.3	1.7	- 23
G 549	2.6	34	1.7	1.1	- 40
ILC 3856	2.2	7	2.2	1.7	- 24
ILC 4935	3.4	23	2.2	1.4	- 35
SE ±	0.5	7.4	0.23	0.21	
CV (%)	23.0	35.4	20.4	26.2	

a = average of three seasons

+ = increase in yield

- = loss in yield

TABLE III. - Relationship between Aschochyta blight severity on a 1-9 disease severity rating scale and yield loss in a set of chickpea germplasm lines, ICARDA, Tel Hadya, Syria, 1982/83, 1983/84 and 1985/86.

TABELLA III. - Relazioni tra l'indice di intensità dell'ascochitosi (scala da 1 a 9) e la perdita di produttività nelle linee di germoplasma, ICARDA, Tel Hadya, Siria, 1982/83, 1983/84 e 1985/86.

Chickpea Germplasm lines	Blight reaction category (a)	Blight severity on vegetative parts on a 1 - 9 scale	Pod infection	Average yield (t/ha) (b)		Yield loss
				Uninoculated	Inoculated	
ILC 3346	HR	2	1 - 5	1.9	1.7	9
ILC 202, ILC 3279, ILC 3856	R	3	6 - 10	1.9	1.8	7
ILC 196, ILC 201	MR	4	11 - 15	1.5	1.6	+ 3
ILC 183, ILC 2548, G 543, G 549, ICC 4935	T	5	16 - 40	2.0	1.7	16
ILC 194, ILC 215, ILC 236, ILC 1695	MS	6	41 - 50	2.0	1.4	26
ILC 482, ILC 484	S	7	51 - 75	2.3	1.6	27
ILC 1919	HS	8	76 - 100	2.2	0.4	81
ILC 263, ILC 1929	HS	9	NR	2.3	0.06	98

a = abbreviations same as in Table I

h = average of three seasons

+ = increase in yield

NR = not recorded (no pods)

TABLE IV. - Aschochyta blight severity and yield loss estimation in a set of resistant chickpea germplasm lines at ICARDA, Tel Hadya, Syria, 1982/83, 1983/84 and 1985/86 (a).

TABELLA IV. - Intensità dell'ascochitosi e valutazione della perdita di produttività nelle linee di germoplasma resistente, ICARDA, Tel Hadya, Siria, 1982/83, 1983/84 e 1985/86 (a).

Chickpea Germplasm lines	Blight severity on vegetative parts on a 1 - 9 scale	Pod infection (%)	Average yield (t/ha)		Yield loss/increase (%)
			Uninoculated	Inoculated	
ILC 72	2.3	8	2.0	2.3	+ 12
ILC 182	2.3	9	2.5	2.6	+ 3
ILC 187	2.4	5	2.2	2.4	+ 11
ILC 191	2.5	12	2.1	2.1	0
ILC 195	2.4	8	2.4	2.4	0
ILC 200	2.4	2	2.5	2.2	- 12
ILC 1757	3.3	36	2.6	1.4	- 46
ILC 2300	2.2	3	2.5	2.5	0
ILC 2506	2.0	9	2.3	2.7	+ 15
ILC 2956	2.7	3	2.0	2.3	+ 15
ILC 3001	2.7	30	1.3	1.8	+ 41
ILC 3274	2.1	4	2.0	2.1	+ 6
ILC 3400	2.7	20	2.2	2.1	- 4
ICC 3634	2.0	16	2.0	2.2	+ 9
ICC 4200	2.9	29	2.3	1.9	- 19
ICC 4248	2.9	32	2.3	1.9	- 18
ICC 5124	2.9	16	2.1	2.2	+ 4
ICC 6262	2.2	2	2.3	2.6	+ 14
ICC 6981	2.0	18	2.3	2.6	+ 13
ILC 1929 (Susceptible Check)	9.0	94	2.6	0.03	99
SE ±	0.27	5.3	0.21	0.17	
CV (%)	16.5	53.7	16.0	14.0	

a = average of 1982/83, 1984/85, and 1985/86 seasons

+ = increase in yield

- = loss in yield

correlations were recorded between blight severity in the vegetative stage and yield ($r=0.5$) and pod infection and yield ($r=0.4$). Chickpea lines ILC 236, ILC 482, and ILC 484 showed low disease severity in the vegetative stage (2.6 to 3.9 rating), but had higher pod infection (44-53%) (Table II). The yield loss in the lines with 2 to 4 score in the vegetative stage was less than 10% and in the lines with 5 score, the loss was about 16% (Table III). In the lines that were scored 6 and 7, the yield loss was below 30%, but in the lines that were scored 8 and 9, the yield loss was very high (more than 80%). The lines ILC 263, ILC 482, ILC 484, ILC 1919, and ILC 1929, which showed a rating of 7 and above yielded significantly higher (more than 2 t/ha) than the lines ILC 196, ILC 201, ILC 202, ILC 3279, ILC 3346, and ILC 3856, which scored 4 or less under protected conditions (Tables II, III).

Experiment 2. All 19 test lines included in this trial showed high levels of resistance in the vegetative stage (2 to 3.3 rating) compared with 9

rating of the susceptible check line ILC 1929 (Table IV). However, the pod infection in lines ILC 1757, ILC 3001, ILC 4200, and ICC 4248 was slightly high (29-36%). The maximum yield loss recorded was 46% in ILC 1757. During three seasons, a majority of the 19 lines tested did not show any average yield loss (Table IV). The average yields of the 19 resistant and moderately resistant lines over the 3 seasons were almost the same under diseased and disease-free conditions (2.3 t/ha) (Table V). The susceptible cultivar ILC 1929, on the other hand, showed 99% yield loss. The yield potential of the susceptible line ILC 1929 under disease free conditions, however, was higher (2.6 t/ha) than any of the resistant lines (2.3 t/ha).

Discussion

There have been several reports of identification of resistance sources to *Ascochyta* blight of

TABLE V. - Yield of some *Ascochyta* blight resistant chickpea germplasm lines in comparison with susceptible cultivar ILC 1929 under blight-free and blight-inoculated conditions, ICARDA, Tel Hadya, Syria.

TABELLA V. - *Produttività di alcune linee resistenti all'ascochitosi in raffronto alla cultivar suscettibile ILC 1929, in condizioni di sanità e di infezione provocata, ICARDA, Tel Hadya, Siria.*

Crop season	Average yield (t/ha)				Yield loss/increase (%)	
	Blight-free		Blight-inoculated		Resistant lines	Susceptible line
	Resistant lines (Range)	Susceptible line	Resistant lines (Range)	Susceptible line		
1982/83	2.5 ^a (1.7 - 2.3)	2.5	2.2 (1.5 - 2.7)	0	+ 6	100
1983/84	2.1 ^b (1.2 - 3.0)	2.8	1.9 (1.4 - 2.6)	0	10	100
1985/86	2.5 ^a (1.8 - 3.2)	2.5	2.7 (1.8 - 3.2)	0.08	+ 4	97
Average	2.3	2.6	2.3	0.03	0	99

a = 19 resistant and one susceptible line were tested

b = 17 resistant and one susceptible line were tested

+ = increase in yield

chickpea from the Indian subcontinent (Ahmad *et al.*, 1952; Aziz, 1962; Bedi and Athwal, 1962; Grewal and Vir, 1974; Luthra *et al.*, 1938), West Asia (Kaiser, 1972; Singh *et al.*, 1981 and 1984; Reddy and Singh, 1984), and Bulgaria (Solel and Konstrinski, 1964; Radkov, 1978; Ganeva and Matsov, 1977). Almost all these reports, however, were based on visual scoring of the lines for blight severity and in no case was identification of resistance based on both disease severity and yield loss estimations. Similarly, as many as seven rating scales have been suggested for scoring blight severity (Aujla and Bedi, 1967; Morral and McKenzie, 1974; Grewal and Vir, 1974; Singh *et al.*, 1981; Reddy *et al.*, 1984). These scales were based only on disease severity on vegetative parts and pods. None clearly indicated the relationship between blight severity and yield loss. The proposed 9-point rating scale considers the extent of breaking of branches and pod infection, the two most damaging symptoms of *Ascochyta* blight. The availability of yield loss figures for each of the disease severity scores of the proposed scale should make it more useful in *Ascochyta* blight resistance breeding work. Further, the identification of several lines that showed less than 5% yield loss in all three seasons tested under high disease pressure should place resistance breeding work on very sound footing.

Many lines with as much as 20% pod infection suffered little yield loss (less than 5% loss) due to either superficial pod infection or very late infection (not affecting pod or seed development). Chickpea is an indeterminate plant with the ability to prolong the reproductive phase if soil moisture is unlimited and temperatures are moderate (below 35°C). If the early formed pods are damaged by any reason, chickpea produces new pods and compensates for the lost pods.

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