Pathology

The Role of Chickpea Root Exudates in Resistance to Fusarium Wilt

The germination of fungal spores in soil is often influenced by the composition of the root exudates of the potential host. The inhibition of spore germination by root exudates is an important mechanism of host-plant resistance. In this study, we examined the effects of root exudates of chickpeas on the spore germination and growth of Fusarium oxysporum f.sp. ciceri, the cause of chickpea wilt.

The seeds of cultivars, susceptible (JG 62) and resistant (CPS 1) to race 1 of F. oxysporum f.sp. ciceri, were surface-treated with 2.5% sodium hypochlorite for 5 min., rinsed in sterile water and transferred to moist blotting paper in petri dishes for 48 hours at ambient temperature (about 28°C). The radicals of germinating seeds were inserted through holes in styroform sheets over 250 ml beakers containing 50 ml of distilled water. Fifty seeds were accommodated in each beaker, which were covered by black paper and incubated at 20°C, the water being maintained at 50 ml. After 7 days, water from the beakers was passed through a bacteria-proof Millipore filter (0.20 μ) under vacuum and the filtrates tested for their effects on the spore germination and mycelial growth of race 1 of F. oxysporum f.sp. ciceri.

Spore germination

We applied 0.2 ml of the filtrates from JG 62 and CPS 1 uniformly to areas of 2.5 cm^2 on each of three glass slides. Seeds spread with sterile, distilled water served as controls. Conidia were obtained by filtration from a liquid growth medium (potato dextrose broth) incubated for 5 days. They were washed with distilled water and made up into a spore suspension of 1000 conidia/ml. The spores were sown on the treated slides which were incubated for 48 h. The percentages of germinated spores were estimated from five microscopic fields on each slide. The filtrate obtained from CPS 1 (resistant) strongly inhibited spore germination (Table 1) while that of JG 62 stimulated spore germination compared with that in sterile water.

Table 1. Germination of the spores of Fusarium oxysporum f.sp. ciceri in filtrates of two chickpea cultivars.

Treatment	Total no. of spores observed	Percent spore germination
Sterile water	619	89.5
CPS 1 filtrate	700	9.0
JG 62 filtrate	369	95.4

Mycelial growth

Fifty ml of each filtrate were thoroughly mixed with 50 ml of potato dextrose agar (PDA) and 15 ml of the medium poured into each of three petri dishes. PDA mixed with sterile water served as the control. A disc cut from the periphery of 7-day-old F. oxysporum f.sp. ciceri growth on PDA in petri dishes using a sterile 12 mm diameter cork borer was placed in the center of each petri dish. The petri dishes were incubated at 25°C and colony diameter was recorded at 4, 6, 8, and 10 days of incubation. At each time of measurement fungal growth was much less with the filtrate from CPS 1 than with those from JG 62 or the control (Table 2).

Table 2. Diameter (mm) of Fusarium oxysporum f.sp. ciceri colonies on potato-dextrose agar medium containing filtrates of two chickpea cultivars.

Treatment	Days of incubation			
	4	6	8	10
Sterile water	41.7	49.7	57.7	87.7
CPS 1 filtrate	15.0	17.7	21.0	29.0
JG 62 filtrate	39.3	49.3	58.0	89.0
SE ±	0.94	0.61	1.02	1.15

These results strongly suggest that the resistance of CPS 1 to race 1 of F. oxysporum f.sp. ciceri is owing to the production of a root exudate which inhibits spore germination and retards mycelial

growth. The roots of JG 62 (susceptible) produce an exudate that appears capable of stimulating spore germination, which may account for the extreme susceptibility of this cultivar.

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Sources of Resistance to Fusarium Wilt in Kabuli Chickpeas

Wilt and root rot diseases are common in Tunisia and are considered major constraints to increased chickpea production. Reddy et al (1) considered ascochyta blight to be more important, but it probably obscures subsequent losses due to fusarium wilt. It is now felt that these two diseases are of equal importance. Wilt caused by Fusarium oxysporum f.sp. ciceri appears to be widely prevalent. The yield reduction due to this disease varies and can be up to 90% in some farmers' fields.

Resistance to fusarium wilt has been identified in desi chickpeas but, to the authors' knowledge, not so far in kabuli chickpeas. Kabuli x desi crosses undertaken at ICRISAT have successfully transferred the desi resistance into kabuli types for cultivation in the Indian subcontinent (Kumar et al)(2). However, such crosses usually produce a high proportion of desi seed types in the segregating generations, thus reducing the chances of obtaining fusarium wilt resistance in a true kabuli seed type. This problem can be overcome by identifying resistance in a kabuli background.

A beginning was made in Tunisia in 1981 by initiating selection for resistance in a crop of the local Tunisian landrace (Amdoun) in a heavily wilt-infested field (Fig. 1) at Béja research station located in the northern part of the country.

A large majority of plants was killed prematurely by fusarium wilt, but many green plants with pods were evident. These were harvested individually and sown in 1982 as progeny rows, 4 m long and 50 cm apart. Progenies which produced the heaviest yields were sown in a wilt-sick plot at Beja research station in a replicated trial in 1983, together with Amdoun and two ICARDA entries as checks. All entries were visually rated for fusarium wilt infection on a 1 to 9 scale (1 = resistant, 9 = complete kill) and seed yields and seed sizes were recorded.

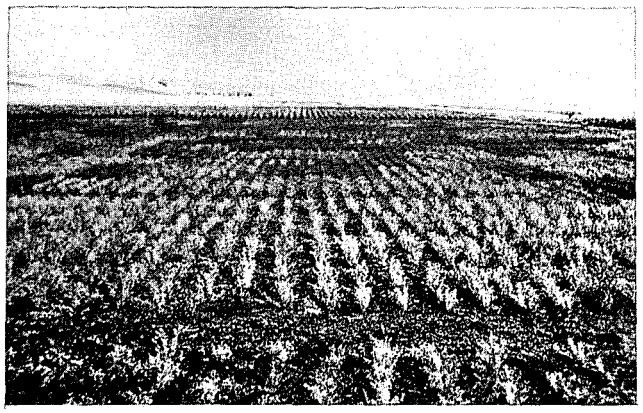

Figure 1. Wilt infested field at Beja.

There were significant differences among entries in wilt scores and seed yields (Table 1). Seven of the progenies showed no wilt symptoms while the remainder exhibited only low levels of infection. The two ICARDA entries showed moderate levels of infection and produced poor seed yields. All entries

Table 1. Performance of selected chickpea lines against wilt, and their seed yields and seed sizes.

Lines and selections	Fusarium rating	Seed yield (kg/ha)	Weight of 100 seeds (g)
PL-Se-Be-81-48	1.0	1680	54.4
PL-Se-Be-81-78	1.0	1550	49.5
PL-Se-Be-81-86	1.0	1440	51.7
PL-Se-Be-81-87	1.0	1360	51.0
PL-Se-Be-81-103	1.0	1490	52.1
PL-Se-Be-81-108	1.5	1220	53.9
PL-Se-Be-81-116	1.0	1480	52.6
PL-Se-Be-81-120	1.5	1420	53.8
PL-Se-Be-81-126	1.5	1360	51.5
PL-Se-Be-81-128	2.0	1200	50.7
PL-Se-Be-81-144	1.5	1560	49.3
PL-Se-Be-81-146	1.0	1580	53.4
PL-Se-Be-81-149	1.5	1610	52.0
PL-Amd-Beja	8.5	49	43.8
FLIP 80-51	5.0	390	24.1
FLIP 80-30	5.0	130	23.1
Mean	2.2	1220	
SE ±	0.38	123.9	
CV %	24.9	14.4	