Screening Pigeonpea for Resistance to Fusarium Wilt

Y. L. NENE, Principal Plant Pathologist and Leader, Pulse Improvement Program, and J. KANNAIYAN, Plant Pathologist, International Crops Research Institute for the Semi-Arid Tropics, ICRISAT P.O., Patancheru 502 324, Andhra Pradesh, India

ABSTRACT

Nene, Y. L., and Kannaiyan, J. 1982. Screening pigeonpea for resistance to Fusarium wilt. Plant Disease 66:306-307.

Field screening of more than 11,000 entries of pigeonpea (*Cajanus cajan*) showed 33 lines to be resistant to *Fusarium udum*, the cause of pigeonpea wilt. However, only one line—ICP-8863—was found to be resistant in both greenhouse and laboratory screening tests.

Pigeonpea (*Cajanus cajan* (L.) Millsp.) wilt caused by *Fusarium udum* Butler was first described by Butler from India in 1906 (1,3). The disease has since been reported from Bangladesh, Ghana, Grenada, Indonesia, Kenya, Malawi, Mauritius, Tanzania, Thailand, Trinidad, Uganda, and Zambia (4). Our surveys have demonstrated the widespread prevalence of this Fusarium wilt in India, Kenya, Malawi, and Tanzania (*unpublished*).

Cultivars resistant to this fungus would be the most practical way to control the disease. As early as 1905, Butler attempted to identify wilt-resistant cultivars (2). Much later, some institutions in India released wilt-resistant cultivars (7). However, most of these releases did not show uniform resistance to *F. udum* when tested in a wilt plot nursery developed at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Pigeonpea is a partially cross-pollinated crop, and we may have been supplied with open-pollinated seed. To improve the resistance of these cultivars and identify new sources of resistance to *F. udum*, we began systematic screening of the world germ plasm collection of pigeonpea at the ICRISAT center in 1976. This paper reports our findings.

Authorized for publication as ICRISAT journal article 171 dated 27 March 1981.

Accepted for publication 20 June 1981.

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0191-2917/82/04030602/$03.00/0

MATERIALS AND METHODS

Field screening. Uniform wilt plots were developed in 3 yr in 3.5 ha of a deep black soil of the Vertisol group and 0.5 ha of a red soil of the Alfisol group at the ICRISAT center by incorporating chopped, wilted pigeonpea plants and growing cultivars susceptible to *F. udum*. As far as we have been able to ascertain, only one pathogenic strain is present in these uniform wilt nursery plots. Since 1976, every fifth row in the wilt plots has been planted to susceptible cultivars ICP-2376 or ICP-6997 to maintain a high inoculum density in the plots as well as to allow comparison of test material with a highly susceptible cultivar.

Cultivars reported as resistant to *F. udum* elsewhere, lines resistant to other important pathogens (eg, sterility mosaic virus and *Phytophthora drechsleri* Tucker f. sp. *cajani* (Pal, Grewal & Sarbhoy) Kannaiyan et al), and germ plasm accessions obtained from ICRISAT's Genetic Resources Unit were screened. Plantings were made in late June or early July in the uniform wilt plots with the onset of the monsoon (rainy) season. The data on wilt incidence (percentage of mortality) were recorded 2 wk before harvest. Lines with less than 20% wilt (based on stand count using a total of about 50 plants) in the first screening and with less than 10% wilt in successive screenings were considered resistant to *F. udum*. Each year, selected plants among the resistant lines were selfed and advanced for repeat screening.

Greenhouse screening. Lines considered homozygous resistant to *F. udum* in the field were evaluated further in the greenhouse. For inoculum, a single-conidium culture of *F. udum* was multiplied on 100 g of 9:1 sand:pigeonpea meal medium for 15 days at 28–30 C. Two hundred grams of this inoculum was mixed well with 2 kg of autoclaved red soil and placed in one 15-cm plastic pot. Pots were watered and incubated at 25–30 C for 2 days before transplanting five 7- to 10-day-old pigeonpea seedlings per pot. There were three replicates per entry. Wilt incidence was recorded 60 days after transplanting.

Laboratory screening. A water-culture technique in the laboratory was used to evaluate field- and greenhouse-selected lines. The technique was similar to procedures described earlier (5,6,8). Single-conidium cultures of *F. udum* were multiplied on 100 ml of potato-dextrose broth in 250-ml flasks that were placed on a rotary shaker for 10 days at 25–30 C. Because we found that the culture filtrates were not toxic to pigeonpea seedlings, the entire contents of each flask were diluted with sterile distilled water to a final inoculum concentration of 2.5%.

Pigeonpea seedlings grown for 7–10 days in sterile, riverbed sand were transferred separately to glass tubes containing 20 ml of inoculum. Seedlings were held in position by cotton plugs. Sterile distilled water was added to tubes every 48 hr to make up for any loss of water. Fifteen seedlings were used for each entry, and one uninoculated seedling in sterile distilled water was kept as a check for each line. The susceptible check line ICP-2376 was also inoculated for comparison with the test entry; it usually wilted in 7–10 days. Data were recorded 15 days after inoculation. Uninoculated seedlings normally remained healthy for more than 3 wk.

RESULTS AND DISCUSSION

Since 1976, more than 11,000 entries (including cultivars supposedly resistant to *F. udum*, lines resistant to other pathogens, breeding populations, and germ plasm accessions) have been screened in the wilt plots. We have discarded the susceptible segregants and selfed individual plants resistant to *F. udum* to fix resistance in a homozygous

condition. Thirty-three entries have been identified as resistant to *F. udum* or have had the level of resistance increased in two to four successive field screenings: ICP-1641, 3753, 3782, 4769, 5097, 6831, 7118, 7120, 7182, 7198, 7201, 7273, 7336, 7867, 8858, 8859, 8860, 8861, 8862, 8863, 8864, 8865, 8866, 8867, 8868, 8869, C. No. 74342, C. No. 74360, C. No. 74363, AWR-74/15, Banda Palera selection, Bori-1 selection, and Purple-1 selection. Of these, T-17 (ICP-1641), C-11 (ICP-7118), No. 148 (ICP-7120), BDN-1 (ICP-7182), KWR-1 (ICP-7198), HY-3A (ICP-7201), NP(WR)-15 (ICP-8859), and HY-3C (ICP-8862) are cultivars that were improved for resistance to *F. udum* through our screening method.

Susceptible checks had 78.2–93.5% wilt in Vertisol wilt plots and 98.6–99.6% in the Alfisol wilt plot. Some of the entries supposedly resistant to *F. udum*—NP(WR)-15, KWR-1, 20-1, T-17, C-11, No. 148, BDN-1, Purple-1, Banda Palera, and Bori-1—had to be selfed for additional wilt-plot screening because they showed 22–70% wilt in the first field screening. Some of the sources of resistance to *F. udum* are now being used extensively in the breeding program at the ICRISAT center and elsewhere to develop pigeonpea cultivars resistant to *F. udum*.

Of these 33 entries, 16 were resistant (ICP-3782, 4769, 5097, 6831, 7201, 7273, 7336, 7867, 8861, 8862, 8867, 8869, C. No. 74342, C. No. 74360, C. No. 74363, and Purple-1 selection) and three (ICP-8858, 8859, and 8860) were tolerant to the sterility mosaic virus; eight (ICP-3753, 7182, 8865, 8866, 8868, C. No. 74360, C. No. 74363, and Banda Palera selection) were resistant to the Phytophthora blight fungus. The ICP-8863 line was resistant only to *F. udum*. Some of the progenies from cross numbers 74360 and 74363 were found resistant to all of the three major pathogens attacking pigeonpea. These progenies may be useful in developing multiple pathogen-resistant pigeonpea cultivars.

Resistance of only the one line ICP-8863 to *F. udum* was confirmed through greenhouse and laboratory screening tests; all other lines and cultivars were found susceptible. This is not surprising. Many lines found resistant to *F. udum* under field conditions were in fact infected by *F. udum*, which could be isolated from unwilted plants of such lines. When we cut the tops off the unwilted plants and allowed regrowth, these plants wilted. Most of the lines were thus only field resistant to *F. udum*. The ICP-8863 line, however, was not infected by *F. udum*. This should explain its resistance to the wilt fungus when tested in the greenhouse and the laboratory.

Lines that appear promising are tested every year through a network of cooperating institutions, mainly in India. In 1980, for example, we sent 16 promising lines of pigeonpea for testing to 14 locations in three countries. In previous years, the ICP-8863 line was found resistant to *F. udum* at most locations and other lines were found field resistant at several locations in India. We are working to obtain information on the existence of races in *F. udum*, if any exist.

Seeds of lines resistant to the major pathogens of pigeonpea are maintained by ICRISAT's Genetic Resources Unit and are available upon request.

ACKNOWLEDGMENT

We gratefully acknowledge the technical assistance of T. N. Raju and V. K. Sheila of Pulse Pathology, ICRISAT.

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