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Effectiveness of hill plots in screening pigeonpea for resistance to Fusarium wilt

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ABSTRACT

In field trials conducted in a wilt-sick vertisol plot at ICRISAT Centre during the 1987-88, 1988-89 and 1989-90 crop seasons, no differences in Fusarium wilt incidence were observed in a set of susceptible, tolerant and resistant pigeonpea cultivars between row - and hill - sown plots. Similarly, no change in wilt reaction was observed when a susceptible and resistant cultivar were sown either pure or mixed on hills. Hill-sowing can be more economical for evaluating large numbers of genotypes for wilt resistance than row-sowing as only one fifth of the area is required and thus operational expenses are reduced.

Fusarium wilt (*Fusarium udum* Bulter) is an important soilborne disease of pigeonpea (*Cajanus cajan* (L) Millsp.) (1). Greenhouse and field-inoculation techniques have been standardized for screening of breeding material and germplasm (3). For wilt resistance, screening in sick plots is normally done by interplanting of known susceptible cultivars after every 2-4 test rows to compare the reaction of the test materials with that of the susceptible genotypes. Screening germplasm and breeding lines in an active breeding program requires large-sized sick plots with uniformly high levels of inoculum. Development and maintenance of sick plots is expensive. Substitution of row- plots with hill-plots is more economical without compromising on the efficiency of screening as only one fifth of the area is required. The present experiment was planned to compare the two sowing systems in a wilt-sick nursery.

MATERIALS AND METHODS

Row vs. hill-sowing

All experiments were conducted in a wilt sick plot, at ICRISAT Centre for three consecutive seasons. During 1987-88, three pigeonpea cultivars representing wilt susceptible, tolerant, and resistant types were included in the trial. In 1988-89 and 1989-90 three additional cultivars representing one of the three reaction types were included. The experimental design used was split-plot with cultivars as main plots and sowing methods as subplots. The size of each subplot was 4.8 m^2, accommodating two 4 m long rows spaced 60 cm apart. In row-sowing, 100 seeds were sown in two rows (Fig. 1). In hill-sowing, 100 seeds were sown in 10 hills of 10 seeds each and five hills per row. The number of replications were three in 1987-88 and 1989-90, and four in 1988-89. The rainfed plots were kept weed-free

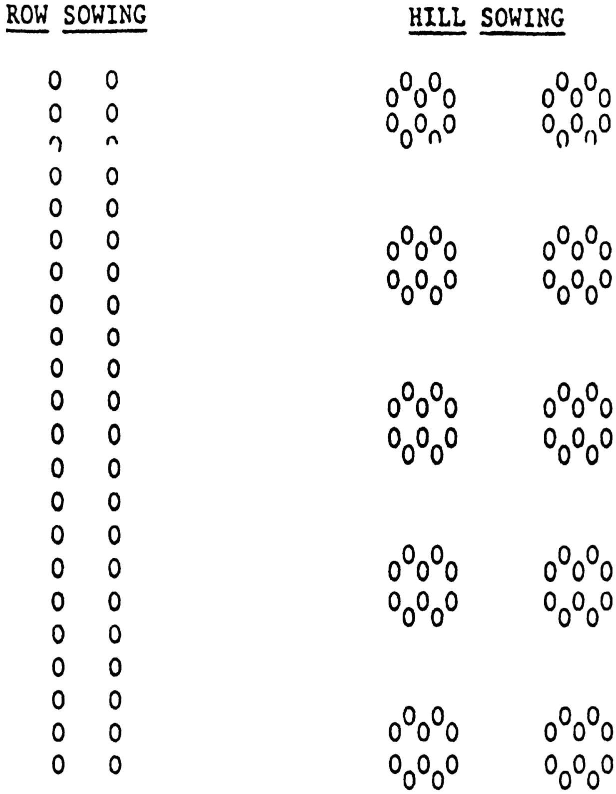

Fig. 1. A schematic diagram showing the row vs. hill-sowing of pigeonpea.

Table 1. Influence of sowing method on Fusarium wilt incidence in pigeonpea in a wilt-sick Vertisol plot

	Will incidence (%)					
	Row sowing			Hill sowing		
Genotypes	1987-88	1988-89	1989-90	1987-88	1988-89	1989-90
ICP 2376	98(86)[1]	96(81)	81(65)	100(90)	88(70)	70(62)
LRG 30	NT[2]	93(78)	88(72)	NT	92(74)	83(66)
C 11	NT	58(50)	32(34)	NT	46(46)	19(25)
BDN 1	98(84)	63(54)	62(52)	90(72)	44(42)	73(61)
ICP 8863	6(9)	7(13)	2(9)	5(11)	3(9)	1(7)
ICPL 227	NT	2(4)	8(16)	NT	32(28)	11(19)

SE ±	1987-88	1988-89	1989-90
Cultivar	1.4(2.1)	9.68(6.15)	6.3(5.1)
Sowing method	1.4(2.3)	1.89(1.75)	2.1(1.8)
Cultivar x Sowing method	2.2(3.6)	10.22(6.86)	7.3(6.0)
CD at 5%			
Cultivar	4.8	31.2	19.8
Sowing method	6.3	11.5	12.8
Cultivar X Sowing method	6.6	29.9	21.4

1. Figures in parentheses are angular transformed values

2. NT= Not tested

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IDENTIFICATION AND INHERITANCE OF A NEW DWARFING GENE IN PIGEONPEA

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ABSTRACT

A spontaneous dwarf (D_{11}) mutant was identified in an advanced line ICPL 146. In order to study inheritance of the dwarfness in D_{11} and its allelic relationship to the D_1 dwarfing gene, D_{11} was crossed with three tall lines (ICPL 146, ICPL 85024, ICPL 85037) and a D_1 dwarf (ICPL 85059) in 1986. The segregation patterns in F_1, F_2, backcrosses to both the parents and F_3 progenies suggested that D_{11} dwarfness is governed by a single recessive gene in homozygous condition (t_5t_5). The genes in D_{11} and D_1 were found to be nonallelic.

Key words: *Cajanus cajan*, dwarf mutant, inheritance.

The excessive vegetative growth related to tallness of traditional pigeonpea [*Cajanus cajan* (L.) Millsp.] cultivars leads to reduced harvest index and hinders efficient crop management practices. Delayed plantings can result in reduced height [1]. However, Mohammed and Ariyanayagam [2] argued that the use of genetic dwarfs would be a more desirable approach to reduce plant height.

A bushy dwarf pigeonpea with brittle branches and condensed internodes was reported [3–5]. They found that the dwarfness was controlled by a single recessive gene. Twelve sources of dwarfism (D_0 to D_{11}) in pigeonpea are available at ICRISAT Center. Genetic studies of the D_0 indicated that the dwarfness was controlled by two nonallelic recessive genes t_1t_1 and t_2t_2 [6]. Jain [7] found that dwarfing in D_1 was controlled by a single recessive gene (t_4t_4). Inheritance of dwarfness D_6, PD_1 (D_7) and PBNA (D_8) indicated that the dwarf phenotype in each of the three lines was controlled by a single recessive gene in homozygous state [8]. They also reported that D_6 and PD_1 had similar alleles (t_3t_3) and PBNA had a different allele ($t_3^h t_3^h$) for dwarfness.

During 1986 rainy season a spontaneous dwarf mutant plant was identified at the ICRISAT Sub-Center, Hisar in an advanced short duration pigeonpea line ICPL 146. Its

height at maturity was 35 cm as against the 130 cm of ICPL 146. This dwarf was designated as D_{11}. The present study was conducted to study the inheritance pattern of the dwarfing gene in D_{11} and its allelic relationship to the gene controlling dwarfness in the D_1 dwarf, an extensively used parent in the crossing program at ICRISAT.

MATERIALS AND METHODS

Two dwarf (D_1 and D_{11}) and three tall (ICPL 146, ICPL 85024 and ICPL 85037) pigeonpea lines were included in this study. Characteristics of these dwarf and tall parents are summarized in Table 1. The D_{11} dwarf was the shortest parent with a mean height of 39.5 cm and ICPL 85037 was the tallest with a mean height of 120 cm. The mean plant height of D_1 dwarf (ICPL 85059) and tall parent ICPL 85024 was about the same (Table 1), however, the branching pattern and the internode length in these two parents were significantly different. ICPL 85024 had on an average 7.2 primary branches per plant at mean internode length of 5.3 cm, while ICPL 85059 (D_1 dwarf) had on an average 12.8 primary branches per plant at mean internode length of 1.9 cm. The internodes in D_1 dwarf are condensed so that acute branches radiate from a narrow region about 10 to 15 cm above the ground level. The main branches are brittle.

Table 1. Characteristics of the parents used in the study on pigeonpea

Parent	Plant height (cm)	No. of primary branches	Internode length (cm)	Days to flowering
D_{11} dwarf	39.5 ± 1.7	5.8 ± 0.3	3.0 ± 0.1	61.8 ± 0.4
D_1 dwarf (ICPL 85059)	85.7 ± 1.4	12.8 ± 0.7	1.9 ± 0.1	64.1 ± 0.6
ICPL 146	106.4 ± 0.9	7.9 ± 0.4	7.2 ± 0.2	66.5 ± 0.4
ICPL 85024	85.6 ± 1.0	7.2 ± 0.3	5.3 ± 0.2	58.5 ± 0.5
ICPL 85037	120.0 ± 0.6	9.0 ± 0.4	8.7 ± 0.2	63.6 ± 0.4

Each of the two dwarf lines was crossed to all the three tall parents and also among themselves to study allelic relationship. The F_1s were grown during 1987 at Hisar to produce F_2 seed and to backcross with both the parents. The parents, F_1, F_2 and backcross to both the parents were grown during 1988 at Hisar. The parents, F_1, and the backcrosses were planted in one row and F_2 populations were grown in 20 row plots of 9 m length. The rows were spaced 60 cm apart with intra-row spacing of 15–20 cm. The number of dwarf and tall plants in each generation for each of the four crosses were recorded. In each of the three F_2 populations involving crosses between D_{11} dwarf and the three tall parents, 20–50 and 52–231 tall plants were selected randomly to study the segregation pattern in the F_3 generation. In the 1989 rainy season F_2-derived F_3 progenies were grown at Hisar, along