The study has thus revealed the scope of combining high yield with wilt resistance in brinjal by crossing resistant varieties to susceptible commercial varieties. Brinjal, being a crop with high reproductive potential, even hand emasculation and pollination would make hybrid seed production commercially viable. It would be worthwhile to conduct such studies in other vegetable crops like chillies and tomato where exploitation of heterosis is a feasible proposition.

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SOURCES AND INHERITANCE OF RESISTANCE TO ALTERNARIA BLIGHT IN PIGEONPEA

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SUMMARY

Alternaria blight is a major disease of post-rainy pigeonpea plantings in Uttar Pradesh, Bihar and West Bengal. Several adapted cultivars, high-yielding advanced breeding lines in different maturity groups, lines resistant to wilt, sterility mosaic and *Phytophthora* and seven *Atylosia* spp. were screened in pot culture under greenhouse conditions. Occurrence of resistance to Alternaria blight in different lines suggested wide distribution of a resistance gene. Inheritance studies involving three crosses suggested that the resistance to Alternaria blight is controlled by a single recessive gene, designated as abr_1..

Alternaria leaf spot or blight of pigeonpea (*Cajanus cajan* (L.) Millsp.) is caused by *Alternaria tenuissima* (Kunze ex. Pers. Wiltshire) (Pavgi and Singh, 1971). Merta and Sinha (1982) reported that the causal organism for this disease was *Alternaria alternata* (Fr.) Keissler. It is a minor disease in the main pigeonpea crop planted with the onset of the monsoon throughout the country. In this crop the symptoms are confined generally to the older leaves (Kannaiyan and Nene, 1977). However, in recent years planting of a post-rainy (September–October) season crop of pigeonpea with high yield potential of over 3000 kg/ha has been recommended (Roy Sharma *et al.*, 1981) for Part of Bihar state.

This system of post-rainy season planting was seriously threatned by Alternaria blight during 1979–80, when the recommended cultivars Bahar and Basant were planted in eastern Uttar Pradesh and Bihar (Merta and Sinha, 1982; Venkateshwarlu *et al.*, 1981). In this season the pathogen attacks all the green parts of the plants. Dark lesions with concentric rings, typical of Alternaria, infection were formed on the leaves (Fig. 1). In severe cases lesions appeared on the branches and stems and caused complete defoliation. This is a good example of a minor diesease becoming a major one due to the change in the cropping system.

Development of Alternaria-resistant varieties suitable for post rainy season planting will be the most effective way to control the losses caused by this disease. In the past no effort was made to identify sources of resistance and study the inheritance of Alternaria blight resistance. Venkateshwarlu *et al.* (1981) observed that the lines MA-128-1, MA-128-2 from Varanasi (U.P.), DA-2 from Dholi (Bihar) and 20 (105), a line from West Bengal were free from the disease under natural field incidence at Varanasi, where disease incidence is usually high. Also ICP 7105, a germplasm collection from Berhampore, West Bengal used in crossing program at ICRISAT and supplied to the national program at Dholi and Varanasi, was found free of the disease.

At ICRISAT we screened parents, advanced lines and promising germplasm lines carrying resistance to other diseases such as, sterility mosaic, wilt and Phytophthora blight, in pot culture under greenhouse conditions. Besides pigeonpea different species of *Atylosia*, a closely related genus and the secondary gene pool for *Cajanus*, were also screened for resistance. The crosses between some of the resistant and susceptible

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MATERIALS AND METHODS

Screening of the pigeonpea lines was done in an Isolation Plant Propagator (Burkard Manufacturing Co. Ltd., Rickmansworth, Herts, England, in a greenhouse. From each genotype, 15–20 seeds were sown in a 15-cm diameter plastic pot filled with sterilized sand (75%) and vermiculite (25%). A field culture of *Alternaria tenuissima* from Varanasi, India was maintained on potato dextrose agar (PDA) or V-8 juice agar. A 5-mm disc of a 1-week old culture was transferred to each of several 250-ml flasks containing 100-ml of potato dextrose broth. The cultures were incubated at 28–30°C for 15 days. Mycelium was collected along with spores by filtering the substrate and macerated intermittently for 2–3 min in a Waring blender with tap water. The macerated fungus and spore suspension were diluted with tap water. Two-week old seedlings were incoculated by sparying macerated fungus and spore suspension carrying 3.25 x 10 conidia per ml. After incoculation the plants were covered with plastic covers for 10 days to maintain high humidity. Ten days after inoculation, observations were recorded on the number of resistant and susceptible plants in each line. Since cross pollination is common in pigeonpea and seeds of the many lines tested where from an open-pollinated source, lines were classified into three groups; resistant, segregating and susceptible. Blighted plants were considered susceptible and plants free from disease were considered resistant.

RESULTS AND DISCUSSION

Screening of adapted cultivars

Of 108 adapted pigeonpea cultivars and high-yielding advanced breeding lines in different maturity groups that were screened 23 were resistant to Alternaria blight. Plant and grain characteristics of these lines are given in Table 1. In extra early (100 days) and early (150 days) maturity groups, respectively, five and 11 lines were resistant. These included the three widely grown early cultivars Prabhat, UPAS–120 and T–21. Other potentially high-yielding lines are in the final stages of testing under. The all India Coordinated Pulses Improvement Project (AICPIP). An examination of the parentage of these cultivars (Table 1) showed that most of the advanced breeding lines were derived from crosses involving UPAS–120, Prabhat or T–21. The latter two are selections made at Kanpur during late 1950s from the cross T–1 x T–190. Therefore, it appears that resistance to Alternaria blight in most of the early maturity lines was probably inherited either from T–1 or T–190 and it has a narrow parental base. It is not known whether one or both of T–1 and T–190 are resistant. Since they were not available they could not be tested for the disease reaction.

Among the four medium (180 days) maturity cultivars, resistant to Alternaria blight (table 1), two (HY3A and HY3C) were selected from a South American germplasm line PI 2817 at AICPIP Rajendranagar, Andhra Pradesh, India. The cultivar 20(105), developed at Berhampore, West Bengal from the cross Prabhat x B–517 has been recommended for cultivation in post-rainy season in West Bengal.

Of the seven late maturity resistant cultivars (250 days), ICPL 365 and ICPL 366 are selections from a high yielding germplasm line ICP 7105, while ICPL 359 and ICPL 368 were derived from crosses involving ICP 7105 as one of the parents (Table 1).

Screening of promising parents resistant to other important diseases of pigeonpea.

Lines with resistance to wilt (62), sterility mosaic (56) and Phytophthora (45)

Table 1. Characteristics of Promising Alternaria-resistant pigeonpea lines of different maturity.

S. No.	Genotype	Pedigree	Days to 50% Flowering	Days to Maturity	Plant height (cm)	Seeds/pod	g/100 seeds	Yield kg/ha	Reaction to Wilt	Reaction to SMD**	Reaction to Phytophthora (P2)
1.	Prabhat	T–1 x T–190	66	103	130	3.3	6.6	2513	–	S	S
2.	H76–11	Prabhat x UPAS–120	62	102	130	3.4	8.4	2390	–	S	–
3.	H76–44	Prabhat x UPAS–120	61	102	127	3.5	6.9	2661	–	S	S
4.	H76–51	UPAS–120 x Prabhat	56	100	107	3.3	6.8	1805	–	S	S
5.	H81–8	Unknown bulk	62	102	127	3.1	6.6	2630	–	S	–
6.	ICPL–146*	ICP–6997 x Prabhat	98	143	205	3.6	9.8	2796	S	R	S
7.	ICPL–155	ICP–6997 x Prabhat	101	150	222	3.9	7.9	4123	S	S	S
8.	ICPL–87	T–21 x Ja 277	103	153	231	3.6	11.2	2074	R	S	S
9.	ICPL–161*	T–21 x Plant A–2	117	160	251	3.7	10.2	1885	S	S	R
10.	TAT–10	TT–2 x TTB	105	149	249	3.1	8.4	1862	S	S	S
11.	H76–208	T–21 x UPAS–120	108	148	251	3.2	5.8	2206	S	S	S
12.	UPAS–120	P–4768 Sel.	107	147	249	3.2	6.8	2106	S	S	S
13.	T–21*	T–1 x T–190	118	159	279	3.3	8.7	1662	S	S	R
14.	TT–5	T–21 Mutant	118	164	272	3.1	11.7	1639	S	S	S
15.	DA–6	–							–	S	–
16.	DA–9	–							–	S	–
17.	HY3A	PI 2817–1–A	131	200	195	4.58	14.62	722	R	R	S
18.	HY3C	PI 2817–2	131	200	187	4.53	14.68	826	R	R	S
19.	BWSMR–1		125	185	214	4.4	14.0	2133	–	R	S
20.	20(105)	Prabhat x B517	126	177	136	4.1	13.8		–	R	S
21.	PS–66		144			3.9	13.17	638	–	R	S
22.	DA–2		156	261	147	3.5	8.9	3070	–	S	S
23.	DA–11								–	R	S
24.	ICPL–359	ICP–7105 x NP–69	138	275	197	3.9	9.7	2625	S	R	S
25.	ICPL–365	ICP–7105 Selection	138	274	185	3.6	8.9	3031	S	S	S
26.	ICPL–366	ICP–7105 Selection	138	269	178	4.1	9.0	2156	S	R	S
27.	ICPL–368	ICP–7105 x ICP–4741	135	275	188	4.0	9.4	2375	S	S	S

R, S Resistant and Susceptible, respectively
– Information not available
* Have high field resistance to Phytophthora isolate present at Pantnagar
** Sterility mosaic disease.

Table 2. Characteristics of promising parents and gemplasm lines showing resistance to Alternaria blight.

S. No.	ICP No.	Pedigree	Days to 50% Flow-ering	Days to 75% Matu-rity	Plant height (cm)	Seeds/ pod	g/100 seeds	Reaction to Wild	Reaction to SMD	Reaction to Phytophthora (P2)
1.	3782	Ja 274 (JNKVV–line)	158	250	230	5.0	15.8	–	R	S
2.	3783 (8867)	Ja 275 (JNKVV–line)	142	280	235	4.8	18.4	R	R	S
3.	4725	Ja 278 (JNKVV–line)	155	215	240	5.2	13.5	S	R	S
4.	6997 (8850)	M.P. Coll.	177	178	182	4.9	13.4	S	R	S
5.	7035 (8861)	M.P. Coll.	136	225	176	4.8	21.4	R	R	S
6.	10960	Purple-1 (BHU line)	139	188	140	3.6	17.6	R	R	S
7.	2376	A.P. Coll.	116	180	235	3.5	9.8	S	R	R*
8.	2630	A.P. Coll.	149	220	220	5.0	16.8	–	R	S
9.	2719	Assam Coll.	141	201	250	3.6	8.1	–	–	R*
10.	7869	Karnataka Coll.	148	205	230	4.5	14.7	S	R	S
11.	7873 (8856)	Karnataka Coll.	144	197	210	4.5	12.2	S	R	–
12.	7904	Karnataka Coll.	151	208	213	3.8	11.9	S	R	S
13.	7906 (8857)	Karnataka Coll.	151	197	245	4.5	14.1	S	R	S
14.	7942 (8869)	Karnataka Coll.	158	210	207	4.1	15.3	R	R	S
15.	5097	Bihar Coll.	130	204	260	4.0	9.0	R	R	R*

* Susceptible to P3 isolate.

diseases were screened and respectively, six, 13 and two were resistant (Table 2). Of the 45 multiple (wilt + Sterility Mosaic + *Phytophthora*) disease-resistant lines screened, 17 were resistant to Alternaria blight. These included 11 inbred lines from a Bihar collection (ICP 5097) and five and one advanced breeding lines, respectively, from crosses 74360 (ICP 7065 x ICP 7035) and 74363 (ICP 7065 x HY3C). These 17 lines are of great value to breeders since they carry resistance genes to all four important diseases. In addition one line from cross 74376 (ICP 4235 x ICP 7105) and two lines viz. MA 128–1 and MA 128–2 developed at BHU, Varanasi were also resistant to Alternaria blight. Some important plant and grain characteristics of these lines are given in Table 2.

Screening of Atylosia species

Seven *Atylosia* spp., viz. *A. albicans* Benth., *A cajanifolia* Haines., *A lineata* W.A, *A platycarpa* Benth., *A. scarabaeoides* (L.) Benth., *A sericea* Benth., and *A volubilis* Gamb. also exhibited resistance to Alternaria blight. Some important characteristics of these *Atylosia* spp. and their crossability with pigeonpea are given in Table 3.

Though five of the *Atylosia* spp. can be easily crossed with *Cajanus*, but at present apparently there is no need to transfer resistance genes from *Atylosia* to pigeonpea, since the resistance is easily available in a number of agronomically promising pigeonpea types.

Genetic studies

Three crosses involving two resistant (JA–275 and ICP 7035) and two susceptible (BDN–1 and C–11) parents were studied to determine the inheritance of resistance in F_1 and F_2 generations.

All the plants in the three F_1 hybrids involving susceptible and resistant parents were susceptible and in F_2 a segregation ratio of 3 susceptible one resistant (Table 4) was observed in each cross. The pooled values over the three crosses also fitted a 3:1 ratio ($P > 0.05$). These results suggest that resistance to Alternaria blight in pigeonpea is conditioned by a single recessive gene, designated as abr_1.

Table 3. Characteristics of various *Atylosia* spp. and their crossability with pigeonpea.

Species	Days to 50% Flowe-ring	Days to 75% Matu-rity	Plant spread	Plant height (cm)	Seeds/ pod	g/100 seeds	Crossability with pigeonpea
A. albicans	150	200	Climber	–	5	3.1	Yes
A. cajanifolia	140	214	Compact	228	6	3.5	Yes
A. lineata	188	264	Semi-spreading	50	3	2.4	Yes
A. scarabaeoides	98	158	Creeper	–	5	7.8	Yes
A. sericea	128	169	Semi-spreading	55	2	1.8	Yes
A. platycarpa	55	90	Creeper	–	6	6.9	No
A. volubilis	202	289	Climber	—	6	3.6	No

Source: Genetic Resources Unit, ICRISAT

Table 4. Segregation for Alternaria blight resistance in the F_2 generation of three resistant x susceptible pigeonpea.

Cross	No. of plants		Prob
	Susceptible	Resistant	(3:1)
BDN–1 x Ja 275	94	32	.90 – .95
C–11 x Ja 275	78	21	.40 – .50
C–11 x ICP–7035	65	23	.80 – .90
Pooled	237	76	.70 – .80

It appears that resistance to Alternaria blight is widely distributed in the pigeonpea germplasm of various states of India and even in areas where occurrence of disease is not severe. The sources of resistance identified in the pigeonpea and *Atylosia* lines can be grouped broadly into: (i) T–1/T–190 derivatives; (ii) Bihar and West Bengal collections; (iii) Madhya Pradesh collections; (iv) Karnataka and Andhra Pradesh collections; (v) South American collections and (vi) *Atylosia* spp. Since the limited study of inheritance indicates that resistance to the field isolate under study is controlled by a single recessive gene, it would be desirable to determine whether the different sources of resistance carry the same gene or different genes.

Though agronomically superior resistant lines are available in all the three major maturity types, late maturity lines are of considerable importance since medium and early types are not suited to post-rainy season planting (Roy Sharma *et al.* 1981), where Alternaria blight is the serious problem. Lines resistant under greenhouse screening were invariably resistant in field conditions.

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SYNTHESIS OF TESTCROSS PARENTS WITH MULTIPLE RECESSIVE CHARACTERS IN WHITE JUTE

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SUMMARY

In an intervarietal cross of white jute, *Corchorus capsularis* var. Sirha Sada from Nepal X Pale yellow Blue seeded(o), a recessive character, elliptic and crenate leaf shape of the former was transmitted to the latter PBS(o) which was evolved earlier with six recessive characters, i.e., non-bitter leaf, unbranched habit, pale yellow corolla, oval pod, blue seed, snow white fibre and stick. The newly produced seven-recessive marker line will prove more useful in selecting out individuals at the seedling stage to facilitate the future breeding program. Genes for bitter taste and branching habit were linked with a recombination value of 27.5%.

The importance of using recessive genetic markers in breeding improved varieties cannot be overemphasised. For instance, such markers can be used to distinguish hybrids from selfed individuals that are to be eliminated from the field. The use of marker parents has become important because hybrids are difficult to distinguish from selfed progenies in jute, particularly in interspecific cross combinations. Furthermore the use of such marker lines will enable the seed multiplication farms to maintain purity of seeds.

With this end in view, Ahmad *et al.* (1981, 1983) produced a three recessive marker strain. Later they synthesized a six-recessive strain by introducing three more recessive characters to the original marker strain. They named this 6-recessive strain PBS(o), P standing for pale yellow petals, BS for blue seeded and (o) for oval podded character.

In this paper, we report the synthesis of a multiple recessive marker strain by combining crenate leaf shape from Sirha Sada, a Nepalese *capsularis,* to the previously established 6-recessive marker parent.

MATERIALS AND METHODS

The types used as parents for crosses were:

(a) Sirha Sada: Branched, broadly elliptic and irregularly crenate leaf with bitter taste, yellow corolla, round podded, brown seeded, white fibre.

(b) PBS(o): Unbranched, ovate-lanceolate leaf with non-bitter taste, pale yellow corolla, oval podded, blue seeded, snow white fibre.

PBS(o) originated from the cross CBS(o) (*capsularis* blue seeded oval podded, full green unbranched type with bitter leaf, yellow corolla and snow white fibre, cf. Ahmad *et al.* 1981) X Lal Naris (brown seeded, round podded, red pigmented, much branched semi wild *capsularis* land race with sweet leaf, pale yellow corolla and white fibre, cf. Ahmad *et al.* 1983).

Seven pairs of contrasting characters including leaf shape (ovate-lanceolate vs elliptic crenate), leaf taste (bitter vs non-bitter), branching habit (branched vs unbranched),

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