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PIGEONPEA (*CAJANUS CAJAN*) AS A WINTER CROP IN PENINSULAR INDIA

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SUMMARY

Pigeonpeas (*Cajanus cajan*) are normally sown in June or July in India, at the beginning of the monsoon, but trials were carried out at Hyderabad by sowing in October or November as a winter crop. The duration of the crop, especially of the 'medium' and 'late' cultivars, was much reduced. In 1975–76, October-sown pigeonpeas gave yields comparable to those of the normal season but much lower yields were produced by planting in November 1975. 'Medium' and 'late' cultivars significantly outyielded early ones. Optimum plant populations for winter crops were 3–5 times higher than are normally used in the monsoon. Pigeonpeas at relatively high population densities could have considerable potential as a winter crop in peninsular India.

In India pigeonpeas (*Cajanus cajan* (L.) Millsp.) are normally sown at the beginning of the monsoon season, in June or July (Mahta and Dave, 1931), often as an intercrop with rows several metres apart (Pathak, 1970), though sole crops of medium and late types are generally grown with row spacings of 0·75–1·35 m. The plants develop into woody shrubs, with flowering and pod development in the winter (*rabi*) season (October–March), when there is little or no rainfall and unirrigated crops depend on moisture stored in the soil.

In large tracts of India, where the soils have a sufficiently high water-holding capacity, unirrigated rabi crops are sown on land left fallow during the monsoon season, or after the harvest of a short-duration monsoon-season crop. The pulse crop most commonly grown in this season is chickpea (*Cicer arietinum* L.), the average yields of which are highest in the plains of Northern India and Pakistan (800–1000 kg/ha): such yields are twice those normally obtained in peninsular India (Argikar, 1970), probably because the rabi season is longer and cooler in the North (van der Maesen, 1972).

Pigeonpeas tolerate higher temperatures than chickpeas, and it seemed possible that they might perform well as a winter crop in peninsular India,where they have indeed been grown traditionally in that way to a small extent. For example, in 1902–03 about 2% of the area under pigeonpeas in the Bombay Presidency was planted as a rabi crop (Watt, 1908).

Most pigeonpeas seem to be 'short-day' plants and recent work at this Institute has shown that flowering of medium and late-maturity cultivars is not initiated (under Hyderabad conditions) when daylengths exceed about 12 h 15 min. They

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develop under short-day conditions, when they are planted at the beginning of the rabi season and flower and mature considerably sooner than when planted at the usual time in June or July (Anon., 1975).

The classification of pigeonpea cultivars into different maturity-groups is based on their duration after planting in June or July, when early, medium and late cultivars mature in 4–5, 5–6 and 6–9 months respectively at Hyderabad. We therefore compared the performance of cultivars belonging to these different groups when grown as rabi crops, and also investigated the effects of population-density on yield.

MATERIALS AND METHODS

In 1975 and 1976 the crop was sown by hand in a vertisol (very fine clayey, montmorillonitic, calcareous, hyperthermic soil, family of Typic Pallustert) at the ICRISAT Centre at Patancheru (17°32′ N, 78°16′ E) 25 km north-west of Hyderabad. The land was left fallow during the monsoon season, and kept free of weeds. Phosphorus (as single superphosphate) and zinc were broadcast and

Table 1. *Rainfall and temperatures during the* rabi *seasons of* 1975–76 *and* 1976–77 *at Hyderabad. Total rainfall during the monsoon season (June-September) was* 872 *mm in* 1975 *and* 673 *mm in* 1976

	1975–76			1976–77		
Month	Rainfall (mm)	Maximum temperature (°C)	Minimum temperature (°C)	Rainfall (mm)	Maximum temperature (°C)	Minimum temperature (°C)
October	74	30·5	19·0	1	33·5	17·6
November	15	28·0	11·3	30	30·1	17·6
December	0	27·8	8·1	0	28·7	15·3
January	0	27·3	9·2	0	29·1	11·3
February	0	32·7	12·0	0	31·0	16·3
March	1	36·9	17·0	0	35·5	20·2

incorporated at the rates of 50 kg/ha P_2O_5 and 25 kg/ha $ZnSO_4$ two months before sowing. In both years the trial was sown and statistically analysed as a split-plot design, with cultivars in the main plots and spacings in the sub-plots. A sprinkler irrigation (25 mm) was given immediately after sowing to ensure that germination was as uniform as possible, but otherwise the trials were unirrigated.

In 1975 four cultivars of different maturity-groups were sown: BS–1 (extra-early), T–21 (early), ST–1 (medium) and ICP–7065 (late). Two spacings, 37·5 × 20 cm (13 plants/m^2) and 30 × 15 cm (22 plants/m^2) were used, with four replicates (plot size 5 × 5 m; harvested area 20 m^2). The trial was sown on 11 November 1975 and harvested on 26 March 1976.

In 1976 six cultivars were sown: Pusa ageti (early), T–21 (early), ICP–1 (medium), C–11 (medium), NP(WR)–15 (late), and ICP–7065 (late). The spacings, which all had a rectangularity of 4:1, were 20 × 5 cm (100 plants/m^2), 28 × 7 cm (50 plants/m^2), 40 × 10 cm (25 plants/m^2) and 57 × 14 cm (12·5 plants/m^2). The trial was sown on 20 October 1976 with four replicates (plot size 5 × 4 m, harvested area 16 m^2). Cvs T–21, Pusa ageti, C–11 and ICP–1 were

harvested between 1–4 March 1977, and ICP–7065 and NP(WR)–15 on 11 March 1977. The fallen leaves were collected from the harvested area of each plot. All air-dry weights were corrected to oven-dry weights on the basis of sub-samples taken from each plot.

In both years the crops were protected against insect pests by sprays of endosulfan, but there were no serious disease problems. Mean monthly temperature and rainfall data for both rabi seasons are presented in Table 1. Sowing the rabi crops was delayed in 1975 owing to the unusually prolonged monsoon, and yields of all such crops in 1975–76 were lower than usual.

RESULTS

Duration

Although the early cultivars flowered and matured earliest and the late ones latest, the time-course of development and maturation was telescoped compared with pigeonpeas planted at the usual time, in June or July. The number of days taken for half of the plants to begin flowering, after plantings in July 1976 and October 1976 (Table 2), showed little or no effect of population-density on the date at which flowering began. However under the classification normally applied to pigeonpeas sown in June or July, those normally regarded as early became

Table 2. *Number of days after sowing before half the plants of six pigeonpea cultivars began flowering from normal sowing (July) and early* rabi *sowing (October) in* 1976

Cultivar	Days after sowing to 50% flowering		
	July sowing (A)	October sowing (B)	Difference (A–B)
T–21	86	71	15
Pusa ageti	89	77	12
ICP–1	116	82	34
C–11	125	80	45
NP(WR)–15	155	99	56
ICP–7065	162	97	65

extra-early, medium cultivars become extra-early to early, and late ones became early in the rabi season. Rabi plants were much smaller (height 0·5–1 m) at the time of harvest than in the normal season (1·5–2·5 m).

Dry matter production and yield

In 1976–77 the highest yields were obtained from the medium-duration cultivars, C–11 and ICP–1, and the lowest from the early cultivars (Table 3). Late cultivars (ICP–7065 and NP(WR)–15) had the highest shoot dry weight (including fallen leaves), but their harvest indices (grain weight/total shoot dry weight) were lower than for the medium cultivars both with and without correction for fallen leaves.

The cultivar × spacing interactions were not significant at $P = 0{\cdot}05$ for any of the measured variables. Means for the effects of spacing (Table 3) showed significantly greater yields and harvest indices at the lower population densities (12·5

and 25 plants/m^2) than at higher densities (50 and 100 plants/m^2), but with no significant effects of population on shoot dry weight per unit area at harvest.

In 1975–76 (as in 1976–77) the early cultivars yielded significantly less than medium and late ones (Table 4), but at much lower levels than in 1976–77. In 1975–76 significantly higher yields were obtained at 22 plants/m^2 (346 kg/ha) than at 13 plants/m^2 (283 kg/ha), but the cultivar × spacing interaction was not significant.

Characteristics of the seed

The seeds produced by the rabi crop were generally somewhat smaller than those produced in the normal season, with a mean 100-seed weight for the six cultivars grown in the 1976–77 rabi of 6·0 g, compared with 7·7 g for the same cultivars planted in July.

Table 3. *Yield and harvest index of pigeonpeas grown in* rabi 1976–77

	Yield (kg/ha)				Harvest index (%)	
	Grain	Shoot dry weight	Dry weight of fallen leaves	Total dry weight	Uncorrected	Corrected for leaf fall
Cultivars			*Cultivar means*			
T–21	1067	3489	1045	4534	30·6	24·1
Pusa ageti	1077	3356	917	4274	32·2	25·4
C–11	1710	4932	1365	6297	35·1	27·2
ICP–1	1493	4827	1198	6026	31·1	24·9
ICP–7065	1408	5492	1605	7098	25·8	20·0
NP(WR)–15	1284	5774	911	6685	22·2	19·3
SE mean	61·0	202·5	143·7	290·7	0·81	0·87
Populations (plants/m^2)			*Population means*			
100	1243	4658	1291	5949	26·9	21·3
50	1293	4704	1274	5978	28·2	22·1
25	1381	4654	1119	5774	30·7	24·3
12·5	1442	4563	1011	5574	32·2	26·4
SE mean	27·4	82·0	68·5	112·4	0·47	0·45

The recoveries of dhal (split peas) after milling seeds of cv ICP–1 from July and October-planted crops were almost the same (78·0 and 76·5% respectively). Numbered samples were supplied to scientists and labourers at the Institute (20 people in all) for a blind test of cooking quality and palatability, but no consistent differences were found in cooking time, and a majority preferred the flavour of the dhal from the rabi crop.

DISCUSSION

The highest yield, of 1710 kg/ha produced by the cv C–11 in 1976–77 rabi, was comparable with that of well-adapted high-yielding chickpea cultivars grown in the same field and planted at the same time (1500–2000 kg/ha). The highest yield obtained at ICRISAT for cv C–11 planted in July 1976 was 1720 kg/ha, and the rabi yield of cv ICP–1 (1490 kg/ha) exceeded that of the same cultivar

planted in July in the same field (1240 kg/ha). These comparisons indicate that good yields can be obtained from rabi pigeonpeas, and that they could have a considerable potential as a rabi crop in peninsular India.

Our results indicate that the best-yielding cultivars are likely to be found in the 'medium' or 'late' maturity groups. Even in 1975–76, when delayed sowings might have been expected to favour the faster-maturing cultivars, the yields of the early ones were poorest. It seems possible that these cultivars, which have been selected under the warmer conditions prevailing in the monsoon and immediately post-monsoon period, are less well-adapted to the cooler temperatures of the rabi season, in which medium and late cultivars normally produce their flowers and pods.

The higher rainfall in 1975 than in 1976 (Table 1) should have provided more favourable reserves of soil moisture, but 1975–76 yields were much lower than in 1976–77, probably because of delayed sowing, which is known to result in reduced

Table 4. *Grain yield of pigeonpea cultivars grown in* rabi 1975–76

Cultivar	Yield (kg/ha)
BS–1	222
T–21	256
ST–1	363
ICP–7065	430
SE mean	10·5

yields in other rabi crops such as chickpeas (Saxena and Yadav, 1975). Furthermore, the night temperatures were unusually low in 1975–76 (Table 1), though they were close to the long-term averages for Hyderabad in 1976–77.

Our data suggest that optimum populations are likely to be around 12·5 plants/m^2 for October sowings and 25 plants/m^2 if sowings are delayed. These populations are much higher than are used in July sowings of medium or late-maturing cultivars (typically 4·4 plants/m^2 or less) because of the smaller stature and quicker maturity of the rabi crop. We are carrying out further trials to investigate the interaction between sowing date and plant population, to identify cultivars which yield well in rabi season, and to compare the yields at different locations in peninsular India.

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