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POTENTIAL OF RATOONING IN PIGEONPEA

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ABSTRACT

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Yield trials of pigeonpea cultivars grouped into early, medium, and late maturity were harvested for grain at maturity by ratooning (cutting the plants off above the branching level). Plant survival after ratooning and regrowth varied among cultivars in all tests. First harvest of early cultivars was affected by high pod-borer damage, and the second grain crop was equal to the first on average; medium cultivars produced a second crop approximately 50% of the first, and late cultivars produced no grain after the first harvest.

Indications of cultivar differences for survival and regeneration after ratooning suggest the possibility of effective selection for these characteristics.

Results presented are from deep black soils in a year of unusually heavy rainfall; the authors recognize the limitations of the data, but believe that the potential for taking a second crop merits further investigation.

Approximately three million hectares of pigeonpeas (*Cajanus cajan* (L.) Millsp.) are grown for food production in semi-arid tropical areas and are harvested for dry grain on the majority of the acreage grown. Cutting the stems at the base and drying the entire plants before threshing is the usual practice, with only minor exception in areas where plants are cut above the branching level to permit vegetative regrowth for grazing. With the crop maturing on residual moisture in the dry season, and the harvest preceding the resumption of the rains by up to six months or more, properly ratooned plants have the potential for producing a second grain crop, or at least providing much-needed forage during the interim period. Success of the ratooned crop will depend on soil moisture supply, regenerative ability of the cultivar grown, and maturity period. It has been observed that in early and medium maturing cultivars, regenerated growth after the first grain harvest develops flowers and pods quickly, whereas in late cultivars new growth is mainly vegetative.

It is the purpose of this paper to report observations on cultivars with a

*Plant Breeder (S-4), Plant Breeder (S-1), and Leader pulse improvement program.

wide range of maturity, and to call attention to the potential value of ratooning as a general practice in pigeonpea agronomy.

Experimental data on the ratoonability and grain yield potential of cultivars of different maturity are lacking. The possibility of harvesting substantial forage and a subsequent seed crop has been indicated by Killinger (1968) in Florida. Sharma (unpublished) observed that a good forage and a grain crop could be harvested by planting the variety No.148 in the first week of July at 30-cm row-to-row and 10-cm plant-to-plant spacing in the deep black soils of Jabalpur (M.P., India). A forage crop was harvested in the third week of September by cutting at 45 cm above the ground. The regenerated growth yielded 1200 kg/ha of grain harvested in the last week of February. The value of pigeonpeas as a forage crop and harvesting of green fodder by repeated cuts has been well documented and reviewed by Akinola et al. (1975). In addition, Akinola and Whiteman (1975) studied two early and two late maturing varieties for dry matter and nitrogen yield under different "defoliation" (ratooning) treatments. They observed that 8- and 12-week "defoliation" frequencies could be successfully integrated to incorporate cattle grazing and forage and seed production into a single management system.

MATERIAL AND METHODS

All India Coordinated varietal tests representing three maturity groups — ACT-1 (7 early cultivars, maturing in 160 d); ACT-2 (15 medium cultivars, maturing in 160—200 d); and ACT-3 (20 late cultivars, maturing in more than 200 d) — were conducted during the rainy season of 1975 at ICRISAT. All three tests were carried out on deep black soil in 5-m-long rows. In ACT-1 the distance between the rows and within the row was 50 cm and 25 cm, respectively, while ACT-2 and ACT-3 were planted on ridges 75 cm apart with 30-cm plant-to-plant spacing. Eight rows were planted per plot in four replicates in ACT-1 and ACT-3, and three in Act-2. Net plot size was 14.4 m^2 in ACT-1 and 21.6 m^2 in ACT-2 and ACT-3. All the trials were planted on 30 June 1975. Fertilizer at the rate of 18 kg N and 46 kg P/ha was applied before planting. Rainfall for the year was above normal, 1053.3 mm compared with an average of 760 mm. All the cultivars were harvested at first grain maturity by cutting at 30—40 cm above the lower most pod bearing branch. Days to first harvest were taken from the date of planting to 75% pod maturity. The ratooned plants were allowed to grow without any additional fertilizer or irrigation. The regenerated growth was first graded on a scale of 1—5 (one being the best) at 35 d in Act-2 and ACT-3 and again at 60 d in the latter. Living plant counts were taken after each harvest. The yield data were analyzed as a split-plot design with harvest time (first and ratoon crop) as main plots, and cultivars as sub-plots. The seeds from both harvests were analyzed for nitrogen by a 'Technicon Auto Analyzer' to compare protein levels ($N \times 6.25$) of the grain from the first and the ratooned crop. Since differences in plant stand at the time of first harvest were not significant and incidence of the wilt disease (*Fusarium oxysporum* f. sp. *udum*) was a major factor affecting yield of the ratoon crop, yields were not adjusted for stand.

RESULTS AND DISCUSSION

Among the early varieties, days to maturity ranged from 130.8 to 151.3 (Table I). The average production of the seven cultivars was essentially the same for first and second harvest, with no significant difference between harvest and no significant interaction of cultivars × harvest (Table II). The earliest cultivar gave the highest ratoon yield in terms of percentage of first harvest; this reflects the extremely low yield of the first harvest. Regenerated growth in early cultivars coincided with cooler temperature, which delayed the earlier genotypes so that all entries matured together with the onset of high temperature.

Seed production by this group in the first harvest approximated world average production; by taking a ratoon crop it was doubled. Grain production was 4.34 kg/ha/d for the first crop; for the ratoon crop 4.90 kg/ha/d, and over both crops 4.60 kg/ha/d.

"Medium" maturity cultivars in ACT-2 produced roughly double the grain yield of the early group, but the ratoon yield was only 50% of the first harvest. Days to first harvest ranged from 142.3 to 204.0, and it appears that the extreme cultivars should not have been included in this group (Table III). However, for present purposes (which are to study ratooning, rather than to compare cultivars on one year's data), using the averages of the group, grain production of the first crop was 7.38 kg/ha/d; for the ratoon

TABLE I

Days to harvest, grain yield and seed protein content (%) of cultivars in first and the ratoon crop in ACT-1

Cultivar	Yield (kg/ha)			Days to harvest			Protein (%)	
	First crop	Ratoon crop	Total	First crop	Ratoon crop	Total	First crop	Ratoon crop
BS-1	297.9	541.7	838.6	130.8	130.2	261.0	20.8	22.7
T-21	640.6	654.5	1295.1	136.0	125.0	261.0	21.0	23.6
Pusa-4-84	718.5	569.4	1287.9	138.5	122.5	261.0	22.1	23.7
HPA-1	505.2	500.0	1005.2	140.3	120.7	261.0	21.6	23.2
DL-74-1	534.7	574.7	1109.4	142.8	118.2	261.0	21.4	23.9
BR-172	791.6	625.0	1416.6	144.3	116.7	261.0	21.6	23.0
HY-1	784.7	668.4	1453.1	151.3	109.7	261.0	21.4	22.5
Mean	610.47	590.52	1200.85	140.6	—	—	21.40	23.23

LSD at 5% for comparison of cultivar yield = 204.95.
LSD at 5% for comparison of cultivar yield within a harvest time = 289.95.

TABLE II

ANOVA for grain yield of first and the ratoon crop in ACT-1 and ACT-2

Source	ACT-1		ACT-2	
	df	MSS	df	MSS
Replications	3	6064	2	109621
Harvest time (main plots)	1	5512	1	9138760**
Error (a)	3	22539	2	342742
Cultivars (sub-plots)	6	101548*	14	252537**
Interaction	6	40860	14	111040*
Error (b)	36	40773	56	51582

* Significant at 5%
** *Significant at 1%*

crop 5.54 kg/ha/d, and over both harvests 6.65 kg/ha/d.

Within trial ACT-2 the interaction of cultivars × harvests was significant, while the main effects were highly significant (Table II). The incidence of *Fusarium* wilt was important in this test but not in ACT-1; percentages of plants surviving at the time of the two harvests are shown in Table V. Plant death resulted from attack by wilt and from other causes; these were not separated in the counts taken. Survival in different varieties after ratooning ranged from 54.69 to 97.08% and differences were highly significant. Resistance to wilt as well as inherent regenerative ability are both essential in a cultivar for good ratoonability.

Within the medium maturity group, where cultivar × harvests was significant, the ratoon crop yield was significantly correlated only with percentage survival of plants after harvest ($r = 0.64^{**}$). Inclusion of other independent variables (viz., days to flower in the first crop, days to maturity in the first crop, and first crop yield) did not substantially improve the relationship ($r = 0.70^{**}$).

The late cultivars in trial ACT-3 were ready for the first harvest 238 d after planting. At 17°N latitude, these cultivars produce only vegetative growth after ratooning. The average seed yield of the test was 1670 kg/ha, and the rate of production was 7.02 kg/ha/d. Entries were scored visually for forage production (Table IV), and the differences among cultivars were highly significant. Selection of cultivars for good ratoonability in the areas where late maturity types are best adapted (where some farmers already ratoon for post-harvest grazing) can increase the value of the crop.

TABLE III

Days to harvest, grain yield and seed protein content (%) of cultivars in first and ratoon crop in ACT-2

Cultivar	Yield (kg/ha)			Days to harvest			Protein (%)		Visual scoring on ra-tooning
	First crop	Ratoon crop	Total	First crop	Ratoon crop	Total	First crop	Ratoon crop	
PS-11	703.7	336.4	1040.1	142.3	127.7	270	23.8	21.3	3.7
HY-4	1088.0	430.6	1518.6	160.3	119.7	280	21.0	20.5	3.7
EB-3870	1111.1	717.6	1828.7	162.6	126.4	289	22.0	21.4	2.0
HY-2	1388.9	300.9	1689.8	163.3	125.7	289	21.3	21.2	4.0
Mukta	1250.0	657.4	1907.4	164.0	125.0	289	22.2	21.3	3.0
No. 148	1304.0	838.0	2142.0	167.7	121.3	289	22.1	21.7	2.3
PM-1	1072.5	488.1	1560.6	173.0	116.0	289	21.4	21.6	3.5
BDN-1	1466.0	898.1	2364.1	173.3	115.7	289	22.6	21.5	1.0
AS-71-37	1504.6	967.6	2472.2	176.7	112.3	289	21.7	21.0	2.3
ICRISAT-1	1134.3	578.7	1713.0	177.0	112.0	289	21.4	21.3	3.0
JA-3	1188.3	976.9	2165.2	177.0	112.0	289	21.6	21.4	1.5
ICRISAT-6997	1302.5	583.3	1885.8	178.3	108.7	287	22.0	19.8	3.6
ST-1	1365.7	740.7	2106.4	185.3	103.7	289	22.6	22.4	3.3
SA-1	1350.2	382.7	1732.9	191.3	99.7	291	22.2	21.7	3.8
C-11	1929.0	702.2	2631.2	204.0	105.0	309	22.5	20.3	3.0
Mean	1277.3	639.9	1917.2	173.0	—	288.5	21.99	19.8	

LSD at 5% for comparison of harvest time mean yield = 531.09.
LSD at 5% for comparison of cultivar yield = 262.78.
LSD at 5% for comparison of cultivar yield within a harvest time = 371.62.
LSD at 5% for comparison a cultivar yield at different harvest time = 596.95.

TABLE IV

Visual scores for vegetative growth after ratooning in ACT-3

Cultivar	35 d after ratooning		60 d after ratooning	
	Mean	Range	*Mean*	*Range*
T-7	4.0	3—5	3.5	3—4
NP(WR)-15	4.0	4	3.3	3—4
B-517	4.3	4—5	4.0	3—5
1258	4.8	4—5	4.5	4—5
1234	4.0	4	3.8	3—4
Gwalior-3	2.5	2—3	2.3	1—3
KWR-1	5.0	5	4.3	3—5
GC-6826-5	4.0	3—5	3.8	3—5
GC-6800-67	3.3	3—4	3.0	3
GC-6842-9	4.0	4	4.0	3—4
AS-44	3.8	3—5	3.8	3—5
K-16	3.3	3—4	2.8	2—3
K-23	4.3	4—5	3.5	3—5
PS-43	4.5	4—5	4.3	4—5
PS-65	4.0	3—5	4.5	3—5
PS-66	3.8	3—4	4.3	4—5
PS-71	5.0	5	4.8	4—5
PS-41	3.5	2—5	3.0	2—4
ICRISAT-7065	2.8	2—3	2.3	2—3
ICRISAT-7086	4.0	3—5	3.3	3—4

TABLE V

Survival of plants (%) at the time of first and ratoon crop harvest in ACT-2

Cultivar	Rep.I		Rep.II		Rep. III		Average	
	First crop	Ratoon crop	First crop	Ratoon crop	First crop	Ratoon crop	First crop	Ratoon crop
PS-11	100.0	95.8	100.0	54.4	100.0	64.6	100.00	71.59
HY-4	97.9	71.9	100.0	72.1	100.0	73.3	99.31	72.43
EB-3870	100.0	87.7	98.8	82.1	91.9	43.4	96.91	71.07
HY-2	93.8	44.3	94.7	67.4	93.8	56.3	94.10	55.98
Mukta	96.6	77.5	97.9	75.3	92.4	60.1	95.62	70.95
No.148	100.0	89.5	100.0	91.5	98.9	83.9	99.62	88.31
PM-1	97.8	73.6	94.8	68.8	91.3	57.3	94.62	66.55
BDN-1	100.0	95.5	100.0	94.5	100.0	96.4	100.00	95.47
AS 71-37	100.0	89.7	100.0	97.4	100.0	96.4	100.00	94.52
ICRISAT-1	100.0	89.4	100.0	78.9	97.7	81.8	99.24	83.37
JA-3	100.0	85.9	100.0	89.9	100.0	84.6	100.00	86.79
ICRISAT-6997	100.0	81.9	100.0	86.1	100.0	78.7	100.00	82.24
ST-1	86.5	81.7	100.0	85.4	90.4	47.9	92.32	71.66
SA-1	73.8	36.5	94.6	64.5	87.4	63.1	85.28	54.69
C-11	98.9	95.7	98.9	97.8	100.0	97.7	99.28	97.08

LSD at 5% = 18.99.

SEm± = 6.56.

BREEDING FOR RATOONABILITY

Varietal differences for ratoonability in terms of grain yield in ACT-2 and in terms of regenerated forage in ACT-3 were quite distinct, and since they were not correlated with the main crop yield it would be desirable to select varieties which have good main crop yield as well as good ratoonability. The high correlation of visual scores (Table III) with ratoon yield ($r = -0.87^{**}$) indicates the possibility of effective selection in non-replicated material. However, when ratoonability of the varieties over the two tests ACT-1 and ACT-2, in terms of ratooned yield as a percentage of the first harvest (ratoonability index), was measured, it appeared to be negatively correlated with days to first harvest (Fig.1). High ratoonability index of the early varieties in ACT-1 was a result of very low first harvest yields. There was heavy damage by pod borers to the earliest cultivars. Though the ratoonability index of the early varieties was very high, the total grain harvest from the first and the ratooned crop was invariably much more in the medium duration varieties than in any early variety.

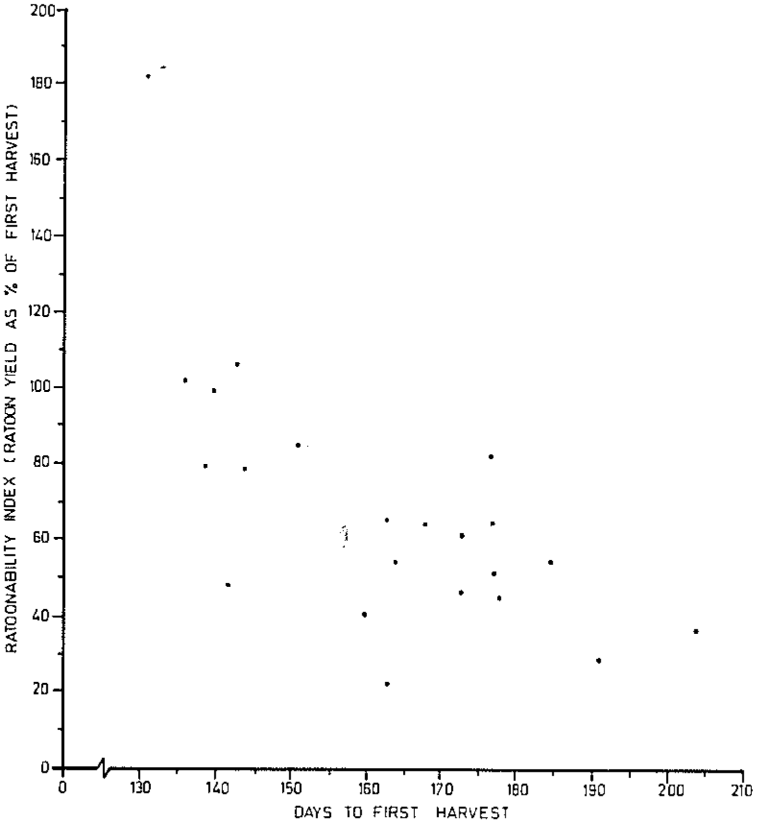

Fig. 1. Relationship between ratoonability index and days to first harvest.

Protein content of the grain from the ratoon crop (23.24%) was significantly higher than protein content of the grain from the main crop (21.39%) in ACT-1, while in ACT-2 there was no significant difference between the two harvests. The 100-seed weight (g/100 seeds) from the first and ratoon crop harvest was 7.89 and 7.62 in ACT-1, and 9.86 and 9.43 in ACT-2, respectively. The difference between harvests was not significant.

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