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STUDIES ON SOME OF THE CAUSES OF THE HIGH ABSCISSION RATE FOUND IN PIGEONPEA /*Cajanus cajan* (L.) Millsp/

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ABSTRACT

Histological observations of the ovaries of the abscised reproductive structures (at anthesis) in the dwarf pigeonpea cultivars (UW10, UW17 and UW26) showed a high incidence of unfertilized ovules (76-90 per cent. In the ovaries of the excised immature pods (post-anthesis) of the above cultivars, a comparatively low proportion of unfertilized ovules (14-17 per cent) was observed. A slightly higher proportion of unfertilized ovules (26-33 per cent) was observed in mature pods of the three cultivars. Statistical analyses revealed no significant differences in the number of unfertilized ovules among the cultivars studied in the abscised, excised, and mature reproductive structures of pigeonpea. These results suggest that, in pigeonpea, there is no critical number of ovules which need to be fertilized in order for successful pod-set to occur.

INTRODUCTION

The great majority of the flowers of pigeonpeas (greater than 85 per cent), are shed without setting pods (1). This phenomenon has been attributed to: competition from earlier formed pods and other sinks within the plant (6); hormonal signals; incomplete development of translocatory tissues (4); the necessity for tripping to achieve successful fertilization (5); self-incompatibility (3): inadequate pollination; inadequate supply of photosynthates (7); and unsuccessful fertilization of ovules (2).

The purpose of this study was to determine whether a critical number of ovules must be fertilized before pod-set could occur.

MATERIALS AND METHODS

The reproductive structures used were obtained randomly from pigeonpea plants (cvs. UW10, UW17, and UW26) grown in tins containing a 1:1:1 mixture of clay, sand, and manure and spaced at 0.5m x 0.5m within a completely rnadomized design.

Abscised flowers at anthesis and excised immature pods at post-anthesis were prepared histochemically and each ovule checked for the presence of tri-nucleate endosperm, the presence of which signifies successful fertilization. Intact mature pods were observed at random on the plants of each cultivar. Gentle pinching of each locule determined whether a full or an aborted ovule existed therein.

Statistical analyses were performed on all data which had been transformed using the relation:

$$Y = \sin^{-1}\sqrt{\frac{X}{Z}}$$

where: X is datum in %;

Y is % transformed to degrees;

Z is 100%.

RESULTS AND DISCUSSION

Table 1 shows that there were fertilized ovules in ovaries of abscised flowers suggesting that successful fertilization of all ovules is not a key factor for pod-set to occur.

Table 1. The numbers of non-fertilized ovules per abscised ovary, expressed in percentages and degrees, are shown for each cultivar (UW10, UW17, and UW26)

Cultivar	UW10			UW17			UW26		
Ovary Number	Number of Ovules	% Non-fertilized	Transformed to degrees	Number of Ovules	% Non-fertilized	Transformed to degrees	Number of Ovules	% Non-fertilized	Transformed to degrees
1	3	66.7	54.7	4	100	90	3	100	90
2	3	100	90	3	100	90	4	100	90
3	5	100	90	3	66.7	54.7	4	50	45
4	4	100	90	4	100	90	4	100	90
5	3	100	90	3	100	90	3	100	90
6	2	100	90	4	100	90	4	25	30
7	5	100	90	3	100	90	4	75	60
8	6	83.3	65.9	2	100	90	4	50	45
9	5	100	90	4	100	90	3	100	90
10	4	100	90	4	100	90	3	100	90
11	3	100	90	3	100	90	3	100	90
12	4	100	90	3	100	90	3	33.3	35.2
13	4	100	90	3	33.3	35.2	4	0	0
14	6	100	90	4	75	60	3	66.7	54.7
15	3	100	90	4	50	45	3	100	90
16	5	40	39.2	3	66.7	54.7	3	100	90
17	5	80	63.4	4	50	45	3	100	90
18	5	100	90	4	75	60	3	66.7	54.7
19	5	80	63.4	3	100	90	3	100	90
20	3	66.7	54.7	2	50	45	4	100	90

The null hypothesis tested was that "there was no difference in the number of non-fertilized ovules per abscised ovary among the cultivars studied". The non-signficant variance ratio in Table 2 indicates that there is a difference in the number of non-fertilized ovules (0-100%) found in an abscised ovary of each cultivar. This suggests that there is no definite nubmer of unfertilized ovules to be found in an abscised ovary of any cultivar.

Table 2. Analysis of variance among the cultivars studied for non-fertilized ovules in flowers abscissed at anthesis.

	Sum of squares	Degrees of freedom	Mean square	Variance ratio
Between varieties	984.3853	2	492.1927	1.015
Error	27645.4965	57	485.0087	
Total	28629.8818	59		

It was expected that most, if not all, the ovules would be fertilized before pod-set was initiated. In these excised immature pods there are ovules which have not been fertilized, yet the pod is developing (Table 3). This suggests that successful fertilization of all the ovules in an ovary is not necessary to initiate pod development.

Table 3. The number of non-fertilized ovules per excised immature pod, expressed in percentages and degrees, are shown for each cultivar (UW10, UW17, UW26).

Cultivar	UW10			UW17			UW26		
Ovary Number	Number of Ovules	% Non-ferti-lized	Trans-formed to degrees	Number of Ovules	% Non-ferti-lized	Trans-formed to degrees	Number of Ovules	% Non-ferti-lized	Trans-formed to degrees
1	3	0	0	4	0	0	3	33.3	35.3
2	4	0	0	4	0	0	3	0	0
3	4	0	0	4	0	0	3	0	0
4	3	0	0	3	33.3	35.2	4	0	0
5	3	0	0	4	25	30	4	0	0
6	4	25	30	4	0	0	4	0	0
7	3	33.3	35.2	4	0	0	4	25	30
8	3	0	0	4	0	0	4	25	30
9	4	0	0	4	25	30	3	33.3	35.2
10	3	33.3	35.2	3	33.3	35.2	3	0	0
11	4	0	0	3	33.3	35.2	3	33.3	35.2
12	4	25	30	4	25	30	3	33.3	35.2
13	6	16.7	24.1	4	50	45	3	33.3	35.2
14	6	33.3	35.2	3	0	0	4	33.3	35.2
15	6	40	39.2	3	0	0	3	50	45

The low variance ratio in table 4 negates the null hypothesis tested, showing that there is no relationship in the number of non-fertilized ovules per immature pod per cultivar studied.

Table 4. Analysis of variance among the cultivars studied for non-fertilized ovules in excised pods at post-anthesis.

	Sum of squares	Degrees of freedom	Mean square	Variance ratio
Between varieties	100.45600	2	50.228	0.156
Error	13520.59378	42	321.920	
Total	13621.04978	44		

Data on Table 5 show that there were non-fertilized and/or aborted ovules in fully developed pods. Aborted ovules ranged in sizes indicating that the critical factor involved was possibly the availability of photosynthates.

Table 5. The numbers of non-fertilized ovules per mature pod, expressed in percentages and degrees, are shown for each cultivar (UW10, UW17 and UW26).

Cultivar	UW10			UW17			UW26		
Ovary Number	Number of Ovules	% Non-ferti-lized	Trans-formed to degrees	Number of Ovules	% Non-ferti-lized	Trans-formed to degrees	Number of Ovules	% Non-ferti-lized	Trans-formed to degrees
1	6	0	0	5	40	39.2	4	0	0
2	4	25	30	4	50	45	3	66.7	54.8
3	6	0	0	4	25	30	2	0	0
4	5	0	0	3	33.3	35.2	4	25	30
5	5	20	26.6	3	66.7	54.8	4	25	30
6	3	33.3	35.2	4	25	30	5	20	26.6
7	6	33.3	35.2	4	25	30	4	0	0
8	5	60	50.8	4	50	45	4	75	60
9	6	66.7	54.8	4	25	30	5	20	26.6
10	7	28.6	32.3	4	0	0	4	75	60

The non-significant variance ratio (Table 6) again led to the null hypothesis being rejected. This shows that there is no relationship in the numbers of non-fertilized (or aborted) ovules per ovary per cultivar.

CONCLUSIONS

Previous reports listed unsuccessful fetilization as a major factor leading to flower abscission. The results of this study showed that flowers abscised in spite of the presence of fertilized ovules. Additionally, pod

Table 6. Analysis of variance among the cultivars studied for non-fertilized ovules in mature pods.

	Sum of squares	Degrees of freedom	Mean square	Variance ratio
Between varieties	289.18467	2	144.59	0.363
Error	10742.22500	27	397.86	
Total	11031.40967	29		

set occurred without all the ovules being fertilized. Mature pods were found having only one ovule fertilized. These results did not support the theory that there is a critical number of ovules needed to be fertilized for pod set to occur, instead they suggested that there were other overriding factors. One such factor could be the insufficient photosynthates to support the growth of all reproductive structures. Linked to this is the fact that pigeonpea is a perennial and there is much partitioning of photosynthates in favor of vegetative growth at the expense of the developing reproductive structures. Thus the plant itself is a stronger sink than the developing reproductive structures, therefore leading to the abscission of these reproductive structures.

REFERENCES

Ariyanayagam, R.P. 1975. Status of research on pigeonpea in Trinidad. In: Proceedings of the International Workshop on Pigeonpea, Vol. 1. ICRISAT. Pantancheru, Andhra Pradesh, India.

Ariyanayama, R.P. 1980. Pigeonpea breeding in the Caribbean Regional Programme. In: Proceedings of the International Workshop on Pigeonpea, Vol. 1. V. Kumble, Ed. ICRISAT. Pantoncheru, Andhra Pradesh, India.

Ariyanayagam, R.P. and James, D. 1986. Self-inhibition of fertilization--A potential cause of floral and pod abscission in pigeonpea. Caribbean Council for Science and Technology Newsletter 2(4).

Brun, W.A. and Betts, K.J. 1984. Source/sink relations of abscissing and nonabscissing soybean flowers. Plant Physiol. 75.

James, D., Ariyanayagam, R.P., and Duncan, E.J. 1988. Effects of tripping flowers of four early varieties of pigeonpea /Cajanus cajan (L.) Millsp./. J. Hort. Sci. 64(2).

Sheldrake, A.R. and Narayanan, A. 1978. Comparisons of earlier and later formed pods of pigeonpeas /Cajanus cajan (L.) Millsp./. Ann. Bot. 43.

Sinha, S.K. 1973. Yield of grain legumes: Problems and prospects. Indian J. Genetics, 34A.