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Cytogenetic Behaviour and Phosphate and Potassium Content in Desynaptic Pearl Millet

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Summary. Continued inbreeding by self pollination resulted in a proportion of sterile plants in some families of the inbred line IP 1475 of *Pennisetum americanum* (L.) Leeke. Cytological examinations of the sterile plants revealed mild to extreme desynapsis and also chromosome fragmentation in some plants. Segregation ratios in the selfed families did not fit into any simple Mendelian ratio; however, in one F_2 family of the cross desynaptic × normal, segregation into 15 normal: 1 desynaptic was observed. Plants from a segregating family were classified as normals, desynaptics with 2-6 univalents, desynaptics with 2-10 univalents, desynaptics with 10-14 univalents and desynaptics with chromosome fragmentation. Estimation of the content of phosphate and potassium from the flag leaves did not reveal significant differences between the five groups of plants.

Key words: *Pennisetum americanum* – Desynapsis – Phosphate – Potassium content – PMC (Pollen mother cell)

Introduction

In *Lolium temulentum*, Law (1963) reported that the mean chiasma frequency in the PMCs increased with an increase in potassium and calcium content in the culture solution, while in rye, Bennett and Rees (1970) reported an increase in mean chiasma frequency in PMCs with an increase in the quantity of phosphate available to the plant. In desynaptic barley, Fedak (1973) reported an increase in the number of ring bivalents with addition of mineral phosphate. Using a desynaptic line of *P. typhoides*, Dhesi et al. (1975) observed increased chiasma frequency and thus decreased desynapsis, with increase in the application of phosphate and potassium to the soil. Thus, there appears to be some relationship, both in normal and desynaptic genotypes, between the level of mineral supply (phosphate, potassium and calcium) to the plants and the chiasma frequency in the PMCs. However, it is not known whether desynaptic mutants have a deficiency of phosphate (P) and potassium (K) in their plant body, particularly at the time of meiosis, and whether the positive response in chiasma frequency is due to a partial or complete compensation of deficiency due to increased availablity of substances in the soil. Therefore an attempt has been made to compare the quantities of P and K in the normal and desynaptic plants of *P. americanum*.

Materials and Methods

Sib families were raised from selfed seeds of IP 1475, an inbred maintained by selfing individual plants for more than ten generations and one in which desynaptic plants have been observed to segregate in some progenies. First spikes, of the size in which meiosis is generally to be expected in the PMCs, and their flag leaves were collected. Spikes were fixed in a 3 : 1 methanol : acetic acid mixture for 24 hours and acetocarmine stained squash preparations of the PMCs were examined to identify the normal and desynaptic plants. The flag leaf samples, including the lamina and sheath, were dried, powdered and saved for the estimation of P and K. The flag leaf was chosen for analysis because it is the nearest leaf to the inflorescence and probably also sustains the nutrition of the developing spikes to a large extent and thus might be expected to reflect the nutritional supply of the spike. The flag leaf sample powder was digested by a wet digestion method using a tri-acid mixture of HNO_3, H_2SO_4 and $HClO_3$ in a 10 : 1 : 4 ratio respectively. The quantities of P and K present in the extract solution were estimated by colourimetric and flame photometric methods respectively. Means of P and K were calculated for normals, desynaptics and desynaptics with chromosome fragmentation.

Results and Discussion

Over several generations some selfed families have been observed to segregate for normal and desynaptic plants in this inbred line but the segregation pattern did not fit into

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Table 1. Quantities of phosphate and potassium (percentage per gm. of ash) in the flag leaves of normal, desynaptic plants and plants with desynapsis and chromosome fragmentation

Class	No. of plants analysed	% phosphate		% potassium	
		Mean	t-value	Mean	t-value
Non-segregating family normal	4	0.463 ± 0.20	–	2.77 ± 1.267	–
Segregating family normal	1	0.521	–	3.66	–
2 – 6 Univalents ($\bar{x}$ = 3.05)	6	0.532 ± 0.174	1.624 (2.31)	3.39 ± 1.273	1.178
2 – 10 Univalents ($\bar{x}$ = 7.40)	3	0.468 ± 0.0221	0.265 (2.57)	2.643 ± 1.263	0.073
10 – 14 Univalents	1	0.371	–	2.02	–
Desynapsis + fragmentation	4	0.561 ± 0.246	0.174 (2.45)	3.415 ± 1.475	1.407

In column 4 the figures within brackets indicate table values of 't' at 5% level

a simple Mendelian ratio (Krishna Rao and Koduru, unpublished). However, in one F_2 family from the cross desynaptic × normal, 49 normals and 6 desynaptic plants were observed, giving a good fit to a 15 : 1 ratio (χ^2 = 2.05; d.f. = 1; p = 0.2-0.1). This indicates that desynapsis results from duplicate recessive factors. Possibly environmental as well as other genetic factors influence the degree of desynapsis.

In the present investigation, of the several selfed sib families, each consisting of 20 plants, checked cytologically, desynaptics were found in only one family. In this family 18 plants were desynaptics with varying degrees of desynapsis and the remaining 2 plants were normals. In some of the desynaptic plants chromosome fragmentation was also observed. In all these plants chromosome pairing at pachytene was complete and hence presence of univalents at diakinesis and metaphase can be attributed to desynapsis. The plants were grouped into five classes (i) normal plants (ii) desynaptics with 2-6 univalents per cell; (iii) desynaptics with 2-10 univalents per cell (iv) desynaptics with 10-14 univalents per cell; and (v) desynaptics with chromosome fragmentation.

The estimated mean quantities of P and K of these five groups of plants in the desynaptic family were compared with those of plants from the normal sib family. In none of the pairwise comparisons, using the t-test, were significant differences in the mean values detected (Table 1).

Thus the desynaptic plants were not deficient either for phosphate or for potassium in the flag leaf at the time of meiosis in the anthers.

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