Colchicine Induced Tetraploids in Ginger (*Zingiber officinale* Rosc.)*

The crop improvement work in ginger (*Zingiber officinale* Rosc.) at present is confined to collection of accessions from different growing areas, their comparative yield evaluation and selection. Evaluation of newer varieties through hybridisation is not feasible since majority of the cultivars do not flower and none of them set seed either by selfing or by cross pollination (Ratnambal, 1979; Nair, Nambiar and Ratnambal, 1982). Cytological evidences indicate that the sterility in the genus *Zingiber* is likely to be chromosomal (Ratnambal, 1979). The present attempt to synthesise tetraploids in ginger was undertaken to explore the possibilities of obtaining regular flowering and seed set.

Tetraploids were induced in ginger cultivar Rio de Janeiro through colchicine treatment during 1977–78 and comparative morphological and anatomical characteristics of diploids and induced tetraploids are presented in this communication.

Fresh rhizomes of ginger cultivar Rio de Janeiro were washed in water, dried with cotton wad and separated into single buds. These buds were treated with 0.1, 0.25, 0.5, 0.6 and 1% aqueous colchicine or colchicine in agar paste for 2, 4, 6, 8, 12 and 24 hr duration. The aqueous colchicine was applied either by wetting the growing point by means of cotton or by keeping germinated rhizomes inverted in vials containing the solution.

Colchicine in agar was applied to the growing points with a camel-hair brush. In control, the rhizomes were treated with distilled water. The treated rhizomes were thoroughly washed in running water and planted in sand along with the control. Germinated rhizomes were transplanted after one month to earthen pots containing potting mixture.

Out of 300 single buds treated with various concentrations of colchicine,

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20 tetraploids were isolated based on somatic chromosome counts (2n=44) (Fig. 1). Thirty six mixoploids were also isolated. The mixoploids had 2n= 22 and 44 chromosomes in their somatic cells. Among the various treatments used for the induction of polyploidy, application of 0.2% aqueous colchicine for 2 hr, 0.5% aqueous colchicine for 4 hr and 1.0% colchicine in 1.0% agar for 8 hr, gave the best results (Table I). Many of the seedlings developed from the treated buds showed morphological deformities like contorted leaves, uneven growth of pseudostem and stunted growth during early stages.

Table I. *Number of tetraploids obtained in various treatments*

Concentration of colchicine	Duration of treatment in hr.	Number of tetraploids obtained
I *Aqueous colchicine*		
0.2	2	3
0.2	4	1
0.5	2	1
0.5	4	3
0.6	4	1
1.0	4	2
II *Colchicine in 1% agar*		
0.2	8	1
0.5	6	2
0.5	8	2
1.0	4	1
1.0	8	3

Considerable changes in the height of pseudostem, number of leaves, length and breadth of last fully opened leaf, length and breadth of stomata and epidermal cells were observed in the tetraploid plants (Table II).

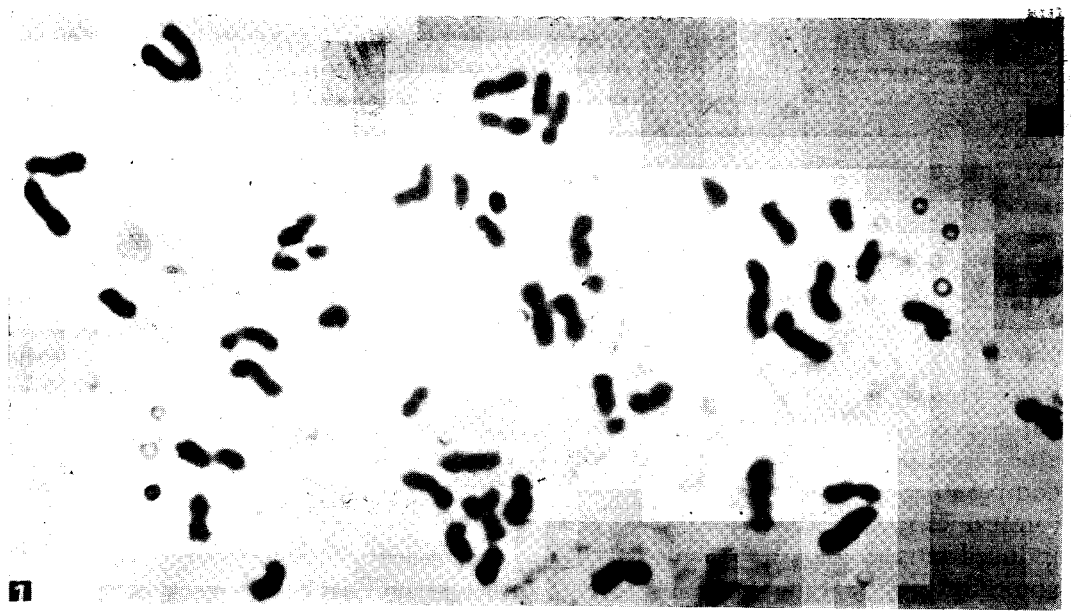

Fig. 1. Somatic chromosomes in tetraploid ginger, 2n = 44

Table II. *Morphological and anatomical characters of diploids and tetraploids of* Z. officinale *Rosc.*

Character	Diploid		Tetraploid	
	Range	Mean	Range	Mean
Height of pseudostem (in cm)	11.0–30.0	22.7	3.5–29.0	19.3
Girth of pseudostem (in cm)	1.6–2.5	1.8	0.6–1.9	1.2
Number of leaves	6–10	7.0	5–17	9.01
Length of last fully opened leaf (in cm)	6.5–18.0	11.1	6.3–17.5	9.95
Breadth of last fully opened leaf (in cm)	1.0–2.3	1.4	0.9–2.0	0.92
Length of largest leaf (in cm)	7.2–15.4	13.0	7.0–13.3	11.9
Breadth of largest leaf (in cm)	9.9–2.0	1.40	1.0–2.0	1.46
Number of epidermal cell	21.0–43.0	28.70	24.0–50.00	33.44
Length of epidermal cell (in cm)	68.42–76.24	74.29	29.48–66.98	41.31
Breadth of epidermal cell (in cm)	23.42–47.95	35.66	29.28–48.69	36.56
Number of stomata/unit area	7.59–3.00	2.04	1.69–2.90	2.20
Length of guard cell (in μ)	35.92–50.49	45.26	31.49–45.83	36.56
Breadth of guard cell (in μ)	7.8–9.42	9.14	8.0–10.74	8.86

Majority of the tetraploids were stunted with dark green leaves, increased number of epidermal and stomatal cells per unit area. One of the tetraploids obtained from rhizomes treated with 1% aqueous colchicine in 1% agar for 4 hr was exceptionally vigorous. (Fig. 2) Flowering was not observed in any of the tetraploid plants.

Comparative morphological study showed that majority of the tetraploids were stunted than the diploids. This was reflected in reduced plant height and number, length and breadth of leaves. The first few leaves in majority of the tetraploids were thick, crinkled and dark green but leaves appearing subsequently were comparatively normal.

Autopolyploids in general are larger than their diploids and there is an increase in size of various plant parts and a delay in growth and flowering (Bali and Tandon, 1957; Raghuvanshi and Joshi, 1964; Swanson, Merz and Young, 1967). However, in autotetraploids of *Trigonella* (Singh and Roy, 1971), *Apluda mutica* (Murthy and Satyavathi, 1978), *Crotalaria* (Gupta and Sinha, 1978), the results were contrary to the general expectations as observed in *Zingiber officinale.* Delayed flowering has been observed in tetraploids of *Glycine max* and this has been attributed to slower rate of metabolic activities in tetraploid plants (Biswas and Bhattacharyya, 1971). The lack of flowering observed in the induced tetraploids of ginger may be due to a similar slowing down of the metabolic activities.

Recently Ramachandran (1982) reported successful induction of tetraploids in *Z. officinale* by treating sprouts with 0.25% aqueous colchicine. According to him tetraploids were more

Fig. 2. Tetraploid and diploid plants of *Z. officinale*

vigorous than the diploids and flowered during the second year of induction.

The results obtained in the present investigation show that while the diploids flowered, the tetraploids failed to flower and hence it is too early to state whether the mechanisms of sterility could be circumvented through induction of polyploidy. However, increase in size of rhizome has been observed in the induced tetraploids.

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