

STUDIES ON COLCHICINE INDUCED TETRAPLOIDS IN *RICINUS COMMUNIS* L.

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On the assumption that duplication of chromosomes would increase the oil content of the seeds of *Ricinus Communis* L. tetraploids were obtained by colchicine treatment. It was however found that in spite of the fact that the size of the seed had increased the process is uneconomical due to late flowering, the failure of tetraploid to form fruits without hand pollination and very small number of seeds produced.

Introduction

As duplication of chromosomes is reported to bring about an increase in the oil content in some oilseed crops,¹ it was thought that similar duplication of chromosomes in *Ricinus communis* L. would increase its oil content. Cross pollinated plants usually respond more favourably to the effect of chromosome doubling and from this point of view as well *R. communis* was found to be a suitable material.

The present paper deals with the preliminary results obtained in the production of tetraploid *R. communis* by means of colchicine treatment.

Methods and Materials

Seeds were collected locally from two varieties of *R. communis*, namely, green and red. Chromosomes were studied from pollen mother cells in aceto-carmin preparation.

Colchicine Treatment.—The freshly germinating seedlings, from which the endosperm was removed, were dipped in a 0.2 per cent aqueous colchicine solution for a duration of 40 and 48 hours. The temperature ranged between 70 and 85°F. at the time of treatment. The results are given in Table 1.

These results show that no seedlings survived

TABLE 1.—RESULTS OF TREATMENT WITH A 0.2 PER CENT COLCHICINE SOLUTION.

Details	Red		green		Total	
	40 hrs	48 hrs	40 hrs	48 hrs	40 hrs	48 hrs
1. Number of seedlings treated	30	15	20	15	50	30
2. Number of survivals	18	—	12	—	30	—
3. Number of tetraploids obtained	2	—	1	—	3	—

the treatment lasting for 48 hours. Of the 50 seedlings treated for 40 hours, 30 survived and of these 3 proved to be tetraploids from stomatal and pollen grains studies.

Morphology of the Treated Plants.—

1. *Cotyledons*: All the treated seedlings showed greatly distorted and reduced cotyledons (Fig. 1).

2. *Height*: All the treated plants were shorter than their diploid counterparts. Table 2 shows

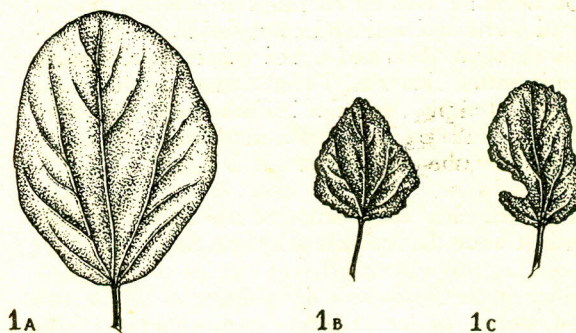


Fig. 1.—Cotyledons: A. Control; B. and C. Treated. $\times \frac{2}{3}$.

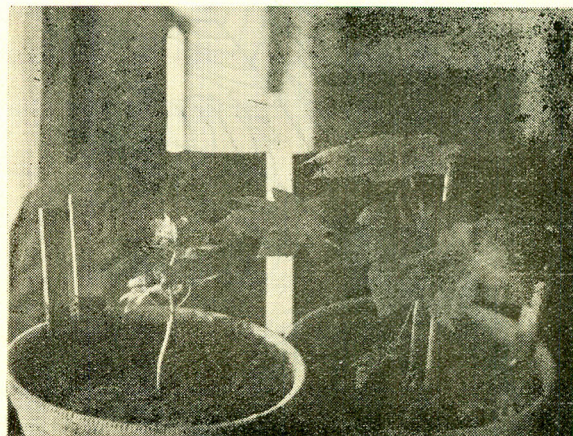


Fig. 2.—Height: A, Treated; and B, Control, $\times 6\frac{1}{2}$

TABLE 2.—COMPARISON OF CHARACTERISTICS IN TREATED AND CONTROL PLANTS.

Characteristics	Red		Green	
	Control	Treated	Control	Treated
1. Height in inches.	29.28± 4.15	27.56± 4.75	26.00± 3.27	23.12± 2.49
2. Leaves				
(a) B/L ratio	1.31	1.34	1.29	1.32
(b) B/L ratio of guard cells	0.58	0.63	0.61	0.67
(c) Number of stomata per unit area	10.44± 1.00	7.68± 0.83	11.30± 1.04	8.78± 1.78
3. Diameter of pollen grains in μ	27.45± 2.30	35.12± 4.52	27.07± 1.59	35.82± 3.11
4. Sterility percentage in pollen grains	3.89	12.50	4.01	10.01

their comparative heights (Fig. 2).

3. *Leaves*: The leaves of the treated plants showed the usual induced tetraploid characteristics, i.e., higher B/L ratio, and thicker and darker green leaves. The venation was more pronounced in the treated plants. The leaf size increased both in length and breadth but the increase was greater in breadth, resulting in higher B/L index (Table 2). The laciniation of leaves was shorter and the width of the leaf lobes was greater in the treated than in the control plants (Fig. 3A and 3B).

4. *Stomata*: As is usual with the induced polyploids, the leaf guard cells in the treated plants showed an increase in the dimensions of the guard cells with consequent reduction in the number of stomata per unit area (=0.0008 sq. inch) (Table 2). Figures 4A and 4B show a comparative size of stomata in the diploid and tetraploid plants.

5. *Inflorescence*: The peduncle of the inflore-

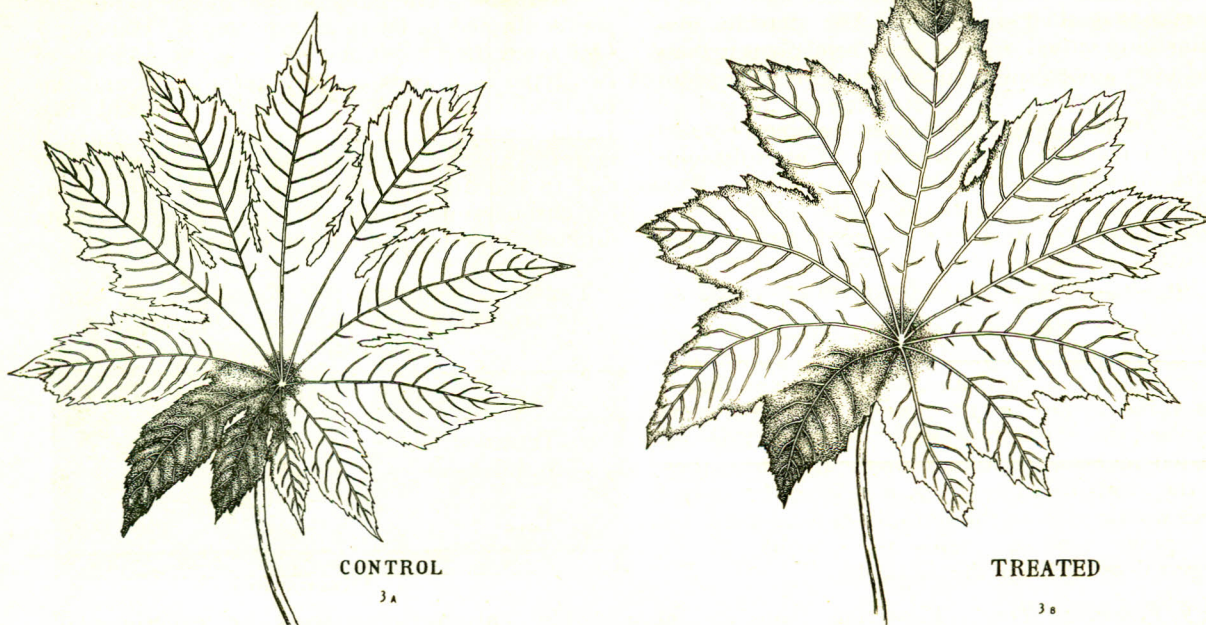
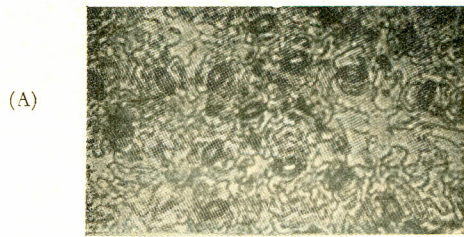
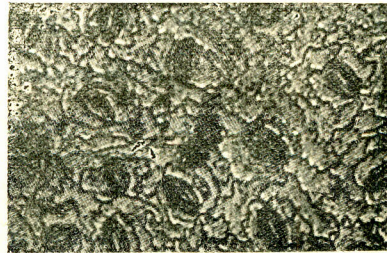


Fig. 3.—Leaves: A, Control; and B, Treated.



(A)

Fig. 4.—Stomata: A, Treated; and B, Control, $\times 280$.



(B)

Fig. 5.—Seeds: A, Control; and B, Treated $\times \frac{3}{4}$.



5 A



5 B

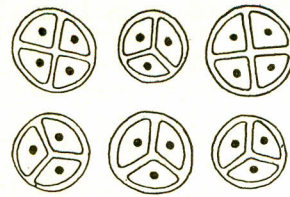
scence was shorter and with a smaller number of flowers as compared to the control.

6. *Pollen grains*: Ten to twelve per cent unstainable pollen grains were noticed in the treated plants (Table 2). They also showed large variations in their diameter. The percentage of stainability varied a great deal from plant to plant and even among different flowers of the same plant.

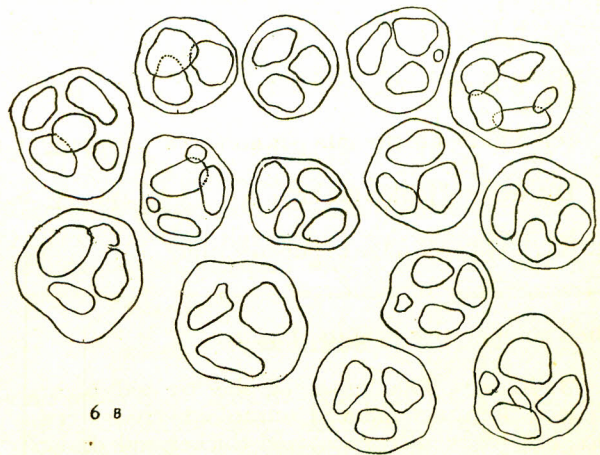
7. *Fruit*: In spite of a large number of pollen grains having good stainability in the tetraploids, there was seldom any fruit formation without hand pollination. The number of fruits in the tetraploids ranged from 4 to 6 as compared to 16 to 40 fruits per peduncle in the control. The fruits in the tetraploids were, however, slightly larger.

8. *Seeds*: Only one seed was found to develop per fruit in the tetraploid plants so far collected as against 3 in the control. It thus appears that of the three ovules in an ovary only one became fertilized in the tetraploids. The seeds in the treated plants were almost double the size of those in the control (Figs. 5A and 5B). The only 6 seeds obtained from the tetraploids weighed 2.1 g. as against 1.66 g. being the weight of the largest 6 seeds from the control.

9. *Flowering Time*: Flowering time of the treated plants was delayed by about 2 months.



(A)



6 B

(B)

Fig. 6.—Tetrahedral and isobilateral tetrads in: A, Control; and B, Treated, $\times 500$.

In blooming later they behaved like the majority of induced polyploids.²

Meiosis.—The gametic chromosome number was confirmed to be 10 as reported by Hagerup.³ One interesting point observed was the presence of two types of tetrads, namely, tetrahedral and isobilateral in the ratio of 2:1 (Figs. 6A and 6B). In the treated plants the ratio was almost changed to 1:1 (Table 3). This change of ratio is probably due to the disturbance in meiosis brought about by chromosome doubling. In tetraploid plants different types of sporads were found.

TABLE 3.—NUMBERS OF TETRAHEDRAL AND ISOBILATERAL TETRADS IN DIPLOID AND TETRAPLOID PLANTS.

Types of tetrads	Diploid	Tetraploid
Tetrahedral	215	87
Isobilateral	107	83
Total	322	170

Discussion

The only previous work on experimentally produced tetraploids was by Sidorov and Sokolov.⁴

Out of 248 plants treated with colchicine they obtained only 3 tetraploid plants. The proportion of tetraploids in our case was higher, as we obtained 3 tetraploids in a population of 80 plants. Except in size and weight of the seeds the tetraploids proved to be very uneconomical, as all of them flowered late and had a smaller number of flowers per inflorescence with a still smaller number of fruits because of the development of only one seed per fruit. What was more disappointing was the failure of the tetraploids to form fruits without hand pollination; this may be due to the differential behaviour of the pollinating agents.

Since in almost all artificially induced polyploids the fertility is considerably increased by hybridization and selection at the tetraploid level, it is hoped that the same result may be obtained in this case also, thus making the tetraploids economically productive.

Summary

Of the 80 seedlings treated with colchicine only 3 pure tetraploids were obtained. They showed all the characteristics associated with induced polyploids, namely, thicker and darker

green leaves with pronounced venation, larger and fewer guard cells, larger pollen diameter with higher sterility, larger but fewer fruits and larger and fewer seeds per fruit.

All the 3 tetraploids, however, proved to be uneconomical due to shy bearing. Methods of improvement are discussed.

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