

Rare case of symmetrical tricotyledony in combination with an irregular phyllotaxis in pomegranate (*Punica granatum* L.)

Monocots and dicots are two categories of angiosperm plants. The eponymous characteristic of these groups is the number of cotyledons. Monocots, like the different species of grasses and lilies, have one cotyledon, while dicots have two. Aberrations are rarely found, but three cotyledons were documented for some species like *Opuntia ficus-indica*¹, *Ceropegia mahabalei*² and *Withania somnifera*³. This so-called tricotyledony or tricotyly may be due to genetic variability^{2,4}. Holtorp⁵ defined three categories of tricotyledony: fission, where one cotyledon is split into two; twinning, where one original cotyledon appears as two conjoint ones; supplementation, where the first true leaf, apical to the original cotyledons, develops as a third cotyledon^{5,6}. A fourth variant of tricotyledony was found in *Phaseolus vulgaris*, with three symmetrically arranged cotyledons of equal size and shape emerging from three or six symmetrically arranged vascular bundles⁷. Pomegranate (*Punica granatum*) is a shrub or treelet of up to 7 m height⁸. It is a species of the dicot

family Lythraceae and is native to South-west Asia; now it is also cultivated in South and Southeast Asia, parts of North and South America, and in the Mediterranean region⁸⁻¹⁰. Common interest in pomegranate increased when the therapeutic value of the fruit was discovered^{9,10}.

A tricotyledonous seedling of *P. granatum* was reported to me by a private breeder. She raised four seedlings of *P. granatum* in Aachen, Western Germany. The four seeds came from the same pomegranate fruit. Only one of the seedlings showed tricotyledony (Figure 1 a and b). A spontaneous mutation leading to this abnormal growth seems likely. The three cotyledons were similar in shape, comparable in size and were symmetrically arranged on the shoot (Figure 1). The first three true leaves following the cotyledons were arranged in a spiral manner. After just three true leaves, the phyllotaxis changed and the leaves grew in a decussate system (Figure 1 b and c). The other seedlings showed a decussate phyllotaxis from the

first true leaves (Figure 1 b). Moreover, the second true leaf of the tricotyledonous seedling showed an incomplete twinning according to Holtorp⁵ (Figure 1 b and c). The vascular bundles of the seedling were visible from the outside; there were three bundles up to the cotyledons. Apical to the cotyledons, in the spiral part, the vascular system was irregular. At the transition to the decussate part, the vascular system established four bundles. The tricotyledonous seedling is about 14-weeks old now, 27 cm in height and developing well.

Symmetrically arranged cotyledons, which do not differ in shape or size, are rare for the three types of tricotyledony as defined by Holtorp⁵. The tricotyledony of *P. granatum*, described here seems to be of the same type as described by Harris *et al.*⁷, with three vascular bundles at the hypocotyl. The authors⁷ also showed that a change in the number of cotyledons has an effect on phyllotaxis. In *P. vulgaris*, a dicot plant has decussate leaf arrangement, while its occasional tricots show whorls with three

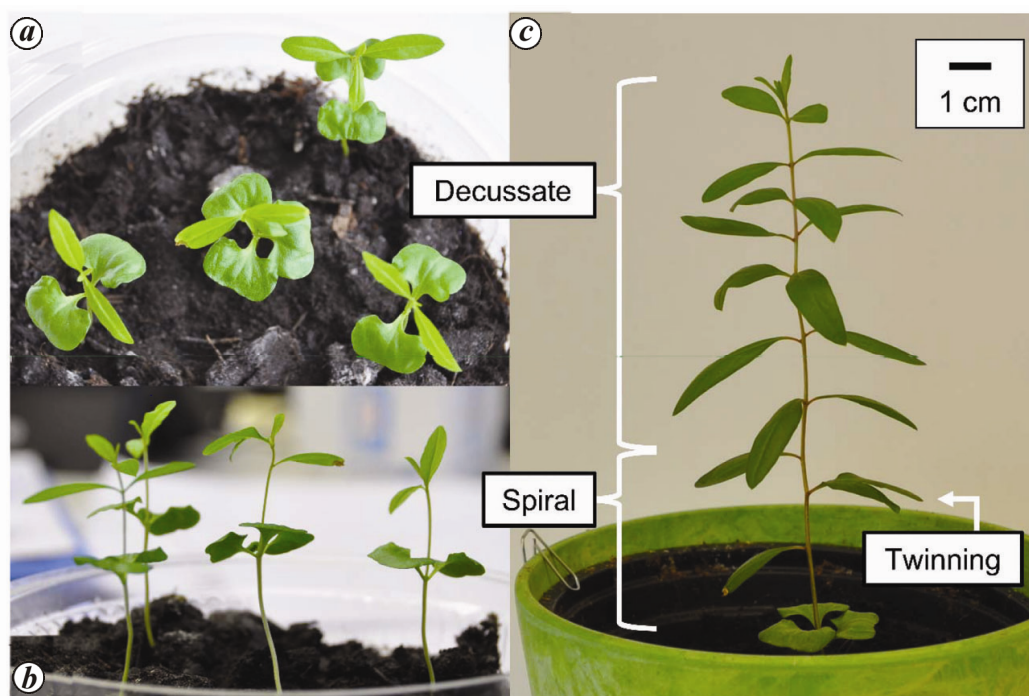


Figure 1. a, Tricotyledonous *Punica granatum* seedling amongst dicotyledonous ones. b, Tricotyledonous seedling showing spiral phyllotaxis and dicotyledonous seedlings showing decussate phyllotaxis. c, Tricotyledonous seedling showing changed phyllotaxis from spiral to decussate after three true leaves.

leaves each. Korekar *et al.*¹¹ found the same result for *Hippophae rhamnoides*, but whorls occurred only at the first few internodes. On the other hand, Wilson¹² found that the decussate phyllotaxis of *Idiospermum australiense* was unaffected by tricotyledony. Oome⁶ reported that the spiral system of *Mammillaria beneckeii* was not altered by tricotyledony, but by tetracotyledony.

The rare combination of tricotyledony, twinning in a true leaf and a change in phyllotaxis shows that a change in the number of cotyledons can have considerable effects on shoot morphology, which might be more variable than expected.

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