Preliminary survey of polyembryony in mango varieties in Sri Lanka

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INTRODUCTION

A large proportion of the mango trees found in our rural home gardens is from self-sown seeds, i.e. seeds which have been disseminated by animals, birds and man. These self-sown mango plants of the popular varieties have shown a remarkable degree of uniformity, resembling vegetatively propagated clones. The high degree of uniformity in vegetative characters, performance and quality of fruits of these varieties have been attributed to the high incidence of polyembryony and production of apogamous sucellar seedlings.

Polyembryony is the formation of more than one embryo in a seed. This phenomenon was recorded by Schacht in 1859. Subsequently, Strassburzer, Englar, Oliver (Belling 1908) independently observed polyembryony in mango.

In polyembryonic seeds one embryo is produced as a result of fertilization and several adventitious embryos arise from the cells of the nucellus. These adventitious embryos are known to originate from the epidermal cells of the nucellus situated close to the micropylar end on the side opposite to the funicle[Juliano (1934), Maheswari et. al. 1955)]. The plants that arise from these nucellar embryos have independent root systems. Hence they are easily distinguished from seedlings with branched or multiple stems.

Varieties which manifest this phenomenon of polyembryony produce several seedlings (Number ranging from 2-8 and at times even more) from one seed. Those seeds however are not extraordinarily large as a consequence. The mass of storage tissue of cotyledons in such seeds would therefore have to nourish several seedlings. Stress on food reserves of the endosperm brought about by several developing seedlings therefore could result in weak plants compared to the single seedling from a monoembryonic seed.

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It is claimed that polyembryonic varieties of mango give uniform stock plants. Hayes (1953) states that asexual or nucellar embryos from polyembroyonic seeds are generally more vigorous than the embryos produced as a result of fertilization. He further states that sexually produced seedlings may not even appear above ground. Campbell (1961) reports that polyembroynic varieties produce more fruits than monoembroynic varieties. He attributes this greater productivity of polyembryonic varieties to the development of asexual embryos even under conditions unfavourable to pollination and fertilization. These embroys supply the growth substances necessary for the development of fruits, and prevent fruit drop. In monoembroyic varieties, when pollination and fertilization have failed sexual embryos are not produced. As they do not appear to produce asexual embryos too, fruits do not develop due to lack of growth substances. This causes a poor fruits set and thereby results in low yields. Hayes (1953), states that important commercial varieties of mango grown in India are monoembryonic. Singh (1960) also reports that a large number of mango varieties in India are monoembryonic, but considers a few to exhibit polyembryony. Sen and Mallik (1940), from a survey conducted in the west coast of India report that out of 400 varieties examined only 10 are polyembryonic. They observed that even in these polyembroynic varieties there was a fair percentage of monoembryonic seed. Whether these monoembryonic seed produce sexual or nucellar seedlings has not been established.

The indigenous species of mango, *Manigfera zeylanica* Hookf. ('Etamba') and the variety of mango, known as 'sour mango' or 'Wal amba' (S) of the species *Manigfera indica* L., were reported to be monoembroyic by Richards (1943). The other varieties of the species *Manigfera indica* L. 'Fibre mango' (Kohu amba—S) Bombay mango (Betti Amba. S) investigated by him were found to be polyembryonic. Richards reports that in polyembryonic varieties such as 'Kohu amba' the growth of sexual seedlings is suppressed by the asexual or nucellar seedlings.

Manigfera zeylanica Hook. f. ('Etamba') was discarded from use as a root stock because it produces long unbranched tap roots. Seedlings of this species cannot stand the shock of root pruning and potting as heavy casualties occur during these operations. 'Wal amba' inspite of it being monoembryonic is still used as a root stock. The seedlings of this variety being monoembryonic in origin show wide variability in vegetative characters and heavy casualties occur during transplanting. The seedlings of this variety show wide variability in vegetative characters and vigour.

In view of the following observations :—

(1) Polyembryonic varieties bear more fruits than monoembryonic varieties (Campbell 1961).

(2) The asexual or nucellar seedlings produced by polyembryonic varieties are more uniform in growth and performance as root stocks.

(3) Nucellar seedlings produce fruits of the same high quality as the mother trees.

The need for a survey of the extent of polyembryony in the mango varieties found in Ceylon was realized. This survey was undertaken to distinguish the monoembryonic from the polyembryonic varieties of mango in Ceylon, and to estimate the extent of polyembryony.

METHODS AND MATERIALS

In this survey samples from 13 varieties grown in Government farms at Kundasale, Peradeniya and Maha Illuppallama were used. A minimum number of 50 fruits was used for each sample except in the case of ' Dampara ' and ' Vellai Colomban ', from which only 35, and 48 fruits respectively were available.

The seeds were extracted from ripe fruits harvested at full maturity shelled and planted in seed beds and wooden boxes. When the seeds were shelled the varieties Vellai Colomban, Chembatan, and Ambalavi were found to be heavily infested with seed weevils.

The data collected at Maha Illuppallama, were from nurseries which were planted before the commencement of this study.

Counts were taken as the seeds germinated. At the final count, made at full maturity of the first set of leaves, the Cotyledons were dissected with seedlings they nourished.

The data collected are given in Table 1.

DISCUSSION

Germination of the varieties Vellai Colomban, Ambalavi and Chembatan was poor compared to Donachi alphonso and Parrot. This can be attributed to the heavy infestation of seed weevils in these varieties.

It is evident from these data that some varieties such as Willard, ' Wal amba ' ' Panditha sekara mango ', Ambalavi and Chembatan produce 100 per cent. monoembryonic seed like the most popular Indian

varieties. In the variety Neelam 92 per cent. of the seeds were monoembryonic. The other varieties under observation, viz. Peterpassand, 'Kohuamba', Donachi Alphonso, Karutha-Colomban, Parrot, Vellai Colomban and Dampara also produce a certain percentage of monoembryonic seed ranging from 2.7-45.8 per cent.

The varieties, Peterpassand, 'Kohuamba', Donachi alphonso, Parrot, Kārutha Colomban and Dampara showed a high incidence of polyembryony ranging from 74.3 to 97.3 per cent. Vellai Colomban and Neelam showed 54.2 and 9.4 per cent. polyembryony respectively.

The single seedling from monoembryonic seed could arise either sexually or asexually. The genotype of these seedlings could only be established by laborious progeny testing. However, the nucellar seedlings could be distinguished from the sexual seedlings by the differences in their vigour and vegetative characters.

The apogamous or nucellar seedlings from polyembryonic seeds are uniform in growth and performance as root stocks (Hayes 1953). As illustrated in Table 1, polyembryonic seed could produce on an average, more than 2 seedlings from each seed sown. The only exception is Vellai Colomban, possibly due to the heavy infestation of insects. Thus it seems that from the practical nurseryman's point of view polyembryonic varieties of mango are more economical for use as root stocks.

Monoembryonic seed with all the food material available for development of a single seedling should produce strong vigorous seedlings. Seedlings of Willard, 'Wal amba' and Ambalavi were found to be well developed, while Chembatan and Pandithasekara with the small seed produced less vigorous seedlings. This observation is contrary to the popular view that seedlings (particularly sexual seedlings) produced by monoembryonic seeds are less vigorous. If this view is to be accepted it is necessary to ascertain whether the vigorous seedlings originating from monoembryonic seed are sexual or asexual.

When this point is clarified and characters for identification of nucellar or apogamous seedlings are established, it would greatly facilitate the selection of true to type clones from among polyembryonic varieties. Such varieties could be propagated from nucellar or apogamous seedlings and the progeny would have the same genotype as the mother tree. It is therefore necessary to find out mother trees with high productivity and incidence of polyembryony, combined with high fruit quality and other desirable characters. Propagation of

such mother trees would then become simple and inexpensive. Seven varieties out of the thirteen studied in this survey showed that they could be used in the manner outlined as they produce polyembryonic seed.

The nucellar or apogamous seedlings with their tap root system would be suitable for transplanting, and establishment in the drier parts of the country. They are also likely to be more drought resistant than grafts. These characters therefore could be used in the establishment of mango plantations in the dry zone of Ceylon.

There are, however, two disadvantages in the use of nucellar seedlings. They are, first the extended and unproductive juvenile phase of the plant, and secondly, the large size which would obviously introduce management problems such as pruning, pest and disease control and harvesting.

SUMMARY

A very high percentage of certain varieties of self-sown mango in Ceylon have been observed to be true to type. This phenomenon could be attributed to the high incidence of polyembryony in these varieties.

This investigation showed that Willard, Ambalavi and Chembatan, three of the popular varieties presently grown are monoembryonic, while the others are polyembryonic.

The varieties with a high incidence of polyembryony could be used to estabished orchards, with plants which are true to type, without resorting to vegetative propagation.

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TABLE 1

Variety	*No. of seeds sown*	*No. of seeds germinated*	*% Germination*	*Total No. of seedlings*	*Mean No. of plants per seed germinated*	*Mean No. of plants per seed sown*	*% of Monoembryonic seed*	*% seed with 2 seedlings*	*% seed with 3 seedlings*	*% seed with 4 seedlings*	*% seed with 5 seedlings*	*% seed with 6 seedlings*	*% seed with 7 seedlings*	*% seed with 8 seedlings*	*Polyembryonic seed*
Peterpassand (1)	50	42	84	124	2.95	2.48	11.9	28.6	30.9	14.3	9.5	4.7	—	—	88.1
Peterpassand (2)	50	36	72	135	3.75	2.70	2.7	11.1	27.7	33.3	19.4	2.7	2.7	—	97.3
Kohuamba M. I.	—	50	—	134	2.68	2.68	16	34	32	6	8	4	—	—	84
Kohuamba R.C.N.	50	35	70	87	2.48	1.74	25.7	25.7	28.5	14.2	5.7	—	—	—	74.3
Donachi alphonso	53	53	100	143	2.69	2.69	15	28.3	30.1	24.5	1.8	—	—	—	85
Willard M. I.	—	50	—	50	1	1	100	—	—	—	—	—	—	—	—
Walamba M. I.	—	50	—	50	1	1	100	—	—	—	—	—	—	—	—
Karutha Colomban	50	42	84	90	2.14	1.80	23.8	42.8	28.5	4.7	—	—	—	—	74.2
Panditha sekera	50	32	64	32	1	1	100	—	—	—	—	—	—	—	—
Parrot	50	50	100	172	3.44	3.44	6	18	36	20	10	8	—	2	94
Nellam	50	48	96	52	1.08	1.04	91.6	—	—	—	—	—	—	—	8.4
Vellai Colomban	48	24	50	45	1.87	0.93	45.8	16.7	8.4	—	—	—	—	—	54.2
Ambalavi	50	27	54	27	1	0.54	100	—	—	—	—	—	—	—	—
Dampara	35	20	57	47	2.35	0.71	25	40	15	15	5	—	—	—	75
Chembatan	50	25	50	25	1	0.50	100	—	—	—	—	—	—	—	—