# INTRODUCTION.

Female sterility in vegetatively parthenocarpic bananas, a prerequisite of edible clones, is a matter of concern where any breeding project is undertaken. Present day parthenocarpic bananas have doubtless arisen from early times in favour of absence of seeds with the result that clones now have complete, or nearly complete, female sterility. This is true of diploid, triploid and tetraploid clones of which the triploids are the most numerous and important in agriculture.

Diploids possess no or scarcely any fertility, partly as a result of gametic sterility arising from structural hybridity, and partly from poorly understood genetic factors, some of which may be a direct effect of parthenocarpy itself (Dodds & Pittendrigh, 1946). 'Pisang Lilan', for example, is quite sterile while in other clones fertility is perceptible but generally less than 1%,that is less than one seed per fruit (Shepherd, unpublished).

Among triploids there is much sterility from irregular meiosis. Seeds that germinate give progeny that are either aneuploid or diploid when embryo sacs arise from reduced meiotic divisions (Cheesman & Dodds,1942), or higher polyploids when restitution nuclei give rise to the sacs (Dodds & Pittendrigh, 1946; Dodds & Simmonds, 1946; Larter, 1948; Dodds 1945; Simmonds, 1953.). It has been established that the best practical approach to breeding is to cross a diploid on to 'Gros Michel' and to select useful tetraploid progeny. Female fertility of 'Gros Michel' is, however, low and variable as 0-60 seeds per bunch (inflorescence) are produced with averages of 1-2 (less than 0.01% fertility) (Shepherd, 1954). 'Awak Legor', the most fertile triploid, produces up to 25 seeds per fruit (5% fertile), although such high yields were not recorded in this project. 'Lacatan' shows total sterility. The range is thus from 0-5% fertility. Moreover, yields include various proportions of bad seeds and of those apparently sound not more than one third germinate. (Shepherd, unpublished). 'Awak Legor', in particular, shows a high proportion of seeds devoid of either endosperm or embryo and endosperm(Cheesman & Dodds, 1942).

Sterility can be considered in three phases, firstly megasporogenesis, secondly fertilisation and thirdly post fertilisation development (Dodds & Simmonds, 1946; Shepherd, 1954; Simmonds, unpublished).

Some data has been collected on embryo sac development in certain diploids and triploids. Significantly more morphologically normal embryo sacs than seeds have been recorded in some. Appearance, perhaps, is not an index of functional capacity but, in some cases at least, sterility is imposed at a later stage. External and internal environment appears to affect the proportion of sacs produced (Shepherd, 1954). No new data are reported for this aspect.

Failures in fertilisation concern the growth of pollen tubes to the embryo sacs and up to the time of nuclear fusion. Irregularities in pollen tube growth in the styles of some clones has been recorded and partial failure of pollen tubes contributes to a reduction in fertility (Shepherd, 1954 and unpublished). Such failures result from delayed, inhibited or limited penetration of normal styles. Two special cases have been defined. In the 'Palimbang' type pollen tubes begin growth normally until some or all are checked, often showing conspicuously swollen and bulbous tips. Inthe 'Tongat - Cavendish' type pollen tube growth is either nil or completely normal. The second case is ascribed to immaturity of the styles at the time of pollination and may be due, in part, to purely mechanical resistance. The time factor is less obviously connected with the 'Palimbang' type, although the isolated examples recorded in the clones 'Pacha Bontha Bathees', 'Ney Mannan' and Mysore' were in post-receptive hands. Shepherd has also collected data on the behaviour of pollen tubes after pollination at various times before and after receptivity (see also, Hancock, 1953). The examples of pollen reaction in 'Palimbang' and 'Tongat-Cavendish' failures are extremes and intermediate or mixed forms are found.

The present work sets out to correlate tube growth with subsequent yields, although in fact few abnormalities were encountered, and to gain further data on the timing of normal and irregular growth with special regard to time of pollination and the effects of auxin and anti-auxin treatments. Pollen tube down the style is associated with increases in indole-acetic acid both in the style and the ovary (Lund, 1955). A method for tube study in vitro would be of value in conjunction with studies in the style. Pollen grains of different species have been germinated and grown on nutrient media based on monosaccharides, most commonly glucose or lactose, sometimes with the addition of extracts from the pollen or stigmas of other species which can stimulate growth (Kühlwein, 1948; Bishop, 1949). Unsuccessful attempts to develop a technique for bananas are reported below.

Nothing is known of pollen tubes beyond the base of the style but failures in the embryo-sac were reported by Dodds (1945).

Sterility imposed subsequent to fertilisation may have two causes, firstly genetical or chromosomal unbalance, at least in triploids, secondly inhibitive or competitive effects arising from parthenocarpic development (Shepherd, unpublished). Dodds (1945) has commented on failures in the ovary. Comparisons between seed development 2-3 weeks after fertilisation and at maturity to indicate the timing of abortions are reported below. No microscopic examination was made.

Fruit development in plants is associated with waves of hormone action (Gustafson, 1939; Witter, 1943). Parthenocarpy can be induced in certain fruits by the application of auxins and natural parthenocarpy is evidently the result of abnormal auxin production in fruit tissues without the stimulus of pollination and fertilisation (Gustafson, 1939; Simmonds, 1953). It is possible that the concentrations of auxins in such fruits actively may inhibit normal fertilisation and seed development and that induced changes in these concentrations may be reflected in seed yields. Indications, so far, have been that application of auxin to banana ovaries before pollination does inhibit seed production (Shepherd, unpublished). Similar results for embryos in culture have been reported. For example, orchid embryos were inhibited by concentrations of 2 ppm. indole-acetic acid (Curtiss & Nichol, 1948 ) and those of Capsella bursa-pastoris by 1-10 ppm., though here a slight stimulation at $10^{-3}$ ppm. was recorded (Rijven, 1952). Datura stramonium embryos were stimulated by concentrations as low as $10^{-7}$ ppm. (Rietsema, Satina, Blakeslee, 1953).

Now indole-acetic acid can be inhibited by maleic hydrazide (Leopold & Klein, 1952) and Simmonds (1953) has shown that parthenocarpic development of banana fruits can be reduced by applications of coumarin (another anti-auxin) although there was no record of increased seed yields. Further comments are reported here on applications of indole-acetic acid and maleic hydrazide to banana fruits.