A detailed account of the above investigation will shortly be published elsewhere.

H. A. SHAH.
R. C. SHAH.

Royal Institute of Science,
Bombay, &
Ismail College, Andheri,
Bombay,
August 6, 1938.

[1] Sethna, Shah and Shah, *J.*, 1938, 228.
[2] Shah and Laiwalla, *Curr. Sci.*, 1936, 197.

Polyploid Plants produced by Colchicine and Acenaphthene.

BY treating germinating seeds of various *Nicotiana* species and hybrids in 0·5 per cent. aqueous solution of colchicine for 20, 40 and 72 hours, deformed seedlings were raised, from which normal and slightly abnormal diploid and polyploid plants of the following species and species hybrids developed: *N. rustica* (in several varieties including the best variety "Khmelevka"), *N. Sanderæ*, *N. glauca*, F_1 hybrids *N. alata-Sanderæ*, F_1 hybrids *N. suaveolens* × *alata*, F_1 hybrids *N. excelsior* × *velutina*, F_1 hybrids between two varieties of *N. suaveolens*, etc. In all these species and hybrids, plants with doubled chromosome numbers were obtained, while in the hybrid *N. alata-Sanderæ*, octaploids were also produced. Sterile hybrids were rendered fertile by chromosome doubling. Tetraploid plants were also obtained in *Phlox* after colchicine treatment.

Treating germinating seeds of Salat (*Lactuca sativa*) with crystals of acenaphthene for six days, I obtained deformed seedlings from which vigorous plants developed. The control plants reached a size of $\frac{2}{3}$ to $\frac{3}{4}$ of the size of treated plants. In other words, acenaphthene has a very high stimulating activity. Among the treated plants with acenaphthene, I found one tetraploid. The latter plant began to flower about ten days later than the diploid treated plants, *i.e.*, it had a much longer vegetation period. This is a profitable character from the agricultural point of view.

Reagent tubes were covered from inside with crystals of acenaphthene. Shoots of various *Nicotiana* species were covered with such tubes and closed from downside with cotton and then left for several days (2–10). Some of the new branches formed from the treated shoots were polyploid. I found in *Nicotiana longiflora*, for example, tetraploid

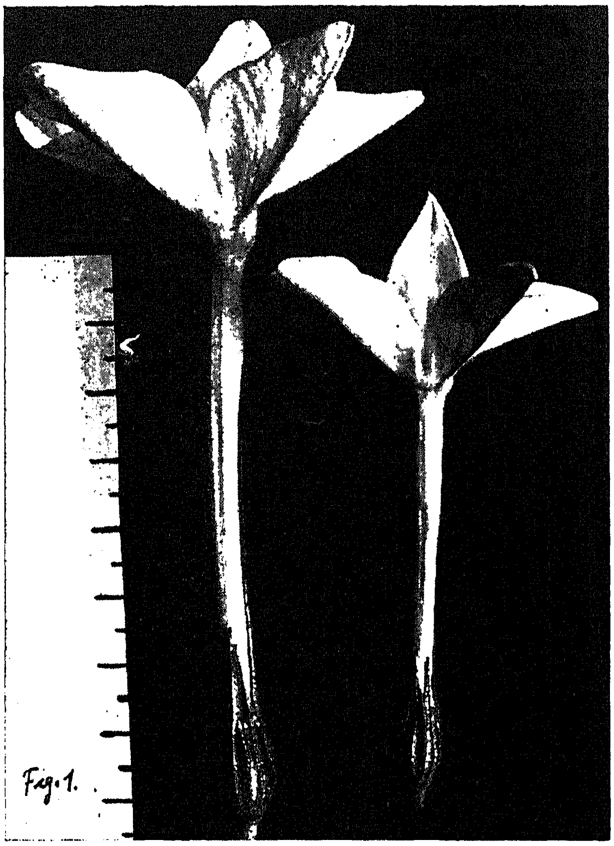

FIG. 1.

Flowers from tetraploid (left) and diploid (right) *N. alata* types.

FIG. 2.

Flowers from left to right: (1) from a tetraploid plant; (2) from a diploid plant of *N. suaveolens* varietal cross; (3) from a tetraploid *N. rustica*; and (4) from a diploid *N. rustica*.

and octaploid shoots. The chromosome numbers in the plants treated with acenaphthene and colchicine were determined in the pollen-mother cells.

Each polyploid plant produced in these experiments had longer vegetation period, thicker and broader leaves, larger pollen and stomata board cells, larger floral buds, broader corolla tubes, larger trichomes, darker green colour, larger ovules, larger seeds and coarser appearance than the

FIG. 3.

Lactuca sativa—left tetraploid, right diploid.

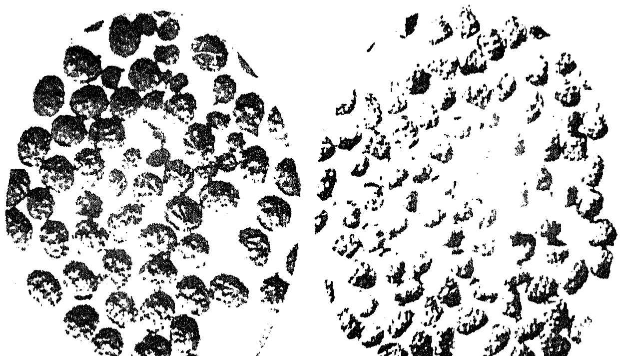

FIG. 4.

Seeds from polyploid *N. longiflora* (left) and from diploid form (right).

diploid ones. Some polyplcid plants had much longer flowers, while others had shorter ones as compared with the diploid plants. There were also tetraploid plants in which the flowers were about as long as in the diploid ones.

Discs with equal diameters were cut out of the leaves about 1 cm. below the apex from diploid, tetraploid, and octaploid plants and were weighed. Discs of tetraploid plants were about 30 per cent. heavier than those of the diploids, while those of the octaploids were about 30 per cent. heavier than those of the tetraploids and about 60 per cent. heavier than the discs of the diploids.

The characters.—Weight of the leaves, size of the seeds, length of the vegetation period, size of the flowers, fertility (rendering

FIG 5.

Stomata board cells of diploid (left) and octaploid *N. alata-Sanderæ* plants.

sterile hybrids fertile and fertile species into partially fertile by chromosome doubling), etc., being affected by chromosome duplication, are of great significance for the plant breeders, especially for the horticulturists.

It is worth while mentioning the following two factors affecting fertility in the autopolyploids: (1) chromosome length and (2) chromosome number. Auto-octoploid *Triticum durum*, for example, obtained by acenaphthene treatment formed multivalent chromosomes during the meiosis of a higher range and was self-sterile, while most of the tobacco species having shorter chromosomes than *T. durum*, formed less multivalents, had more regular meiosis, and their fertility was less affected. Tetraploid *N. rustica*, having 96 chromosomes formed rarely multivalent chromosomes, but it had irregular meiosis, probably because of a too great crowding of the chromosomes, especially during the second meiosis. This seems to bear a causal connection with the non-significant increase of the distance between the nucleus and the cell wall. On the basis of these observations one might conclude that fertility of autotetraploids will be less affected in plants, having shorter chromosomes and small chromosome numbers.

DONTCHO KOSTOFF.
Institute of Genetics,
Academy of Sciences of USSR,
Moscow,
July 31, 1938.

Minimum Adequate Size of Sample of F_2 required in Experiments on Hybrid Vigour and Inheritance of Quantitative Characters.

IT has been pointed out that the most unsatisfactory feature in hybrid vigour experiments has been the inadequacy of numerical data. Examples of inadequate data are not rare, probably the most outstanding is that of Kadam[1] who based his conclusions on a population of 2, 3 and 4 plants. One of the outstanding reasons for this is the difficulty of obtaining sufficient number of F_1 seeds. Efforts have always been made by workers to compare an F_1 generation directly with the parents and subsequent filial generations. The difficulty of comparing parents with an F_1 generation and not relying on the subsequent generations has compelled them to limit their trials to only small experiments. There are two reasons for not relying upon F_2 and subsequent generations. First is that, in these generations, segregation of genes takes place and therefore, it becomes difficult to observe clearly the manifestation of hybrid vigour; second reason is that because it is almost impossible to use all the F_2 seeds in trials, there is every likelihood of taking a sample of such combinations which may show more or less vigour than the whole population. It is mainly for these reasons that hybrid vigour experiments have not been usually conducted on modern system of field trials, *e.g.*, in randomised blocks and latin squares. Engledow and Pal[2] and Pal *et al*[3] seem to be the only workers who conducted hybrid vigour experiments on wheat in latin squares and randomised blocks so that the data could be subjected to statistical analysis.

Similarly, review of literature shows that for studying the inheritance of quantitative characters, workers have been using, very wide ranged F_2 populations. For instance Nohara[4] based his conclusions on an F_2 population of 24. Whereas Ramiah[5] used as many as 2466. Another worker working on cotton concluded that a certain character was governed by four pairs of factors, the F_2 population on which he based his conclusions was even less than 256 plants which is the least number for getting all the genotypes. Similarly East[6] studied height character in tobacco on an F_2 population of 114 plants, while Howard[7] did the same on 647, 356 and 331 plants in case of different tobacco crosses.

It is evident that there has not been any standardisation of taking F_2 populations for studying the inheritance of quantitative characters. Of course, there is not much harm in taking larger populations but it is quite obvious that there are very few chances to arrive at valid conclusions from such meagre populations as 2, 24 or 114 plants.

The purpose of this paper is to determine:

(1) How far it is admissible to compare F_2 with parents and F_1 in randomised blocks and latin squares in hybrid vigour experiments.

(2) What should be the least adequate size of sample in F_2 for studying the inheritance of quantitative characters? Both these problems do not seem to have hitherto received the attention of the workers. These will be dealt with separately under two different headings, namely, hybrid vigour and inheritance of quantitative characters.

I. *Hybrid Vigour.*—According to Mendelian laws of inheritance if the difference between two characters is governed by three pairs of factors, a population of at least sixty-four is required to have all the genotypes in F_2. Similarly for four pairs of factors 256, for five 1024 and for six 4096. To compare F_2 against parents and F_1 in randomised blocks and latin squares it will be necessary to grow in each block a population of 4096 in case of six pairs of factors or at least such a representative sample average of which may not differ from that of 4096 plants. When looking into this aspect of the problem the following questions are apt to arise:—

(1) Whether the total F_2 population raised from F_1 is the same or is at least representative of the expected F_2 population.

(2) If the total F_2 population is the same as the expected F_2 or is representative of that, what should be the minimum adequate size of the sample which may be obtained