Discussion
Discussion

Morphological changes associated with ploidy change

Stomatal frequency, guard cell length and stomatal chloroplast number have often been used as a morphological marker for identifying ploidy levels in many plant species viz. alfalfa (Bingham 1968), Gossypium (Krishnaswami and Andal 1978), Dactylis (Santen and Casler 1986), rye grass (speckman et al 1965), wheat (wang et al 1989) and Bromus inermis (Tan and Dun 1973, Lea et al 1977). However, not much effort has been made to study such parameter with respect stem anatomy and / or micromorphology of storage tissues / organs, along the evolutionary or induced polyploidy. During the present study an effort has been made to elucidate the polyploid associated micromorphological feature of economic importance taking into account the polyploid mediated
change with respect to polyploidy *per se* as well as polyploid stressed *de novo* generated somatic changes.

The observations recorded here clearly reveal that in general there is increase in cell size on account of polyploidy, which is equally reflected at all stages of plant tissues and organs. However, the frequency of cell number is decreased on account of polyploidy. Thus, polyploidy does not cumulate the increasing effect of cell size but only add to gigas characteristics. This is in consonance with the observations of Mishra (1997) who observed a general increase in stomatal guard cells but decrease in stomatal and epidermal cell frequency with increase of ploidy level in *Coffea* L. This is also reflected in other somatic tissues such as stem etc. as shown by the instant study. Like epidermal cells, the other kinds of cells such as those contributing to glandular hairs are also expected to behave in similar fashion. Such glandular cells are the sites of storage of active plant principles – the secondary metabolites, e.g. essential oils, alkaloids and saponins etc. Therefore, an increase in the area covered by such storage tissues is likely to add
to the productivity of concerned metabolite. The comprehensive data on cell size associated changes in the diploid vs. polyploid of all the seven taxa as given in Table 12 clearly reveal that there is an overall increase in the surface area of storage cells on being changed to polyploid state as reflected from Gland Index. It is revealed from the observations recorded that increase in Gland Index is on account of increased cell size of gland even though there is reduction in gland number. As such, a simple observation on Gland Index could be useful to predict the productivity of gland associated secondary plant product. This is commensurate with the observations on enhanced productivity of secondary metabolites associated with polyploid change (Dhawan and Lavana 1996).

**Morphological changes associated with bud-sport mutations**

The plants that reproduce obligatorily vegetatively harbor inherent tendency to generate somatic mutations
de novo which contributes to their evolution in the absence of sexual mechanisms. In such species, their somatic tissue comprises of chromosome mosaics generated on account of endopolploidy and disturbed anaphase segregation (vide Sharma 1978). A changed somatic chromosome complement when channeled to differentiating bud will give way to generation of bud sports (Sharma 1956, Sharma and Sharma 1956, Sharma 1978). *Mentha arvensis* is one such species that evince natural tendency of releasing bud-sport mutations. It could be assumed that if artificial polyploids of *Mentha arvensis* are screened for incidence of bud-sport mutations, there exists a clear possibility that incidence of bud-sports may be enhanced because of increased chances of disturbances in somatic tissues. This has in fact been observed in the instant study where it is shown that incidence of both frequency and spectrum of bud-sport mutations is enhanced by four fold. A large number of bud-sport mutations differing in gross exomorphology and also in their micro-morphology for yield contributing characters could be realized. The data presented in
Tables 13-17 reveal incidence of over 20-30% diversity in morphological features and over 20-40 variation in essential concentration and its qualitative composition, generated on account of bud-sport mutation. Occurrence of such huge variation without obviating the need for sexual recombination is exhilarating, having value in genetic improvement programme of the target species.

In the present study an exhaustive analysis on histomorphological features has been undertaken to deduce meaningful information to deduce correlation between the size and frequency on micromorphological characters such as epidermal features and essential oil secretary cells, as also to identify bud-sport mutants of enhanced production of useful secondary metabolite – the essential oil both in terms of quantitative and qualitative identification. The study not only promises generation of valuable genetic material, but also helps to provide micro-morphological markers to facilitate selection for improved plant types in Mentha arvensis in particular, and other related species in general. Although, a few reports on the incidence of bud-sport and their
utilization for breeding purposes have earlier been reported in *Mentha arvensis* (Tyagi and Naqvi 1987), but the present study is new of its kind, dealing with exhaustive analysis and isolation of bud-sports, and augmentation of bud-sport formation *per se* under polyploid stress. The latter has not been reported earlier.