crop plant. It will perhaps be relevant to mention that work on another muskmelon isolate of *F. solani* disclosed complete absence of the usual root rotting in that particular case but the pathogen was never found in the vessels[4].

Grateful thanks are due to Dr. L. M. Joshi, for facilities. PR acknowledges the award of a fellowship from ICAR.

22 *October* 1981

1. Dufrenoy, J., *Ann., Epiphytics.*, 1921, 7, 405.
2. Kosswig. W., The symptomatology of the Fusarium wilt of cucumber (*Cucumis sativus* L.) and their relation to wilt disease of other plants. Hamburg and Berlin, Paul Parey., 1975, 148.
3. Christou, T. and Snyder, W. C., *Phytopathology*, 1962, 52, 219.
4. Sen, B. and Palodhi, P. R., *Curr. Sci.*, 1979, 48, 166.

INTERMEDIATE SHOOT APEX OF *PAPAVER* SPECIES

SURESH C. GOYAL AND AMBUJA PILLAI
Department of Botany, University of Rajasthan, Jaipur 302004, India

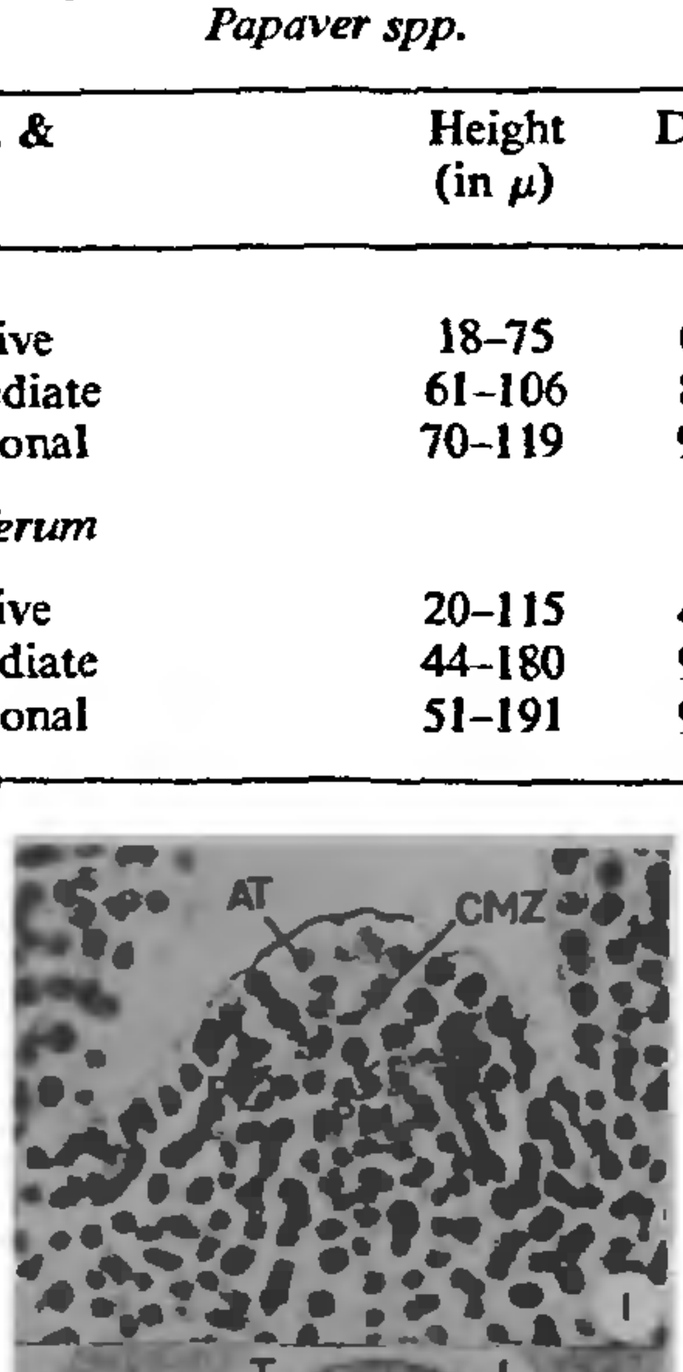
CONSIDERABLE progress has been made in the last few years in anatomical studies of shoot apices as influenced by environmental factors such as photoperiod[1,2]. It was found that meristems of plants held under non-inductive conditions pass from the vegetative stage to an intermediate stage. This condition was described[3,4] as intermediate because the apex continues to initiate new leaves but gradually acquires new characteristics that are partly vegetative and partly transitional. This paper attempts to characterise the vegetative and intermediate apices in *Papaver rhoeas* Linn. and *P. somniferum* Linn. using anatomical techniques.

The vegetative shoot apex is a low to high dome depending on the age and plastochronic stage (table 1) and shows a cytohistological zonation pattern superimposed on a tunica-corpus organisation. A gradual age-related increase in size of the apex is maintained from germination to seven weeks. The tunica in the active vegetative apex is single-layered in *P. rhoeas* and two-layered in *P. somniferum*. At the summit of the apex a few tunica cells are larger and more vacuolated, so the term "axial tunica" is used for these cells (figure 1).

The central mother cell zone (CMZ) at the summit of the apical dome shows a group of large, lightly stained and irregularly arranged cells. Occasional divisions in this zone contribute cells to the peripheral

TABLE 1
Average height and diameter of the shoot apex in Papaver spp.

Plant spp. & stages	Height (in μ)	Diameter (in μ)
P. rhoeas		
Vegetative	18–75	60–140
Intermediate	61–106	80–146
Transitional	70–119	90–164
P. somniferum		
Vegetative	20–115	40–146
Intermediate	44–180	90–160
Transitional	51–191	96–181



Figures 1–3. L. S. of the shoot apex in *Papaver* spp. **1.** *P. rhoeas* showing cytohistological zonation in the vegetative apex (× 500). *2. P. somniferum* showing elongate, less zonate intermediate apex (×300). **3.** *P. rhoeas* showing early mantle-core organisation in transitional apex. Note the lighter staining in the axially located cells (×255). (AT, axial tunica; CMZ, central mother cell zone; CO, core; L. leaf; M. mantle; PM, pith meristem; PZ peripheral zone; T, tunica; darts indicate mitotic figures).

zone (PZ) and pith meristem (PM) (figure 1). The peripheral zone forms a cylinder of 2-3 cell layers around the CMZ and PM zones. The cells are slightly elongated along the long axis of the shoot and densely stained (figure 1). Transverse divisions at the base of the CMZ result in a subjacent group of more or less regularly arranged cells which form the pith by further divisions.

At 5 weeks the apex passes from the vegetative to the intermediate and then gradually to the transitional and flowering stages in the next two weeks. The intermediate apex is larger than the vegetative apex and increased in height more than in diameter (table 1) and has common features with the vegetative and transitional apices. It resembles the vegetative apex in tunica-corpus organisation and continued production of leaves. The similarity to the transitional apex is the less marked zonation (figure 2). There is considerable variation in the degree of corpus stratification, though the outermost CMZ layers tend to simulate tunica layers (figure 2). The intermediate apex becomes elevated above the youngest leaves as a result of apical elongation and elongation of the youngest internode.

Once the apex reaches a critical stage it passes from the intermediate to the transitional stage. The transitional apex is broader than the intermediate apex (table 1). Stratification increases in the corpus region leading to the establishment of a 3-5 layered mantle with densely chromophilic cells and enclosing a lightly stained core of inner cells. Axial cells of the transitional apex are still lighlty stained (figure 3).

The term intermediate apex was first used by Lance[3]. The vegetative apex of *Cosmos* was reported[5] to change to the intermediate one when grown under conditions unfavourable to flowering. In *Delphinium* the intermediate type of apex was reported in plants grown under natural conditions[6]. The less prominent cytohistological zonation in the intermediate apex as compared to the vegetative apex may be in preparation for the changeover to the floral phase during which leaves become progressively smaller. It was mentioned[7] that increase in stratification and loss of zonation characteristic of earlier phase is one of the many changes in the shoot apex during changeover from vegetative to intermediate. The number of tunica layers seems to increase or it may be considered as the outermost corpus layers simulating the tunica to form a mantle over the shoot apex. This becomes a constant feature in the floral apex. Data presented indicate that the intermediate apex need not necessarily be the result of exposure to photoperiods unfavourable to flowering.

One of us (SCG) thanks the CSIR, New Delhi for financial assistance.

23 *November* 1981

1. Gifford, E. M. Jr. and Tepper, H. B., *Am. J. Bot.*, 1962, **49**, 706.
2. Nougarede, A., Gifford, E. M. Jr. and Rondet, P., *Bot. Gaz.*, 1965, **126**, 281.
3. Lance, A., *Ann. Sci. Nat. Bot.*, 1957, **11**, 91.
4. Poux, N., *CR Acad. Sci.*, 1957, **245**, 2522.
5. Molder, M. and Owens, J. N., *Can. J. Bot.*, 1973, **51**, 535.
6. Kavathekar, K. Y. and Pillai, A., *Proc. Indian Nat. Sci., Acad.*, 1979, **B45**, 577.
7. Gifford, E. M. Jr. and Corson, G. E. Jr. *Bot. Rev.*, 1971, **37**, 143.

INHERITANCE OF FROST RESISTANCE IN POTATO

S. P. TIWARI AND K. C. GARG*
Cytogenetics Section,
National Research Centre for Groundnut,
Junagadh 362 002, India
*Division of Genetics, Central Potato Research Institute, Simla 171 001, India.

INFORMATION available on inheritance of frost resistance in potato is meagre and reports available merely indicate the presence of a continuous variation in segregating populations thereby inferring that the resistance is probably controlled by polygenes [1,2,3]. The studies are limited due to (i) the difficulty in quantifying frost resistance in individual plants and (ii) sterility in F_1 plants and parental clones. Although it is not feasible to obtain F_2 generations in potato, the available strains are highly heterozygous and right in F_1, the segregation and recombination are realised which have been utilized in several genetic studies in this crop. The present study was taken up to investigate (a) the mode of inheritance of frost resistance in Indian varieties and (b) the genetics of resistance by analysing F_1 and test-cross generations.

Frost resistant varieties Kufri Sheetman, Kufri Dewa and Phulwa were used in combination with susceptible varieties Kufri Lauvkar and Craigs Defiance. Kufri Sheetman was crossed reciprocally with Kufri Lauvkar. Because of its male sterility, Kufri Dewa was used only as female in cross with Kufri Lauvkar. Phulwa (P-18) was hybridised with the male sterile Craigs Defiance. Two selections from the cross Kufri Sheetman x Kufri Lauvkar were back-crossed with Kufri Lauvkar. The selections used were designated FR(R) for the resistant one, and FR(S) for the susceptible one. Crosses were also made between Craigs Defiance and Kufri Lauvkar.

About 200 seeds from each of these crosses were used to raise F_1 and test-cross generations in the field during late autumn season in Simla. Observations