Summary and Conclusions

Metabolic changes and physiological processes due to light and temperature were investigated in mustard (Brassica juncea L) plant. Mustard is an important cash crop of Gujarat which experiences wide fluctuations during winter season. The basis for the approach in the present study has been described in the 'Introduction' part.

Two factors, viz. vernalisation as a temperature factor and photoperiod as a light factor were considered. Vernalisation treatment was given at 3 stages of germination and seedling growth viz. a. imbibed seeds, b. radicle stage, c. cotyledon stage. As most of the vernalised seedlings could not survive the high temperature after transplantation, gibberellic acid was tried as a substitute for vernalisation. This also helped in understanding the probable physiological role of gibberellic acid in growth and development.

The influence of photoperiod and gibberellic acid on levels of metabolites in leaves (inductive process) and the influence of photoperiod and vernalisation on the metabolite status in shoot apex (evocation process) were investigated. The endogenous levels of gibberellins and cytokinins during transition phase were also measured in the top two leaves and shoot tips.

Various standard biochemical and histochemical techniques and mathematical models were employed in the present study. The results obtained and the conclusions drawn from these are as under:
(1) Higher lipase activity in the first three weeks and increase in the contents of RNA, proteins and reducing sugars during the subsequent period of vernalisation with a rapid fall in the amino acid level might be related to the capacity to accelerate the growth and development processes of the seedlings when transplanted to favourable growth conditions (like soil, photoperiod and temperature).

(2) The phenolic content of the vernalised seedlings was higher than that of control ones. The seedling growth during vernalisation was also slower. The qualitative changes in phenols during vernalisation were seldom studied. It is important to conduct investigation before an explanation is made for the higher content of phenols in vernalised seedlings.

(3) The developmental stage at which seedlings received vernalisation treatment had profound effect on flowering. Imbibed seeds did not evoke vernalisation response. On the contrary, the plant took more days to flower when the treatment was given at cotyledon stage. Radicle stage was suitable for vernalisation as this evoked early flowering.

(4) Long days and vernalisation caused early flowering in B. juncea but neither treatments were absolutely required for floral induction. Long day as well as cold-temperature requirements are quantitative.

(5) GA caused effects were akin to the long day evoked responses. GA enhanced flowering in SD and ND grown plants but not in LD grown
plants. The effects of applied GA were long lasting since the flowering response to GA was observed only after the 'intermediate stage' under non-inductive condition. In further developmental process the concentration of hormone is more important and higher dose may show inhibitory responses.

(6) Translocation of GA from leaf to shoot tip might occur before flowering since flower bud initiation was preceded by a marked increase in GA levels of shoot tip extracts and their concomitant decline in leaf extracts.

The levels of endogenous cytokinins in shoot tip extracts have not shown a significant rise during transition phase.

(7) After 22 short day cycles the plant achieves an intermediate state when the vegetative apex shows a rise in RNA content in tunica and central zone cells. This state may signal the readiness of plant for photoperiodic and hormonal induction, because it is only after this period that the endogenous levels of gibberellins in shoot tips increased.

(8) The levels of RNA, protein and reducing sugars in leaves increased before the floral bud appearance. Total leaf phenolic content also increased up to flowering in all photoperiods. But treatment with GA decreased the phenolic content in SD and increased in ND and LD. Since phenols constitute both growth promoters and inhibitors, the qualitative changes of endogenous phenols may help to understand their possible role in induction of flowering.
Net assimilation rate was positively correlated with relative growth rate and negatively with leaf weight ratio. Increase in net assimilation rate resulted into increased yield. GA enhanced seed weight also was mediated through increased net assimilation rate. However, no significant correlation was found between applied GA and yield characters under ND. This might be perhaps due to the growth saturating levels of endogenous GA caused by applied GA.

Higher photosynthetic rates as shown by net assimilation rate resulted into more pods, pod length and 1000 seed weight. Thus photosynthetic rate or net assimilation rate is more important internal factor governing the process of development.

The rate and duration of developmental processes are influenced by hormone (GA) also. The concentration of the endogenous hormone may be more important in determining their activity since a favourable hormone may cause inhibitory responses at higher concentrations. This was observed in ND and LD grown plants where the applied hormone markedly increased its endogenous levels which were already higher due to the favourable photoperiod, to the saturating levels of its activity.

Warmer temperatures at the time of pod-setting may favour for more pods/plant as in ND, while cool temperatures increase seeds/pod and pod length as in LD perhaps due to high GA content at low temperatures rather than availability of photosynthates.
(12) When the process of development is accelerated, the dry matter production of vegetative organs will be less. This is envisaged by higher 1000 seed weight and less dry matter production in LD and GA treated plants than in ND untreated plants respectively. This acceleration of development, however, leads to an overall reduction in yield due to the shorter vegetative growth.

(13) The time of flowering, pod setting and seed formation is important in determining yield. A shift in hormonal balance is likely to occur during this period which may activate the translocation of photosynthates to inflorsecences. Pod photosynthesis contributes much of the dry matter required for seed formation because leaf formation is greatly reduced after flowering.

(14) Studies on pod photosynthesis and hormonal balance during pod growth are required to assess the physiological process of development in this crop plant.

$^{14}$C labelled photosynthetic and assimilation studies are required to probe the GA enhanced net assimilation rates in the present study.