SUMMARY AND CONCLUSIONS

Grain legumes, also known as pulse crops are the major source of protein (as much as 80%) for millions all over the world. Importance of pulses for household nutritional security is, therefore, obvious. Pulses assume added importance, for sustainable agriculture as they enrich the soil with nitrogen.

Our agriculture is justifiably proud of its achievements in cereal production but in contrast, production of pulses has remained stagnant and in fact declerated. Almiost 50% of world area under pulses contributed today roughly 44% of world production compared to 58% in 1961. The basic constraint is poor productivity (less than 1 ton per hectare). Therefore to meet the requirement of pulses, within the purchasing capacity of the economically weaker section of population, their increased production should have the top priority.

However, substantial progress has been made as evident by the number of improved cultivars available but the rate of growth both in terms of production and productivity has not been impressive in India. Availability of improved seed and other inputs has been the major constraint as pulses are grown by resource poor small farmers. So, research on pulses needs to focus on improving a yield technology at economical level.

The beneficial effects of plant growth regulators (PGRs) and other nutrient have been reported by their ubiquitous role in controlling many facet of plant life. They may bring about favourable shift in various physio-bio-chemical aspects which offer an immense practical application of bioregulants in agriculture. The presowing presoaking or the pretreatments of seeds with PGRs offer greater controversies, especially for presoaking, in which chemical should or should not be applied on every occasion, irrespective of all other conditions. Pretreatments are required to be correctly applied both in terms of correct dosage rate and uniform application. Thus, the selection of the right type of chemical and its dosage, the soaking duration, temperature, volume for each type of seed is necessary for their ameliorative effects.

Nitrogen availability during the pod filling stage is the principal factor limiting realization of
yield potential in most short duration pulse crops. Many plant physiologists are primarily concerned with elucidation and regulation of flower and immature pod abscission through foliar spray of various PGRs and nutrients. This may fulfill the scarcity of source during reproductive development which in turn strongly influences the quality and quantity of seed yield.

Seed harvesting at its physiological maturity (when no significant increase in the dry matter deposition with time is observed) is another important criteria for high seed production as it possesses maximum vigour, germinability and food reserves at that particular stage. Seed gleanig at harvest maturity, i.e. when seed and plant are almost dry show better seed quality.

The exogenous application of PGRs through pretreatment has added new dimension to the possibility of modifying the rate of deterioration in seeds during storage. They greatly minimise the loss of various quantitative and qualitative characters of seed by controlling various internal physiological and biochemical processes occurring during ageing.

Therefore, objectives of the present study were to understand various aspects of pulse crop productivity through comprehensive studies of various physiological and biochemical changes during vegetative and reproductive growth of plant, seed maturation and seed storage under influence of PGRs application in four important pulse crops viz. mungbean (Greengram, Vigna radiata L. wilzeck, cv K-851, urdbean (Blackgram, Vigna mungo L. cv T-9), cowpea (Vigna unguiculata L. walp cv pursaphalguni) and pigeonpea (Cajanus cajan L. millps, cv BDN-2).

The summary of the detailed studies conducted are given as follows:

1. **SEED SOAKING STUDIES:**

A. Optimum soaking volume weight(g)/volume(ml) and duration in hours (h) at optimum temperature (BOD 26±2°C) for mungbean is double the volume for 4 h, urdbean double the volume for 5 h, cowpea six time volume for 4 h and for pigeonpea six time volume for 6 h. The lower concentration (10⁻⁵M and 10⁻⁶M) of GA₃, kinetin, NAA and ethrel show better seed germination and seedling growth in all the four crop.
B. Pretreatments with KIN, ETH and GA$_3$ significantly increase many enzyme activities and metabolites in all the four type of seeds during early germination due to acceleration in seed germination by PGRs.

2. PRETREATMENT AND FOLIAR SPRAY STUDIES:

A. Seeds of all the four type of crop treated with KIN, ETH, GA$_3$ and NAA have improved field emergence, vegetative and reproductive growth, dry matter accumulation and final yield. The superior treatment KIN showed increased yield over control in mungbean upto 21%; urdbean 17%; cowpea 18%; and in pigeonpea 17%. These treatments also showed improvement in harvest index in each crop.

B. In all the four crops spraying of lower concentration of PGRs ($10^{-6}$M to $10^{-7}$M), Urea and KNO$_3$ at every five days interval, starting from flower initiation was done to study various vegetative and reproductive changes in crop. The foliar sprays of KIN, ETH, GA$_3$ and NAA showed marginal improvement in vegetative growth but it significantly checked abscission of immature pods and flower after three sprays. This also showed significant increase in root nodulation, leaf chlorophyll content and leaf nitrogen content by delaying their senescence. Urea and KNO$_3$ also showed their beneficial results in the same way but at lower magnitudes. Here maximum increase in yield through KIN spray is upto 27% in mungbean; 26% in urdbean; 24% in cowpea; and 22% in pigeonpea. This clearly demonstrate that PGRs applications at reproductive phase help the plant to modify its physiological processes which ultimately improve the yield of the crop.

3. SEED MATURATION STUDIES:

Cumulative effect of foliar spray of KIN, ETH, GA$_3$ and NAA with urea (source of nitrogen) at flowering stage showed increase in fresh and dry weight of seeds due to increase in reserve food accumulation during different stages of seed maturation. The moisture content of maturing seeds decreased gradually whereas germination, seedling performance and vigour of the seeds increased with maturation upto certain level and thereafter it declined after physiological
maturity in all the four crops. The SDS-PAGE separated protein bands revealed the differences among the seedlots harvested at different maturation stages. Similarly isoenzymes of peroxidase and amylase show distinct patterns through KIN, ETH and GA₃ foliar sprays in all the four crops.

4. SEED STORAGE STUDIES:
Seed stored under ambient conditions in the moisture resistant sealed polythene bags (600 gauge) showed gradual decline in germination, seedling performance and vigour and increase in the moisture content of seeds. This loss is reduced through GA₃, ETH and KIN treatments during initial months of storage whereas ABA showed beneficial effect at later storage periods. These four treatments also showed restricted leaching of soluble organic and inorganic compounds in each crop. Increased storage potentiality of ABA, KIN, ETH and GA₃ treatment is also reported through TTZ test and protein profile of viable and nonviable pretreated seeds in each crop. Electrophoretic protein profiles revealed remarkable differences in terms of more and intense bands in viable than non-viable seeds. Apart from these TTZ studies indicated the decline in intensity of formazon colour production with passage of time in control seeds in comparison to the pretreated seeds. This screening thus showed prolonged viability of each type of pretreated seeds by declining various deteriorating processes and by maintaining membrane integrity system during storage period in all the four crop.

FOLLOWING ARE THE SALIENT FEATURES:

1. Seed soaking treatments require perfect standardization for required soaking volume, duration, temperature and type of PGRs used with proper dosage in each type of seed to improve various physio-biochemical processes during early seed germination.

2. The yield increments in each crop is in between 2-21% through pretreatment and 5-27% through foliar spray along with improved vegetative and reproductive growth in each crop through various PGRs application. Seven day early flowering and maturity through pretreatment is reported in all the crops.
3. Delay in root nodule and leaf chlorophyll senescence and increase in nitrogen content due to KIN, GA₃, ETH and NAA treatments highly influence the dry matter and reserve food accumulation during seed maturation which finally leads to high yield in each crop.

4. Pretreatments of ABA, GA₃, ETH and KIN increased the storage potential of each type of seed by improving the germinability and vigour of the seeds by reducing various deteriorative processes during storage as revealed through electrophoretic patterns and TTZ studies.

It is thus, clear from the above mentioned studies that relevance of this work is significant to improve the productivity of these four short duration pulse crops through pretreatment and foliar spray application of different PGRs. Pretreatment with PGRs would greatly help in improving physiology of crop seeds right from germination and/or seed emergence till final yield of crop. Cumulative effect of PGRs and urea sprays at critical periods (fruiting and seed filling) proved very vital to each crop as they are mostly grown in dry and rainfed areas of the country. Besides this PGRs application helps in saving quality seed (resources or precious germplasm) for next season and an added tonnage of food to storage stock. PGRs application also shows high cost-to-benefit ratios and demanding no extra agricultural inputs of any sort and capable of further potentiating the yield of even the high yielding cultivars, exclusively by affecting the distributive patterns within the plant as per the situational demands.