SUMMARY

The present work was undertaken to understand the mechanism of temperature pretreatment of seeds of wheat and soybean. The following three aspects were studied:

1. Effect of thermal pretreatment of seeds of wheat and soybean on ascorbic acid turnover, nucleic acids, protein, sulphydryl and different enzymic activities during early stages of germination.

2. Effect of temperature pretreatment of seeds of wheat and soybean upon their metabolic and enzymic activities during vegetative and reproductive stages of life cycle.

3. Effect of temperature pretreatment of seeds of wheat and soybean on their growth, flowering and seed development.

The seeds of wheat (*Triticum aestivum* L.) cv. NP 718 and soybean (*Glycine max.* L.Merr.) cv. Lee were subjected in an oven to 2 kinds of temperature pretreatments.

1. The temperature of the oven was gradually raised to the requisite level, called the gradual temperature
pretreatment. The temperature was raised by 6°C during 24 hours. When requisite temperature was obtained, seeds were kept at that constant temperature continuously for 24 hours.

2. Treating the seeds directly at a certain temperature for 24 hours called the direct temperature pretreatment.

The temperature pretreatments of the seeds are as follow:

1. Control (untreated).
2. 50°C gradual temperature treatment (50°C G).
3. 50°C direct temperature treatment (50°C D).
4. 70°C gradual temperature treatment (70°C G).
5. 70°C direct temperature treatment (70°C D).
6. 100°C gradual temperature treatment (100°C G).
7. 100°C direct temperature treatment (100°C D).

Experiment I: The seeds of wheat (*Triticum aestivum* L.) cv. NP 718 were germinated at temperature (25-26°C) upto 96 hours in distilled water. The embryo axis and endosperms were analyzed at 24 hourly intervals for moisture content, dry weight as well as biochemical changes associated with germination. Different metabolites like ascorbic acid, ascorbigen, AA-macromolecule complexing, RNA, DNA, protein,
histone, sulfhydryl content (SH) and sugars as well as different enzymic activities such as ascorbic acid utilization, peroxidase, AA-FR-peroxidase, catalase, invertase, amylase, protease and RNase were studied.

The moisture content of the embryo axis as well as endosperm increases with the advance in germination, while, the dry weight of embryo axis increases constantly during germination and it decreases continuously in the endosperm on account of degradation of food-reserves and losses due to respiration. The thermal pretreatments do not show any significant difference from the control for the moisture and dry weight during the early stages of germination. The ascorbic acid content of embryo axis decreases, while it remains at more or less the same level in the endosperm during germination. On the other hand, utilization of AA increases in the embryo-axis with advance of germination. As the utilization of AA increases, AA content decreases. A point worthy of note is that with an increase in the temperature of pretreatment both the synthesis as well as utilization of AA increases. Besides this, SH content shows a fluctuating trend during juvenile differentiation in both embryo axis as well as endosperm. At higher temperature (100°C) SH content is higher compared with that of the control. This also indicates that there is more conversion of SS → SH and hence reductive balance is maintained. Ascorbigen shows a rhythmic
trend and the ability of complexing of AA with macromolecules increases with decrease in AA in the embryo axis. The oxidative enzymes such as AA-FR-peroxidase, peroxidase, catalase and hydrolysing enzymes like amylase, invertase, protease, and RNase show an increasing trend in embryo axis during the early part of germination. Thermal pretreatments of seeds also show significant stimulation of the above mentioned enzymic activities. Metabolites like RNA, DNA, protein, histone, sugars and starch also show increasing trends in the embryo axis during early stages of juvenile differentiation. Thus accelerated rates of biosynthesis of metabolites as well as stimulation of enzymic activities lead to faster growth of embryo axis in plants raised from seeds pretreated with higher temperature.

**Experiment II**: Biochemical changes during germination of soybean were studied after thermal pretreatments of seeds. Germination was carried out up to 96 hours at temperature (27°C). Embryo axis and cotyledon were analyzed at 24-hourly intervals for moisture content, dry weight, AA-turnover, RNA, DNA, protein, histone, sugars, lipase, AA-FR-peroxidase, peroxidase, catalase, RNase, protease and invertase.

The reserve food material of soybean seed is broken down during germination. This is supported by an increase in lipase activity in embryo axis. This enzyme also
increases in the embryo axis of plants grown from pretreated seeds. Oxidative enzymes like catalase, peroxidase, and AA-PR-peroxidase increase in embryo axis during the early stages of germination. The application of thermal pretreatment to dry seeds also enhances the activity of the above mentioned enzymes indicating faster oxidation (breakdown) of the reserves for better growth. AA utilization increases with a decline in the AA content and simultaneously the SH content also declines. This suggest a protective role of SH towards AA. The other hydrolysing enzymes like invertase, protease and RNase also increase in the embryo axis with the march of germination, while in cotyledon generally they increase during the early stages of juvenile differentiation. Metabolites like RNA, DNA, protein, histone and sugars increase in embryo axis with an increase in germination. On the other hand, they show a rhythmic trend in the cotyledon. All the metabolites increase significantly as a result of temperature pretreatments. As the temperature for pretreatment increases the rate of synthesis of metabolites also increases. Increased rates of synthesis of metabolites and their faster utilization result in faster growth in the juvenile phase.

Experiment III: For this experiment, temperature pretreated seeds of wheat var NP 718 were sown in earthenware pots (9" in diameter). Pots were watered daily. Manuring was done
once a week at the rate of one gram per pot, the manure consisted of a mixture of ammonium sulphate and super phosphate (2:1).

A. Metabolic and enzymic studies:

Various metabolites and enzymic activities as mentioned earlier were determined from vegetative shoot apex, different reproductive organs and their top most fully expanded leaf subtending the reproductive organ of temperature pretreated plants. Analysis was carried out in duplicate samples.

Various enzyme activities such as peroxidase AA-FR-peroxidase, invertase, amylase, protease, RNase and ascorbic acid utilization as well as metabolites like total sugar, AA, ascorbigen and AA-MM-complex are all at a higher level during reproductive differentiation as compared to the vegetative phase. Thus, increase in the rate of enzymic activities as well as biosynthesis of metabolites is associated with the decrease in SH biosynthesis. During the period of seed development rates of above mentioned enzymic activities and biosynthesis of metabolites decline. Further, rates of enzymic activities and biosynthesis of metabolites are enhanced over those of the control by temperature pretreatment. Rate of biosynthesis of RNA is, however more in the case of untreated plants. While, the rate of hydrolyzing enzymes like
RNase, protease, amylase, and invertase are also at higher level during the transformation of vegetative shoot apex to a reproductive apex. The most important point is that during the whole life-cycle rates of enzymic activities and biosynthesis of metabolites are higher in temperature pretreated plants.

B. Growth and Developmental studies:

Growth characters viz. height, leaf, tiller number and leaf number were recorded periodically and plants were sampled for fresh and dry weights at weekly intervals. At the end of the life cycle, the yield characters such as grain number, grain weight, 1000 kernel weight were also recorded for plants of all temperature pretreatments as well as for control plants of wheat in 10 replicates.

From dry weights of root, stem, leaf and whole plant, their relative growth rate (RGR), net assimilation rate (NAR) and leaf weight ratio (LWR) were worked out. Flowering data was recorded daily.

The growth characters like height, leaf, tiller number and number of leaves on tillers are increased with the march of time. Tiller number is enhanced to a high level by the temperature pretreatment of seeds.
With advance of growth period dry weights of root, stem and leaf increase and they are enhanced by temperature pretreatment of seeds. Generally, direct temperature pretreatment of seeds gives higher value of dry weight compared with that of other thermal pretreatment and control. The relative growth rate (RGR) of root, stem and leaf shows a fluctuating trend throughout the life cycle. Initially, it is more in the plants of temperature pretreated seeds. Besides this, the mean values for the same is also higher in the plants of temperature pretreated seeds. There is earlier floral induction in the plants of thermal pretreatment compared with that of the untreated one. Onset of ripening of spikes was very late in plants of temperature pretreated seeds like 50°D and 70°D. Number of seeds were more in plants of 100°G and 70°G but, 1000 kernel weight was not high in these pretreatments compared with that in 50°D. Though, ripening is early in high temperature pretreatment of the seeds and hence the size of the seed is also small in plants of high thermal pretreatments.

Experiment IV: The temperature pretreatments of soybean seeds are the same as mentioned earlier. Sowing and manuring were done in a similar manner as mentioned in 'Experiment III' while, the watering was done according to the weather condition.

A. Metabolic and enzymic studies:

Biochemical estimations were carried out in the same way as cited in Experiment III. The enzymic and metabolic
activities are accelerated during the reproductive differentiation. Later on rates of biosynthesis of metabolites and enzymic activities are lower. A study of rate of enzymic activities and biosynthesis of metabolites clearly reveals that the synthesis of AA, nucleic acids and proteins as well as peroxidase, AA-FR-peroxidase, protease, RNase and invertase activities are accelerated in plants grown from temperature pretreated seeds. Maximum enhancement in the rate of metabolic and enzymic activities is found in the plants of 50\textdegree D. Thus, as a result of temperature pretreatment of seeds the entire metabolic machinery is maintained at a higher level, and as a result of that processes of growth and development are accelerated.

B. Growth and developmental studies:

The growth characters such as height, tiller number and total leaf numbers are increased with the growth period. The noteworthy point is that as the temperature for the pretreatment increases, all the above mentioned characters also increase to a higher value. In soybean under 100\textdegree D pretreatment the height of the plant is reduced but tiller production is greater.

RGR, NAR and LWR of soybean show the same trend as those of wheat. Mean value for LWR is however, higher in untreated plants compared with that in temperature pretreated
Flowering is always faster in plants raised from untreated seeds compared with that under temperature pretreatment. While, the seed numbers are also more as the pod numbers are more in the plants of temperature pretreated seeds. Although, the 1000 kernel weight is more in case of $50^\circ$D; whereas it is less in plants of $100^\circ$D.