SUMMARY AND CONCLUSIONS

Numerous efforts have been made to decrease the period between sowing and emergence on the assumption that quick germination or emergence will spare the seed from the 'agony' of prolonged exposure to hostile environment during imbibition and seedling establishment and thus in turn, may help in improving crop yields. Treatment of seeds before they are distributed and sown in the seed bed and exposed to complex uncontrollable conditions of the field, presents a unique opportunity to the growers interested in giving his crops a good start. Henckel (1964) and Haydecker (1974) have summarised some of the results of the early studies dealing with physiological preconditioning of various sorts by different means. These include subjecting seeds to cycles of wetting and drying, referred to as hardening or advancing.

Chemical stimulation of seed material to increase crop yield has now been employed for more than 200 years and various aspects of presowing hardening pretreatment have been critically examined by various workers. The whole subject had been a matter of great controversy as regards the beneficial effects of presowing treatments on growth and yield. It has been shown that one pretreatment cycle gives better results in many crops as compared to conventional three pretreatment cycles in case of sesamum, wheat and pea as suggested.
originally by P.A. Nemecel. Various salts, nutrients vitamins and hormones have been used for these presoaking studies. Most of these pretreatments have proved effective to varying degrees. However, there are more contradictions than agreements in the results obtained by various workers. Very few studies have been undertaken to understand biochemical events during pre and post soakings subsequently resulting in enhanced growth and yield. We need work in greater details for different crops. Hence, in order to test the effectiveness of pretreatment cycles and to understand the basic changes (during pretreatment) and their metabolic reflections during early germination, growth, development and final yields under the influence of gibberellic acid (GA$_3$), cycocel (CCC) and their combination (CCC + GA), following studies were undertaken in two genetically different wheat varieties, cv. Lok-1 (*Triticum vulgare* L.) and cv. *moe* (*Triticum durum* L.).

**Experiment No. I**

1. **Effect of soaking with different percent moistures and number of cycles on (a) soaking length and (b) fresh and dry weights of shoot, root and endosperm.**

2. **Physiological and biochemical changes during pretreatment and due to pretreatment.**

**Experiment No. II**

1. **Studies on cell number and cell volume as influenced by pretreatments.**
2. Histochemical parameters at 24 hours of germination as affected by pretreatments.

3. Studies on the effect of pretreatments and number of cycles on the leaching behaviour of metabolites.

**Experiment - III**

1. Studies on growth and development of pretreated and control seeds raised under field conditions.

2. Studies on growth indices, chlorophyll content, carotenoid content and mineral (K, Na, P) content during vegetative, reproductive and senescence stages.

3. Studies on the effect of foliar spray with GA($10^{-6}$M), CCC($10^{-5}$M), CCC ($10^{-5}$M) + GA ($10^{-6}$M) and DM at anthesis for comparative studies with pretreatments.

4. Studies on final yield attributes.

1.1 To determine the best moisture percentage and number of presoaking cycles, seeds of wheat cv. Lok-1 and Amej were given three cycles each of 6 hours of alternate soaking and drying with 30, 45, 70, 100, 150 and 200 percent moisture ($Dm$). Seeds were dried back to their original weight after the treatment and germinated in petridishes lined with filter paper and moistened with DM. Seedling length, fresh and dry weight of root, shoot and endosperm were recorded at the end of 96 hours of germination. The shoot length, fresh and dry weights of root, shoot and endosperm decreased as the number of
pretreatment cycles increased. The screening showed that only one cycle of 6 hours of soaking with 60% moisture content is very beneficial.

1.2 Physiological and biochemical changes during pretreatment and due to pretreatments: Seeds of wheat, cv. Lok-1 (Triticum vulgare L.) and cv. Arnej (Triticum durum L.) were used to incorporate gibberellic acid (GA $10^{-6}$), cycocel ($10^{-5}$) and their combination (CCC $10^{-5}$ + GA $10^{-6}$) using presoaking technique for 6 hours (100 g seeds in 60 ml solution) seeds soaked under similar condition in distilled water (Dw) served as control.

Pretreated seeds of both varieties were germinated in sterilized Petri-dishes lined with filter paper (Monol-X) under laboratory conditions (25-28°C). Embryo axis and endosperm were separated at 3, 3, 6 hours during presoaking; at 12 and 18 hours (early germinating) and at 24 hourly interval upto 96 hours. Fresh and dry weights of embryo axis increase with the advancement of germination and it is higher under the influence of GA and CCC + GA pretreatments. There is a corresponding decrease in the endosperm. Seedling length is stimulated by GA pretreatment while slightly inhibited by CCC. Peroxidase activity decrease during presoaking (from 3 hours to 6 hours) and also after 48 hours in Lok-1 and 24 hours in Arnej. Endosperm register a continuous increase upto 96
hours of germination. Polyphenol oxidase (PPO) is higher in pretreated seeds and it increases up to 96 hours. PPO is absent in the controls of Arneja. Amylase activity is appreciably higher in the endosperm of pretreated seeds during and after pretreatments. It is interesting to note that amylase activity is completely absent in the embryo axis. Invertase activity is higher initially (at 3 hours) during presoaking and also at the later stages of germination. Reducing sugars are absent during presoaking period. Nonreducing sugars, DNA and RNA decrease with increase in presoaking periods followed by an increase in the embryo. Protein and DNA and RNA shows the reverse trend in endosperm while reducing and nonreducing sugars follow the same pattern as that seen in embryo. On the whole it appears that pretreated seeds are more active metabolically as revealed by the increased levels of various metabolites and enzymatic activities, which in turn, lead to increased seedling growth and thus exhibit higher vigour.

11.1 **Cell number and cell volume studies** of pretreated seeds (done at 24 hours of germination) showed that cell number decreased as the number of pretreatment cycles increased but cell volume increased.

11.2 **Histochromal studies**: Pretreated seeds along with untreated controls were germinated in Petri dishes lined with filter paper and moistened with D2O. Shoot part was separated at 24 hours and fixed in Carnoy's fixative.
Tissue dehydration and paraffin infiltration process was carried out as mentioned by Johansen (1940). Sections were cut using microtome at 10 μ in series. Cell area, extinction values, total nucleic acid content, total proteins and polysaccharides were studied. Cell area, extinction values, total nucleic acids, total protein and polysaccharides are more in pretreated seed than in controls. However, pretreatments do not show any effect on cell area in case of Arneja.

11.3 Leachates: Electroconductivity and metabolites determinations were made from leachates collected at the end of 1, 6, 24 hours of soaking and 24 hours of continuous soaking. The electroconductivity values decreased from one hour to sixth hour of leaching and also as the number of cycles increased. The increase in manifold in 24 hours (Changed soaking) and 24 hours of continuous leaching. The leakage of RNA and sugar was more during first and sixth hour of leaching and RNA leaching increased at 24 hours of changed soaking and 24 hours of continuous soaking while the values of sugar decreased. Appreciable protein leaching was only observed in the 24 hours of changed soaking and 24 hours of continuous leaching.

111.1 Growth and development studies of pretreated seeds under field conditions: Pretreated as well as untreated
controls of both the varieties of wheat were sown in the field following standard agronomic practices. Watering and manuring were done from time to time. Dry weights of root, shoot, leaf and reproductive parts were recorded at 20 days interval. Relative growth rate (RGR), net assimilation rate (NAR), and leaf weight ratio (LWR) were worked out. Pretreated plants were generally taller as compared to untreated controls. Dry weight of root, shoot, leaves and reproductive parts increased as the growth advanced. Dry weight of shoot, leaf, spike and leaf area decreased as the number of cycles increased. RGR of stem, leaf and whole plant was more in pretreated seeds than in controls. LWR and NAR were higher during vegetative and flowering stages. The rates were decreased as the number of cycles increased. Pretreated seeds showed higher LWR and NAR.

III.2 Chlorophyll content decreased at flowering phase whereas carotenoids showed the reverse trend. Phosphorus and potassium decreased from vegetative stage to senescence stage. Sodium increased from flowering phase. Pretreated seeds had higher mineral contents.

III.3 Foliar sprays do not have any effect on the plant height and they are not beneficial as far as dry matter
production of shoot, root and leaves are concerned.
Foliar sprays do not show any influence in increasing the tiller number. But CCC and GA sprays initiated slightly more tillers even in the senescence stage. Dry weights of the main spike and extra spikes are more in Ds and GA sprayed plants when compared to CCC and CCC + GA. Foliar sprays produce slightly heavier seeds than control.

Statistical analyses of the data show that foliar sprays significantly increase spike length, spike weight, extra spike weight, grain weight of the main spike, number of grains of the main spike and 1000 grain weight. Foliar sprays are not effective in increasing plant height. Root weight and tiller numbers significantly.

Harvest data: Pretreatment increase the plant height and other yield characters like dry weights of stem, root, leaf, spike and spike length. Presoaking treatments with GA and CCC + GA are very effective. Pretreatments increase the tiller number and also dry weights of main as well as extra spike. Grain number, grain per spike, are increased by pretreatments. 1000-grain weights is also slightly higher in pretreated seeds. Analysis of variance of the harvest data confirms the beneficial effects of pretreatments as mentioned above significantly by increasing the yield and growth characters.
like dry weights of root, stem, leaf, plant, spike, spike length, number of spikes, tiller number, grains per main spike and 1000 grains weight.

Salient features of this study are as follows:

1. One cycle of 6 hours with 60% of soaking and drying is better than three cycles.
2. Pretreated seeds had higher cell volume but cell number decreased with increase in pretreatment cycles.
3. Seedling length, fresh and dry weights were higher in pretreated seeds.
4. Higher biochemical activities were shown by pretreated seeds (also confirmed, in situ, by histochemical localization of metabolites).
5. Vegetative growth, dry weight of root, shoot and reproductive parts, leaf area, RGR, NAR, LAR and mineral content are higher in pretreated seeds.
6. Pretreatment produced heavier seeds and thus finally better and higher yields.

Though pretreatment (seed soaking) is claimed to be a method of wide applicability it is to be considered with much caution. The practical value of pretreatment technique over a wide range of conditions in different countries need to be explored. To avail the beneficial effects of pretreatment every variety
should be studied critically for moisture, stage of germination at dehydration, number of cycles, temperature, right dosage of the right type of chemical and its mode of application (Henckel, 1964; Heydecker, 1973; Saxena, 1974, 1979, 1983).