SUMMARY

The present work was undertaken to understand the mechanism of action of temperature, ascorbic acid and hydrogen peroxide pretreatment of the seeds in the related processes of growth, differentiation and maturation in Cumin Cv. S-404:

1. Biochemical changes during germination of Cumin Cv. S-404 pretreated with temperature and ascorbic acid - $\text{H}_2\text{O}_2$.

2. The effect of temperature and ascorbic acid - $\text{H}_2\text{O}_2$ pretreatment of Cumin seeds on biochemical changes during growth and development.

3. Effect of temperature and ascorbic acid - $\text{H}_2\text{O}_2$ pretreatment on various yield components of Cumin as seen in various fields of North Gujarat (India).

Graded seeds of Cumin Cv. S-404 were treated at 70°C.D. (D = Direct) for a week in an oven and subsequently pretreated with distilled water (DW), ascorbic acid (AA), hydrogen peroxide (H$_2$O$_2$) and their combinations (AA + H$_2$O$_2$). Similar pretreatments were given to the seeds under normal room temperature of 25 ± 2°C.
The pretreatments of the seeds are as follows:

(1) C (control) (6) 70°D + AA
(2) 70°D (7) H_2O_2
(3) DW (8) 70°D + H_2O_2
(4) 70°D + DW (9) AA + H_2O_2
(5) AA (10) 70°D + AA + H_2O_2

Experiment - I:

Pretreated Cumin seeds, along with the control (untreated) were germinated in sterilized petridishes (12.5 cm. diameter) lined with sterilized filter paper (Whatman No. 1) in glass distilled water (DW), at room temperature (25±2°C) in normal day light. Whole seedlings were analyzed at 3-days interval for moisture content, fresh weight, dry weight and seedling length as well as biochemical changes associated with germination up to 12 days. Different metabolic and enzymic activities like ascorbic acid, ascorbigen, AA-MM-complexing, AA utilization, RNA, DNA, protein, sugars, histone, sulfhydryl (SH) content, peroxidase, AA-FR-peroxidase, catalase, invertase, protease and RNase were studied.

With the initiation of imbibition, moisture content of the seed increases causing a rapid hydration of protoplastic constituents thus activating enzymic systems and metabolism. Peroxidase, AA-FR-peroxidase, catalase, protease activities increases, while invertase activity remains at the same
level and RNase activity decreases up to 9 days then it increases with advance in germination causing a breakdown of complex reserves into simpler and utilisable substances which are translocated to the growing embryo axis. Dry weight of the seedling decreases with increase in germination period on account of the depletion of food reserves and losses due to respiration. RNA and DNA contents decrease as RNase activity in the beginning decreases but at 12 days it increases resulting in the formation of simpler and soluble nucleotides necessary for the growth of embryo axis.

With increase in germination period ascorbic acid and AA utilization increase. This helps in the mobilization of soluble nutrients towards the growing point. Fluctuation in the level of ASG and increasing level of NAD help in the maintenance of the balance between oxidative and reductive atmosphere within the cell. Free radicals of AA are also produced due to intensified peroxidative action. Metabolites like protein and histone upto 6 days, show increasing trend while sugar content decreases throughout the germination suggesting a possible utilization of sugars as substrates for increased respiration as well as AA biosynthesis. Pretreatments of seeds show a significant stimulation of the above mentioned enzymic and metabolic activities. Thus accelerated activities lead to faster growth of embryo axis in plants raised from pretreated seeds.
Experiment - II:

The field was thoroughly ploughed several times and was harrowed to remove all the weeds. Farm yard manure was ploughed in at the rate of 2 tons per acre. Plots of equal size were prepared and sowing was done at the rate of 8 kg seeds per acre. Watering and manuring was done at weekly intervals.

A. Metabolic and enzymic studies:

Various metabolites and enzymic activities as mentioned earlier were determined from various stages of reproductive differentiation and of corresponding leaves. Analysis was carried out in duplicate samples.

Various enzyme activities such as peroxidase, AA-FR-peroxidase, invertase, protease, RNase, catalase as well as metabolites like AA, AA utilization, AA-MM-complexing, protein and DNA are all at higher levels during vegetative shoot apex - flower bud stage. Thus, increase in enzymic activities as well as biosynthesis of metabolites is associated with SH biosynthesis. During this period sugar content decreases and play a possible role of utilization of sugars as substrates for increased respiration as well as AA biosynthesis. During seed maturation period above mentioned activities declined. The most important point is that during
the whole life cycle, enzymic activities and biosynthesis of metabolites are higher in all pretreated plants and $70^\circ D + AA + H_2O_2$ showed the maximum enhancement. Among the various pretreatments, the effect of $70^\circ D + AA + H_2O_2$ was well pronounced.

B. Growth and developmental studies:

Growth characters viz. height, leaf production, inflorescence 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 whole plant weight, height of the plant, root weight, number of branches, weight of branches, number of seeds, weight of seeds and 1000 kernel weight were also recorded for plants of all pretreatments as well as for control plants of Cumin in 10 replicates. Flowering data was taken every day.

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.

The growth characters like height, leaf and inflorescence increased with the march of time. All characters enhanced by pretreatments of seeds.

With advance of growth period, dry weights of root, stem and leaf increases and they are enhanced by pretreatments. Generally $70^\circ D + AA + H_2O_2$ followed by other pretreatments
-gives higher value of growth characters and dry weight than that of control. The relative growth rate (RGR) of root, stem, leaf and whole plant increases up to 55 days of growth then it shows fluctuating trend. It is more in the plants of pretreated seeds. Besides this the mean value for the same is also higher in $70^\circ D + AA + H_2O_2$ followed by other pretreatments. Net assimilation rate (NAR) increases at 55 and 69 days of growth while leaf-weight ratio decreases with the march of growth period. The stimulation is also seen in anthesis, flower production, and seed ripening date. As the plants of $70^\circ D + AA + H_2O_2$ followed by other pretreated seeds enter senescence phase later the ripening period is prolonged. The 1000 kernel weight is therefore more.

Experiment - III:

With a view to study the effect of pretreatment over a large area, pretreated ($70^\circ D + AA + H_2O_2$) and control seeds were distributed to farmers of various places in North Gujarat (India).

At the end of the season, the crop was harvested, the yield data was taken and % increase over control was calculated to compare the effects of pretreatment.

The results from farmers field of last 2 years are very promising. They show a 30-50% increase in the yield of Cumin crop. Another result is the prevention of
fungus disease by the pretreatment. There is considerable
damage to Cumin crop due to the fungus attack. Prevention
of the fungal disease is reflected in higher yields. Thus
these findings have an important bearing upon practical
problems of crop production.

In the current Cumin season 1100 kgs. of seeds were
pretreated \((70^\circ D + AA + H_2O_2)\) and given to 115 farmers of
Gujarat state for large scale trials in their fields.
Pretreated seeds are already showing better germination and
stand of the crop compared with those of the control.