CHAPTER IV

EXPERIMENTAL FINDINGS ON WHEAT SEEDLINGS
EXPERIMENTAL FINDINGS ON WHEAT SEEDLINGS

Experiment I

Effect of Different Osmotica on the Biochemical Changes During the Germination of Wheat Seedlings.

The results of this experiment are presented in Plates 1 to 10. The statistical analysis of the result is given in Table 1 and is discussed after the presentation of the "Experimental Findings".

Graded and certified seeds of Wheat (Triticum aestivum, L.) (Var. Kalyan Sona) were germinated in sterilized petri-dishes of (9.0 cm. diameter) lined with sterilized filter paper (Whatman No. 1) in 5.0 ml. of D.W. (these seedlings served as the control) and in various osmotica of two different concentrations 1 and 3 of (A.R. grade) NaCl, Sucrose, Mannitol and PEG (6,000 Mol. Wt.) up to 120 hours at room temperature (28 ± 2°C) in normal daylight. Two changes of D.W. and Osmotica were made in a day and the filter papers were changed once in two days so as to prevent fungal contamination.

Samples of Embryo Axis and Endosperm were analyzed separately at 48 hours and 120 hours of germination for the
PLATE - 1

Effects of Osmotic Treatment On:

Fig. 1 - Per Cent (%) Moisture Content - Embryo Axis

Fig. 2 - Fresh Weight - Embryo Axis.

Fig. 3 - Dry Weight - Embryo Axis.

Fig. 4 - Root Length - cms.

Fig. 5 - Shoot Length - cms.
Wheat Var: Kalyan Sonn

GERMINATION HOURS

PLATE-1
following metabolites and enzymic activities.

The data on the effect of osmotica have been compared with controlled (D.W.) seedlings. Following observations were found.

**Per cent. (%) Moisture Content:**

Per cent (% moisture content) of embryo axis (Plate 1.1*) increased with germination time. At 48 hours of germination there was a slight lowering effect by all $ar{1}$ osmotica. $ar{5}$ caused more reduction of moisture uptake. At 120 hours of germination also, all osmotica caused a lowering effect except $\bar{5}$ PEG, which slightly enhanced it.

**Fresh Weight:**

Fresh weight of embryo axis (1.2) increased with the advancement of germination period from 48 hours to 120 hours. At 48 hours of germination all $\bar{1}$ osmotica slightly increased it, however $\bar{5}$ osmotica reduced it. At 120 hours of germination, fresh weight of embryo axis was enhanced by $\bar{1}$ NaCl and $\bar{1}$ Mannitol. Other osmotica lowered it and $\bar{5}$ PEG caused the maximum lowering effect.

* The Initial Number indicates the Plate No. and the Second Number indicates the Chart Number in each plate. This notation has been used throughout this thesis.
Dry Weight:

Dry weight of embryo axis increased with the march of germination. At 48 hours of germination all osmotica increased the dry weight of embryo axis but osmotica decreased it. At 120 hours of germination dry weight of embryo axis was increased, the increase being more in osmotica as compared with osmotica. In PEG, embryo axis had the maximum dry weight. In the osmotica series, Sucrose and PEG seedlings had the same weight as the controlled (D.W.) seedlings.

Root Length (1,4)

Extension growth of the root as measured at 120 hours of germination was enhanced by NaCl and Mannitol. All osmotica reduced the growth of the root almost equally. Sucrose and PEG also caused inhibition of the root growth. The maximum inhibition was observed in PEG.

Shoot Length: (1,5)

Extension growth of the shoot as measured at 120 hours of germination was enhanced by NaCl and Mannitol. Other osmotica inhibited the growth and the inhibition was greater in osmotica. Mannitol caused the least inhibition whereas PEG caused the maximum inhibition.
Effects of Osmotic Treatment On

Fig. 1 - Fresh Weight - Endosperm.

Fig. 2 - Dry Weight - Endosperm.

Fig. 3 - Per cent (%) Moisture Content - Endosperm.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-2
**Fresh Weight:**

Fresh weight of endosperm (2.1) of seedlings showed a declining trend with the advancement of germination. At 48 hours of germination, all osmotica slightly lowered the Fresh Weight, with \( \text{T NaCl} \) osmotica lowering it more than \( \text{T} \). At 120 hours of germination, \( \text{T NaCl} \) and \( \text{T Sucrose} \) caused more reduction of fresh weight than by \( \text{T Mannitol} \) and \( \text{T PEG} \).

**Dry Weight:**

Dry weight of endosperm (2.2) of seedlings like that of fresh weight decreased with the march of germination. Both at 48 hours and 120 hours of germination, the dry weight of the controlled (D.W.) seedlings of endosperm was lesser than that of osmotically stressed seedlings. At 48 hours of germination, all 3 osmotica seedlings had more dry weight of endosperm than \( \text{T} \), of which Mannitol and PEG had the same maximum dry weight. At 120 hours of germination also, the same enhancement of dry weight was maintained.

**Per cent (%) Moisture Content:**

Per cent (%) Moisture content of endosperm (2.3) increased with the germination. Both at 48 hours and 120 hours of germination, it was lowered by all osmotica. More lowering
PLATE - 3

Effects of Canotic Treatment On:

Fig. 1 - Catalase Activity - Embryo Axis.

Fig. 2 - Peroxidase Activity - Embryo Axis.

Fig. 3 - Amylase Activity - Embryo Axis.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-3
effect was caused by \( \overline{5} \) osmotica than \( \overline{1} \). The effects of different osmotica with each concentration were not different.

**Catalase Activity:**

Catalase Activity of embryo axis (3.1) rose many fold as germination period advanced from 48 hours to 120 hours. At 48 hours of germination no adverse effect of osmotica was seen except that of slight suppression by \( \overline{5} \) PEG. But at 120 hours of germination, \( \overline{1} \) NaCl stimulated the activity and other osmotica depressed it. \( \overline{5} \) Sucrose caused greater suppression than all other osmotica. \( \overline{5} \) PEG increased the activity as compared to \( \overline{1} \).

**Peroxidase Activity:**

Peroxidase Activity of embryo axis (3.2) increased with the advancement of germination. At 48 hours of germination, the activity was more or less depressed equally by all osmotica. \( \overline{1} \) PEG had no effect on the enzymic activity. At 120 hours of germination, all osmotica depressed the activity. \( \overline{1} \) osmotica caused more depression than \( \overline{5} \). Least depression was caused by \( \overline{1} \) NaCl in \( \overline{1} \) series and \( \overline{5} \) NaCl in \( \overline{5} \) series. \( \overline{1} \) PEG caused the maximum depression in \( \overline{1} \) series and \( \overline{5} \) Sucrose caused the maximum depression in \( \overline{5} \) series. On the whole osmotica lowered the enzymic activity of peroxidase.
Amylase Activity:

Amylase Activity of embryo axis (3×3) increased with the advancement of germination period from 48 hours to 120 hours. It was suppressed by osmotica during both periods and the suppression was more by 1 series than by 5 series. Both at 48 hours of germination and 120 hours of germination, 1 NaCl and 1 Mannitol suppressed the activity considerably. The least suppression was observed in 5 NaCl. On the whole 5 caused less suppression than 1.

Catalase Activity:

Catalase Activity of endosperm (4×1) increased very substantially with the advancement of germination. At 48 hours of germination, no osmotic effect was seen except of a slight increase or decrease. But at 120 hours of germination, the osmotic effects were quite clear in causing depressed activity, the depression being greater by 5 osmotica. In 1 series, PEG caused the least depression followed by Sucrose, NaCl and Mannitol. But in the 5 series, PEG caused the minimum depression and NaCl the maximum depression.
Effects of Canotic Treatment On:

Fig. 1 - Catalase Activity - Endosperm.

Fig. 2 - Peroxidase Activity - Endosperm.

Fig. 3 - Amylase Activity - Endosperm.

Fig. 4 - Starch Content - Endosperm.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-4
**Peroxidase Activity:**

Peroxidase Activity of endosperm (4.2) increased with the advancement of germination. At 48 hours of germination, \( \bar{1} \) and \( \bar{5} \) NaCl caused a slight change of raise in the enzymic activity. \( \bar{1} \) Sucrose, \( \bar{1} \) Mannitol and \( \bar{1} \) PEG suppressed the activity. \( \bar{5} \) Sucrose stimulated it, while there was no effect of \( \bar{5} \) Mannitol and \( \bar{5} \) PEG. At 120 hours of germination, all other osmotica, except \( \bar{1} \) Mannitol and \( \bar{1} \) PEG, caused little variation in the enzymic activity. \( \bar{1} \) Mannitol suppressed the activity, while \( \bar{1} \) PEG stimulated it.

**Amylase Activity:**

Amylase Activity of endosperm (4.3) rose with the advancement of germination. At 48 hours of germination, all osmotica depressed the activity, and it was more in \( \bar{5} \) series than \( \bar{1} \). At 120 hours of germination, stimulation of the amylase activity however was seen in the case of \( \bar{1} \) NaCl, \( \bar{1} \) PEG and \( \bar{5} \) Mannitol while all other osmotica depressed the activity. Thus there was a general depressive effect in the enzymic activity.

**Starch Content:**

Starch Content of endosperm (4.4) depleted with the
advancement of germination period and the depletion was greater in controlled (D, W) seedlings. At 48 hours of germination, less starch content was seen in the endosperm of osmotically stressed seedlings. At 48 hours of germination, Sucrose (\( \bar{1} \) and \( \bar{5} \)) caused lesser reduction of starch content than all other osmotica. However, at 120 hours of germination, a completely reverse picture was seen. Endosperm of osmotically stressed wheat seedlings showed more starch content than the controlled (D, W) seedlings. At 120 hours of germination, \( \bar{5} \) Sucrose had the maximum starch content. It is quite significant to note that almost all \( \bar{5} \) osmotica showed more starch content than \( \bar{1} \) except in PEG, where \( \bar{1} \) had more starch content than \( \bar{5} \).

**Invertase Activity:**

Invertase Activity of embryo axis (5,1) increased with the advancement of germination period from 48 hours to 120 hours. At 48 hours of germination, \( \bar{1} \) NaCl and \( \bar{1} \) Mannitol stimulated the activity while all other osmotica suppressed it. \( \bar{5} \) osmotica caused greater suppression than \( \bar{1} \). At 120 hours of germination, invertase activity of embryo axis was depressed by all osmotica. Both \( \bar{1} \) and \( \bar{5} \) had an equal impact.
Effects of Osmotic Treatment on

Fig. 1 - Invertase Activity - Embryo Axis.

Fig. 2 - Reducing Sugar Content - Embryo Axis.

Fig. 3 - Non-Reducing Sugar Content - Embryo Axis.

Fig. 4 - Total Sugar Content - Embryo Axis.
NaCl (both 1 and 3) caused the least suppression and PEG (both 1 and 5) caused the maximum suppression.

Reducing Sugar Content:
Reducing Sugar Content of embryo axis (5.2) of wheat seedlings increased with the advancement of germination. At 48 hours of germination all osmotica raised the reducing sugar content except 5 PEG and 5 NaCl. 5 PEG caused the maximum lowering effect. Maximum content was seen in 5 sucrose. At 120 hours of germination however, 1 NaCl, 1 Sucrose, 1 PEG and 5 Mannitol lowered this sugar content. 5 Sucrose increased it many fold and all other 5 osmotica caused only slight change in sugar content.

Non-Reducing Sugar Content:
Non-reducing Sugar Content of embryo axis (5.3) increased with the advancement of germination period from 48 hours to 120 hours. At 48 hours of germination, both 1 and 5 NaCl and 1 and 5 PEG caused considerable reduction of this sugar content. On the contrary, 1 and 5 Sucrose raised this sugar content slightly. At 120 hours of germination, however, 1 NaCl considerably enhanced this sugar content. But all other osmotica caused reduction of this sugar content.
Sucrose caused the maximum reduction. At 120 hours of germination, \( \text{I Sucrose and I Mannitol} \) caused considerable decrease in this sugar content.

But at 48 hours of germination, it was significant to note that \( \bar{5} \) Sucrose caused slight enhancement and the opposite effect at 120 hours of germination.

**Total Sugar Content:**

Total Sugar Content of embryo axis (5.4) increased with the advancement of germination. At 48 hours of germination, \( \text{I and 5 NaCl} \) lowered this sugar content. However, \( \bar{5} \) lowered it more than \( \bar{I} \). As in the case of non-reducing sugar content, Sucrose (both \( \bar{I} \) and \( \bar{5} \)) increased this sugar content. \( \bar{I} \) Mannitol also increased it. \( \bar{5} \) Mannitol slightly lowered it. \( \bar{I} \) PEG did not affect it. \( \bar{5} \) PEG considerably reduced it. At 120 hours of germination \( \bar{I} \) NaCl enhanced the total sugar content, whereas all other osmotica decreased the content. \( \bar{I} \) Sucrose caused the maximum decrease and \( \bar{5} \) PEG caused the minimum decrease. All other osmotica equally decreased it.

**Invertase Activity:**

Invertase Activity of endosperm (6.1) rose with the
Effects of Osmotic Treatment On:

Fig. 1 - Invertase Activity - Endosperm.

Fig. 2 - Reducing Sugar Content - Endosperm.

Fig. 3 - Non-Reducing Sugar Content - Endosperm.

Fig. 4 - Total Sugar Content - Endosperm.
advancement of germination period from 48 hours to 120 hours. All osmotica depressed the activity, depression being greater in \( \tilde{5} \) series than in \( \tilde{1} \) series. At 48 hours of germination, PEG (both \( \tilde{1} \) and \( \tilde{5} \)) caused more depression than any other osmotica. But \( \tilde{1} \) Sucrose caused the least depression. At 120 hours of germination \( \tilde{1} \) NaCl caused the least depression of this enzymic activity and \( \tilde{5} \) PEG caused the maximum depression.

Reduction Sugar Content:

Reducing Sugar Content of endosperm \((6.2)\) increased with the advancement of germination. At 48 hours of germination it was quite low. However, at 120 hours of germination, it increased considerably. At 48 hours of germination, all \( \tilde{1} \) osmotica increased this sugar content. All \( \tilde{5} \) osmotica however reduced this sugar content. However, effects of various osmotica in their osmotic potentials did not differ considerably from each other. At 120 hours of germination, all osmotica caused a decrease of the sugar content and the decrease was more by \( \tilde{5} \) osmotica than by \( \tilde{1} \).

Non-Reducing Sugar Content:

Non-reducing Sugar Content of endosperm \((6.3)\) increased with the advancement of germination period from 48 hours to
120 hours. At 48 hours of germination, \( \text{T NaCl} \) and \( \text{T PEG} \) slightly increased this sugar content and all other osmotica lowered it. Endosperm of \( \text{T Mannitol} \) practically contained no non-reducing sugar content. Other osmotica had more or less an equal effect. At 120 hours of germination, all osmotica reduced this sugar content. All \( \text{T osmotica} \) caused lesser reduction as compared with \( \text{5 NaCl} \). \( \text{T NaCl} \) caused the minimum reduction but \( \text{5 NaCl} \) caused the maximum reduction. Effects of other osmotica were more or less equal.

**Total Sugar Content:**

Total Sugar Content of endosperm (6.4) rose with the advancement of germination period from 48 hours to 120 hours. At 48 hours of germination, all \( \text{T osmotica} \) slightly increased this sugar content, while \( \text{5 osmotica} \) lowered it. \( \text{5 NaCl} \) caused the maximum lowering effect. At 120 hours of germination, all osmotica decreased, total sugar content and the decrease was more by \( \text{5 osmotica} \) than by \( \text{T NaCl} \). \( \text{T NaCl} \) caused the least decrease and \( \text{5 NaCl} \) caused the maximum decrease of this sugar content.

**Protease Activity:**

Protease Activity of embryo axis (7.1) rose with the advancement of germination. It was depressed by osmotica
Effects of Osmotic Treatment On:

Fig. 1 - Protease Activity - Embryo Axis.

Fig. 2 - Protein Content - Embryo Axis.

Fig. 3 - Histone Content - Embryo Axis.
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GERMINATION HOURS

PLATE-7
and the depression was greater by 3 osmotica than 1. At 48 hours of germination, 1 PEG caused the least depression but 5 PEG caused the maximum depression. At 120 hours of germination, 1 NaCl stimulated the enzymic activity. Other osmotica had a depressive effect. In this case also, 5 PEG caused the maximum depression.

**Protein Content:**

Protein Content of embryo axis (7,2) showed more or less the same level during both periods of germination, i.e., 48 hours and 120 hours, except the controlled (D.W.) seedlings. At 48 hours of germination, protein content was lowered by all osmotica, 5 causing more reduction of protein content than 1. 1 NaCl, 1 Sucrose and 1 Mannitol caused slight reduction of protein content. At 120 hours of germination, the protein content of embryo axis of controlled (D.W.) seedlings was raised many fold and 1 NaCl slightly increased this content. But in the case of other osmotica the protein content was lowered as germination period increased from 48 hours to 120 hours. At 120 hours 5 Mannitol caused the least reduction and 5 PEG caused the maximum reduction.
Effects of Camotic Treatment On:

Fig. 1 - Protease Activity - Endosperm.

Fig. 2 - Protein Content - Endosperm.

Fig. 3 - Histone Content - Endosperm.
HISTONE
Wheat Var.: Kalyan Sona

GERMINATION HOURS

PLATE-8
Histone Content:

Histone Content of embryo axis (7.3) increased with the advancement of germination. At 48 hours of germination, all osmotica decreased the content. $\overline{1}$ Mannitol and $\overline{1}$ PEG decrease the histone content more than $\overline{1}$ NaCl and $\overline{1}$ Sucrose. $\overline{3}$ NaCl and $\overline{3}$ Sucrose also decreased it. At 120 hours of germination, also, all osmotica lowered histone content. $\overline{1}$ NaCl caused the minimum decrease, whereas $\overline{1}$ Sucrose and $\overline{1}$ PEG caused the maximum decrease.

Protease Activity:

Protease Activity of endosperm (8.1) increased with the advancement of germination. At 48 hours of germination, all osmotica depressed the enzymic activity and the depression was caused more by $\overline{3}$ osmotica than $\overline{1}$. The effects of different osmotica within each concentration were not different. At 120 hours of germination, except $\overline{1}$ NaCl, all other osmotica depressed the enzymic activity whereas $\overline{1}$ NaCl slightly stimulated it. Thus during both 48 hours and 120 hours of germination, on the whole a depressed activity was caused by osmotica.

Protein Content:

Protein Content of endosperm (8.2) rose with the
PLATE 9

Effects of Osmotic Treatment on

Fig. 1 - RNase Activity - Embryo Axis.

Fig. 2 - RNA Content - Embryo Axis.

Fig. 3 - DNA Content - Embryo Axis.
advancement of germination period from 48 hours to 120 hours. At 48 hours of germination, NaCl and PEG (both \( \overline{1} \) and \( \overline{5} \)) reduced slightly the protein content, while \( \overline{1} \) Sucrose and \( \overline{1} \) Mannitol increased it, whereas \( \overline{5} \) Mannitol reduced the content. At 120 hours of germination, only \( \overline{1} \) Sucrose increased the protein content of the endosperm. All other osmotica lowered it. \( \overline{5} \) PEG caused the maximum reduction of protein content.

**Histone Content:**

Histone content of endosperm (8.3) increased with the advancement of germination. At 48 hours of germination, \( \overline{1} \) and \( \overline{5} \) NaCl, \( \overline{1} \) and \( \overline{5} \) Sucrose and \( \overline{5} \) PEG caused little change, while \( \overline{1} \) Mannitol, \( \overline{1} \) PEG and \( \overline{5} \) Mannitol lowered the content. But at 120 hours of germination, all osmotica lowered the histone content which varied from one osmoticum to another.

Thus \( \overline{5} \) NaCl and \( \overline{5} \) PEG caused more reduction of histone content than \( \overline{1} \) NaCl and \( \overline{1} \) PEG. \( \overline{5} \) Mannitol lowered the histone content slightly. \( \overline{1} \) Sucrose and \( \overline{1} \) Mannitol caused the greatest reduction.

**RNAase Activity:**

RNAase Activity of embryo axis (9.1) increased with the germination period from 48 hours to 120 hours. It was depressed
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-9
by all osmotica. At 48 hours of germination, depression of this enzymic activity was less as compared with 120 hours. At 48 hours of germination, NaCl caused more depression than other osmotica. But at 120 hours of germination, all osmotica depressed the activity. Mannitol and Sucrose caused less suppression of the enzymic activity than others. PEG caused the maximum depression of the enzymic activity.

RNA Content:

RNA Content of embryo axis (9.2) decreased as germination advanced from 48 hours to 120 hours. At 48 hours of germination, all osmotica lowered the RNA content. NaCl, Mannitol and PEG caused lesser reduction as compared with other osmotica. At 120 hours of germination, Mannitol and Sucrose increased the RNA content while others decreased it. PEG caused the maximum decrease followed by Mannitol. All other osmotica caused an equal decrease of the RNA content.

DNA Content:

DNA Content of embryo axis (9.3) increased with the march of germination. At 48 hours of germination, all osmotica caused slight decrease of the DNA content while
Effects of Osmotic Treatment On:

Fig. 1 - RNAse Activity - Endosperm

Fig. 2 - RNA Content - Endosperm

Fig. 3 - DNA Content - Endosperm
GERMINATION HOURS

PLATE-10
osmotica caused more decrease. At 120 hours of germination, both $\overline{1}$ and $\overline{5}$ caused a decrease. $\overline{1}$ NaCl caused the minimum reduction. PEG (both $\overline{1}$ and $\overline{5}$) caused the maximum decrease.

**RNase Activity:**

RNase Activity of endosperm (10.1) increased with the advancement of germination period from 48 hours to 120 hours. At 48 hours of germination, the activity was slightly depressed. At 120 hours of germination, also it was depressed and the depression was more in $\overline{5}$ series. All osmotica in $\overline{1}$ series as well as $\overline{5}$ series had an equal effect except $\overline{5}$ PEG which considerably suppressed the activity.

**RNA Content:**

RNA Content of endosperm (10.2) increased with the advancement of germination. At 48 hours of germination, a decrease in content was observed in the endosperm of osmotically stressed seedlings. The decrease was more in $\overline{1}$ NaCl, $\overline{1}$ Sucrose and $\overline{1}$ Mannitol than $\overline{5}$ NaCl, $\overline{5}$ Sucrose and $\overline{5}$ Mannitol. In the case of PEG, $\overline{5}$ caused more decrease than $\overline{1}$. But at 120 hours of germination, the minimum decrease was caused by $\overline{1}$ Mannitol and the maximum decrease by $\overline{5}$ PEG. Here in this case, $\overline{5}$ caused more lowering effect.
than \( \bar{1} \) except in NaCl, where \( \bar{1} \) NaCl caused more lowering effect than \( \bar{5} \).

**DNA Content:**

DNA Content of endosperm (10.3) increased with the advancement of germination. At 48 hours of germination, there was no marked change observed in DNA content by osmotica. It was only slightly lowered by osmotica. \( \bar{5} \) caused greater reduction than \( \bar{1} \). Effect of the various osmotica in the same series was not different. At 120 hours of germination, however the DNA content was lowered by all osmotica with \( \bar{5} \) series causing more reduction. \( \bar{1} \) PEG caused the least reduction in DNA content, whereas \( \bar{5} \) caused the maximum reduction. Other osmotica in their respective potentials had an equal effect.

The "Overall Effect" of different osmotica on various biochemical changes of wheat seedlings during germination in comparison with controlled (D.W.) seedlings is presented in Table (A).
### Table (4) "Overall Effect" of Gentiana on the Biochemical Changes of Shoot Sections during Germination in Conjunction with Controlled (D.M.) Seeding

#### Embryo Axes

<table>
<thead>
<tr>
<th>Growth Parameters &amp; Biochemical Activities</th>
<th>T Success</th>
<th>T Hamada</th>
<th>T PSB</th>
<th>T Inc.</th>
<th>T Success</th>
<th>T Hamada</th>
<th>T PSB</th>
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**Key:**
- I = Increase
- E = Equal
- R = Reduction
- L = Lowering
- M = Maximal Increase
- M = Maximal Reduction
- M = Minimum Increase
- M = Minimum Reduction
### Table 1

"Overall Effect" of Osmotic on the Biochemical Changes of Seed Germination in Comparison with Controlled (C.I.) Seedlings

<table>
<thead>
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<th>Growth Parameters &amp; Biochemical Estimation</th>
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<th>7 Hanakita</th>
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<th>7 Pala</th>
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<td>120 hr. of germination</td>
<td>48 hr. of germination</td>
<td>120 hr. of germination</td>
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<td>L Min.</td>
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<td>L</td>
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<tr>
<td>Dry Weight</td>
<td>X</td>
<td>L Max.</td>
<td>I</td>
<td>I Min.</td>
<td>I</td>
<td>I Min.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Per cent (%) Moisture Content</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Catalase Activity</td>
<td>S</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L Max.</td>
<td>L</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Peroxidase Activity</td>
<td>S</td>
<td>L</td>
<td>I Min.</td>
<td>L</td>
<td>L Max.</td>
<td>L</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Amylase Activity</td>
<td>L</td>
<td>I Max.</td>
<td>L Min.</td>
<td>L</td>
<td>L Max.</td>
<td>I Min.</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Search Content</td>
<td>L</td>
<td>X</td>
<td>I Min.</td>
<td>X</td>
<td>I</td>
<td>I Max.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Invertase Activity</td>
<td>L</td>
<td>L Min.</td>
<td>L Min.</td>
<td>L</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Reducing Sugar Content</td>
<td>I</td>
<td>L</td>
<td>L Min.</td>
<td>X</td>
<td>Max.</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Non-Reducing Sugar Content</td>
<td>I Min.</td>
<td>L Min.</td>
<td>L Min.</td>
<td>L</td>
<td>L Max.</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
</tr>
<tr>
<td>Total Sugar Content</td>
<td>I Min.</td>
<td>L Min.</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L Max.</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Protease Activity</td>
<td>L Min.</td>
<td>X</td>
<td>L</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L Max.</td>
<td>L</td>
</tr>
<tr>
<td>Protein Content</td>
<td>L</td>
<td>L</td>
<td>I Max.</td>
<td>X</td>
<td>L</td>
<td>L</td>
<td>L Max.</td>
<td>L</td>
</tr>
<tr>
<td>Histone Content</td>
<td>L</td>
<td>L</td>
<td>L Max.</td>
<td>L</td>
<td>L</td>
<td>L Min.</td>
<td>L Max.</td>
<td>L</td>
</tr>
<tr>
<td>Sialic Activity</td>
<td>L Max.</td>
<td>L Min.</td>
<td>L</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L Max.</td>
<td>L</td>
</tr>
<tr>
<td>RIA Content</td>
<td>L Max.</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>DNA Content</td>
<td>L</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L</td>
<td>L Min.</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

**Note:**
- I = Increase
- I Max. = Maximum Increase
- I Min. = Minimum Increase
- S = Equal
- L = Lowering
- L Max. = Maximum Lowering
- L Min. = Minimum Lowering
**Statistical Analysis of the Results (Table 1)**

The results of these experiments have been analysed statistically by the "Method of Analysis of Variance" for RNAase Activity, RNA Content, DNA Content, Protease Activity, Protein Content, Histone Content, Invertase Activity, Reducing Sugar Content, Total Sugar Content, Non-Reducing Sugar Content, Catalase Activity, Peroxidase Activity, Amylase Activity and Starch Content in Embryo Axis and Endosperm separately, taking the effect of D.W. (controlled seedlings - germinated in D.W. ) as the standard in each case. Degrees of Freedom, Sum of Squares and P Values for Germination Hours, Media (Osmotica), Concentrations, Replicates and interactions between Germination Hours and Media, Germination Hours and Concentration and Media and Concentrations are presented in summarised form in Table 1, for the results of all the above biochemical estimations. The significance of the various treatment effect have been tested at 1% and 5% levels.

A. In the case of Embryo Axis, the following conclusions are arrived at:

1. The effect of the treatments under consideration, viz. Germination Hours, Media, Concentrations, Replicates,
<table>
<thead>
<tr>
<th>Source</th>
<th>A</th>
<th>B (Control)</th>
<th>C</th>
<th>A x B</th>
<th>A x C</th>
<th>A x B x C</th>
<th>Treatment</th>
<th>Error</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td>Germination Hours (A)</td>
<td>1 145.95</td>
<td>1 1909.19**</td>
<td>1</td>
<td>577.02</td>
<td>1</td>
<td>398.04</td>
<td>1 190.57</td>
<td>1 3.78</td>
<td>31 730.24</td>
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<tr>
<td>Media (d) (Control)</td>
<td>1 17.28</td>
<td>3 122.38**</td>
<td>1</td>
<td>8.27</td>
<td>1</td>
<td>31.34</td>
<td>1 15</td>
<td>31</td>
<td>122.38**</td>
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<tr>
<td>Concentrations (g)</td>
<td>1 3.172</td>
<td>1 42.31**</td>
<td>1 27.73</td>
<td>1 46.69**</td>
<td>1 76.31**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B x C</td>
<td>1 13.68</td>
<td>1 182.79**</td>
<td>1 3.19</td>
<td>1 46.69**</td>
<td>1 76.31**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A x C</td>
<td>1 0.30</td>
<td>1 9.84</td>
<td>1 24.26</td>
<td>1 59.72**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A x B x C</td>
<td>1 1.68</td>
<td>1 9.84</td>
<td>1 24.26</td>
<td>1 59.72**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>1 10.67</td>
<td>1 9.84</td>
<td>1 24.26</td>
<td>1 59.72**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>1 0.07</td>
<td>1 0.07</td>
<td>1 0.07</td>
<td>1 0.07</td>
<td>1 0.07</td>
<td>1 0.07</td>
<td>1 0.07</td>
<td>1 0.07</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>31 2.5</td>
<td>31 2.5</td>
<td>31 2.5</td>
<td>31 2.5</td>
<td>31 2.5</td>
<td>31 2.5</td>
<td>31 2.5</td>
<td>31 2.5</td>
<td></td>
</tr>
</tbody>
</table>

* Significant  ** Highly Significant  Others - Not Significant
null
Interactions between Germination Hours and Media, Germination Hours and Concentrations, Media and Concentrations on most of the observed variables are "Highly Significant".

2. The effect of Germination Hours on RNA content is "Significant" at 5% level whereas the effect of Germination Hours on Protein Content is "Not Significant at all".

3. The effect of Concentrations on Catalase Activity is "Significant" at 5% level.

4. The effect of interactions between Germination Hours and Concentrations on RNA Content is "Significant" at 5% level whereas the effect of Germination Hours and Concentrations on RNAse Activity, Protease Activity and Histone Content is "Not Significant at all".

B. In the case of Endosperm, the following conclusions are arrived at:

1. The effect of the treatments under considerations, viz. Germination Hours, Media, Concentrations, Replicates, Interactions between Germination Hours and Media,
Germination Hours and Concentrations, Media and Concentrations on most of the observed variables are "Highly Significant".

2. The effect of interactions between Germination Hours and Media on Protease Activity is "Not Significant at all".

3. The effect of interactions between Germination Hours and Concentrations on Histone Content and Amylase Activity is "Not Significant at all".

**Experiment II**

Effect of Desiccation on the Metabolic Changes in the Germinated Wheat Seedlings.

The results of this experiment are presented in Plates 19-26. The statistical analysis of the result is given in Table II and is discussed after the presentation of the "Experimental Findings".

Graded and Certified seeds of Wheat (*Triticum aestivum*, L.) (Var. Kalyan Sona) were germinated in sterilized petridishes of (9.0 cm. diameter) lined with
sterilized filter paper (Whatman No. 1) for a period of 120 hours at room temperature (28 ± 2°C) in normal daylight. 5 ml. of D.W. were pipetted in and pipetted out daily (twice a day) and the filter papers were changed once in two days so as to prevent fungal contaminations. The 48 hours and 120 hours germinated seedlings were transferred to clean, dry, sterilized petridishes lined with a dry, sterilized filter paper (Whatman No. 1) and these petridishes were placed in clean desiccators of (20 cm. diameter) containing 250 ml. of 98% H₂SO₄ (G.R.) grade. The seedlings were desiccated up to 120 hours. After every 24 hours some of these desiccated seedlings were taken out and analyzed for the following biochemical estimations separately in Embryo Axis and Endosperm.

The data on the effect of periods of desiccation treatment have been compared with controlled (undesiccated) seedlings. Following observations were found:

**Desiccated Weight:**

Desiccated weight of embryo axis (19.1) of wheat seedlings germinated for 48 hours and 120 hours were enhanced. Thus the desiccated weight of embryo axis were more than the
Effects of Desiccation Treatment On:

Fig. 1 - Desiccated Weight - Embryo Axis.

Fig. 2 - Per cent (%) Moisture Loss - Embryo Axis.

Fig. 3 - Catalase Activity - Embryo Axis.

Fig. 4 - Peroxidase Activity - Embryo Axis.

Fig. 5 - Amylase Activity - Embryo Axis.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-19
dry weight of controlled (undesiccated) seedlings. The maximum enhancement of weight was by 24 hours of treatment and the minimum was by 120 hours of treatment. Therefore, the maximum weight was seen at 24 hours of desiccation treatment and the minimum at 120 hours of treatment.

**Per cent (%) Moisture Loss:**

Per cent (%) Moisture Loss of embryo axis (19.2) of the seedlings of 48 hours and 120 hours of germination was very much lowered by desiccation treatment. The moisture loss was minimum at 24 hours of desiccation treatment and the moisture loss increased as the treatment period increased. Therefore, the maximum moisture loss was at 96 hours of desiccation treatment.

**Catalase Activity:**

Catalase Activity of embryo axis (19.3) of seedlings of 48 hours of germination was stimulated by all periods of desiccation treatment and the stimulation was positively related to the treatment period. On the contrary, the seedlings germinated for 120 hours showed a depressed activity by desiccation treatment from 24 hours to 96 hours. 120 hours of desiccation treatment, however, stimulated it.
Peroxidase Activity:

Peroxidase Activity of embryo axis (19.4) of seedlings germinated for 48 hours was depressed by all desiccation treatments ranging from 24 hours to 72 hours and the suppression was maximum by desiccation treatment of 24 hours. The suppression became less as the desiccation period increased. Desiccation treatment of 96 hours and 120 hours stimulated the peroxidase activity. The initial suppression up to 72 hours of treatment and the later stimulation by 96 hours and 120 hours of treatment was observed in the peroxidase activity of embryo axis germinated for 120 hours.

Amylase Activity:

Amylase Activity of embryo axis (19.5) was suppressed by all periods of desiccation treatment in the seedlings of 48 hours and 120 hours of germination. The minimum suppression was caused by 120 hours of desiccation treatment. The extent of suppression became less with the increase in the treatment period. Thus 24 hours of treatment caused the maximum suppression of the activity and the minimum suppression by 120 hours of treatment. In the seedlings of 120 hours of germination, all periods of desiccation treatment depressed
Effects of Desiccation Treatment On:

Fig. 1 - Desiccated Weight - Endosperm.

Fig. 2 - Per cent (%) Moisture Loss - Endosperm.

Fig. 3 - Catalase Activity - Endosperm.

Fig. 4 - Peroxidase Activity - Endosperm.

Fig. 5 - Amylase Activity - Endosperm.

Fig. 6 - Starch Content - Endosperm.
Wheat Var: Kalyan Sona

Germination Hours

Plate-20
the activity and this had no positive or negative relationship with the treatment period. The maximum suppression was caused by 72 hours of desiccation treatment and the minimum by 96 hours of treatment.

**Desiccated Weight:**

Desiccated weight of endosperm (20.1) of the seedlings of 48 hours and 120 hours of germination were enhanced. Thus the desiccated weight of endosperm were more than the dry weight of controlled (undesiccated) seedlings. The maximum weight was seen at 24 hours of treatment and the minimum at 120 hours of treatment.

**Per cent (%) Moisture Loss:**

Per cent (%) Moisture Loss of endosperm (20.2) of seedlings germinated for 48 hours as well as for 120 hours was lowered by all desiccation treatments and the minimum withdrawal of water or dehydration had occurred at 24 hours of desiccation treatment. Further the moisture withdrawal was more and more with increase in the periods of desiccation treatment so that, 120 hours of desiccation treatment caused the maximum withdrawal of water.
Catalase Activity:

Catalase Activity of endosperm (20.3) of the seedlings showed entirely a different behaviour between the seedlings of 48 hours and 120 hours of germination. In the case of seedlings of 48 hours of germination, there was an increase in catalase activity with the increase in the desiccation period. But the activity was suppressed in the endosperm of seedlings of 120 hours of germination. The maximum suppression was caused by 24 hours of desiccation treatment and the minimum by 120 hours of treatment. As the desiccation period increased, the suppressive effect became less and less.

Peroxidase Activity:

Peroxidase Activity of endosperm (20.4) of seedlings of 48 hours of germination was not influenced by periods of desiccation treatment. In these seedlings, 24 hours of desiccation treatment suppressed the activity and all other periods of treatment stimulated it. The greatest stimulation was caused by 48 hours of desiccation treatment. A different picture emerged for seedlings of 120 hours of germination, where 24 hours of desiccation treatment caused a very substantial suppression. While 48 hours of desiccation
treatment also caused suppression, the subsequent periods of desiccation treatment stimulated the enzymic activity, with
the activity increasing with periods of desiccation treatment. A very high level of enzymic activity was caused by 120 hours
of desiccation treatment.

Amylase Activity:

Amylase Activity of endosperm (20.5) of seedlings of 48 hours and 120 hours of germination, was suppressed by
all periods of desiccation treatment. In the seedlings of 48 hours of germination, the suppression became less and less
with increased periods of desiccation treatment upto 96 hours. However, suppression at 120 hours of desiccation was
more than what it was at 96 hours. In the seedlings of 120 hours of germination, more or less equal suppression of the
activity was observed at 24 hours, 72 hours, 96 hours and 120 hours of desiccation treatment while 48 hours of desici-
cation treatment caused the maximum inhibition.

Starch Content:

Starch Content of endosperm (20.6) of seedlings of 48 hours of germination was lowered by all periods of desiccation
treatment and the depletion of starch was maximum with 24 hours of desiccation treatment and the minimum with 120 hours of treatment. The depletion of starch content of endosperm of seedlings of 120 hours of germination was seen during 24 hours and 48 hours of desiccation treatment. Slightly higher starch content was seen during the other periods of treatment. On the whole, the starch content of endosperm of 120 hours germinated seedlings was affected little by desiccation treatment.

Invertase Activity:

Invertase Activity of embryo axis (21, 1) of seedlings germinated for 48 hours remained almost steady by desiccation treatment from 48 hours to 120 hours. However, 24 hours of desiccation treatment caused a very substantial depression of the activity. The seedlings of 120 hours of germination showed a depressed invertase activity in the embryo axis by desiccation treatment from 24 hours to 48 hours. Maximum suppression here also was caused by 24 hours of desiccation treatment. However, 120 hours of desiccation treatment resulted in double the activity as seen in controlled (undesiccated) seedlings. Periods of treatment beyond 48
Effects of Desiccation Treatment On:

Fig. 1 - Invertase Activity - Embryo Axis.

Fig. 2 - Reducing Sugar Content - Embryo Axis.

Fig. 3 - Non-Reducing Sugar Content - Embryo Axis.

Fig. 4 - Total Sugar Content - Embryo Axis.
hours stimulated the invertase activity.

**Reducing Sugar Content:**

Reducing Sugar Content of embryo axis (21.2) of seedlings germinated for 48 hours was not affected by 24 hours of desiccation treatment but the subsequent periods of desiccation treatment slightly enhanced this sugar content. In the case of seedlings germinated for 120 hours, the reducing sugar content of embryo axis was lowered by 24 hours of desiccation treatment. The subsequent periods of desiccation treatment enhanced this sugar content, and the enhancement increased with increasing period of desiccation treatment.

**Non-Reducing Sugar Content:**

Non-Reducing Sugar Content of embryo axis (21.3) of seedlings of 48 hours and 120 hours of germination went on increasing with increased period of desiccation treatment. In the seedlings germinated for 120 hours, non-reducing sugar content was lowered by 24 hours of desiccation treatment whereas 120 hours of treatment increased it severalfold.

**Total Sugar Content:**

Total Sugar Content of embryo axis (21.4) of the
Effects of Desiccation Treatment On:

Fig. 1 - Invertase Activity - Endosperm.

Fig. 2 - Reducing Sugar Content - Endosperm.

Fig. 3 - Non-Reducing Sugar Content - Endosperm.

Fig. 4 - Total Sugar Content - Endosperm.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-22
seedlings of 48 hours and 120 hours of germination was enhanced by all periods of desiccation treatment except in the case of 120 hours germinated seedlings in which 24 hours of desiccation treatment lowered this sugar content.

Invertase Activity:

Invertase Activity of endosperm (22.1) was suppressed by all periods of desiccation treatment. In the seedlings of 48 hours of germination, the maximum suppression was by 24 hours of desiccation treatment and the minimum suppression was by 120 hours of treatment. The maximum suppressive effect by 24 hours of treatment and the minimum by 120 hours of treatment was noted in the endosperm of seedlings of 120 hours of germination. As the periods of desiccation treatment increased, there was lesser suppression of this activity. In other words, the suppression of the enzymic activity was inverse with the periods of desiccation treatment.

Reducing Sugar Content:

Reducing Sugar Content of endosperm (22.2) of seedlings germinated for 48 hours was little affected by desiccation treatment. The content was slightly lowered by 24 hours of
desiccation treatment and slightly increased by 48 hours of desiccation treatment. Other periods of desiccation treatment did not affect this sugar content. In the case of seedlings germinated for 120 hours, all periods of desiccation treatment lowered the reducing sugar content. The effect of desiccation treatment was uneven. 24 hours of desiccation treatment caused maximum reduction of reducing sugar content. The reduction was less for 48 hours and 72 hours of treatment. Again 96 hours of desiccation treatment caused a greater reduction than treatment of 48 hours and 72 hours. 120 hours of treatment caused lesser reduction than 96 hours of treatment.

Non-Reducing Sugar Content:

Non-Reducing Sugar Content of endosperm (22.3) was slightly affected by desiccation treatment in seedlings of 48 hours of germination. In the case of seedlings of 120 hours of germination, this sugar content was lowered by 24 hours to 72 hours of treatment and the periods beyond 72 hours of desiccation treatment enhanced this sugar content. Almost a three fold increase in the sugar content was caused by 120 hours of desiccation treatment over the
controlled (undesiccated) seedlings.

**Total Sugar Content:**

Total Sugar Content of endosperm (22.4) of seedlings of 48 hours of germination was lowered by 24 hours of desiccation treatment while other periods of desiccation treatment had no effect. However, in the case of seedlings of 120 hours of germination, all desiccation treatment except 120 hours of treatment, caused reduction of this sugar content and the reduction was less with the increase of desiccation treatment. However, 120 hours of desiccation treatment, enhanced this sugar content.

**Protease Activity:**

Protease Activity of embryo axis (23.1) of seedlings germinated for 48 hours and 120 hours had the same response to the desiccation treatment. The desiccation treatments from 24 hours to 96 hours depressed the enzymic activity whereas 120 hours of treatment stimulated it. The depressive effect was less and less with increasing periods of desiccation treatment. Thus the maximum suppression was caused by 24 hours of desiccation treatment and the minimum by 96 hours of treatment.
Effects of Desiccation Treatment On:

Fig. 1 - Protease Activity - Embryo Axis.

Fig. 2 - Protein Content - Embryo Axis.

Fig. 3 - Histone Content - Embryo Axis.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-23
Protein Content:

Protein Content of embryo axis (23,2) of seedlings of 48 hours of germination, did not show any change in amount up to 72 hours of desiccation treatment and during periods of desiccation treatment beyond that (72 hours), it was slightly reduced. Embryo axis of seedlings germinated for 120 hours showed entirely a different behaviour with regard to protein content. All periods of desiccation treatment lowered the protein content which was maximum at 48 hours of desiccation treatment. 96 hours and 120 hours of desiccation treatment caused a lesser reduction of protein content as compared with other periods of desiccation treatment, the least reduction was caused by 120 hours of desiccation treatment.

Histone Content:

Histone Content of embryo axis (23,3) of seedlings germinated for 48 hours was lowered by desiccation treatment upto 48 hours and the subsequent periods of desiccation treatment enhanced the histone content and it was at the maximum with 120 hours of desiccation treatment. The maximum lowering of histone content was caused by 24 hours
Effects of Desiccation Treatment On

Fig. 1 - Protease Activity - Endosperm.

Fig. 2 - Protein Content - Endosperm.

Fig. 3 - Histone Content - Endosperm.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-24
of desiccation treatment. The same effect was also seen in the seedlings germinated for 120 hours. The maximum reduction was caused by 24 hours of desiccation treatment while 120 hours of desiccation treatment caused a very substantial increase of histone content.

**Protease Activity:**

Protease Activity of endosperm (24.1) of seedlings of 48 hours of germination was depressed by all periods of desiccation treatment more or less equally, but the response was not in the same direction for all desiccation treatments in the case of 120 hours germinated seedlings. There was a suppression of this activity from 24 hours to 72 hours of desiccation treatment, while at 96 hours of treatment no change in activity was found. The activity of the enzyme was raised twice as compared with controlled (undesiccated) seedlings by 120 hours of desiccation treatment.

**Protein Content:**

Protein Content of endosperm (24.2) of seedlings of 48 hours of germination was lowered by desiccation treatment of 24 hours and 48 hours. 72 hours and 96 hours of desiccation treatment enhanced the protein content and by
96 hours of treatment about three times more protein content was found as compared with controlled (undesiccated) seedlings. No change in protein content was found at 120 hours of desiccation treatment but when compared with 96 hours of treatment, the protein content was highly lowered. The protein content of endosperm of seedlings of 120 hours of germination was lowered by all periods of desiccation treatment. 48 hours and 72 hours of desiccation treatment caused greater reduction of this content when compared with other periods of treatment.

Histone Content

Histone Content of endosperm (24.3) of seedlings of 48 hours of germination did not show any relationship to the periods of desiccation treatment. 24 hours of desiccation treatment reduced the histone content and the subsequent periods of desiccation treatment enhanced the histone content and the maximum enhancement was caused by 96 hours of treatment followed by 72 hours of treatment. In the case of seedlings of 120 hours of germination, the endospermic histone content was lowered by all periods of desiccation treatment, except 120 hours of treatment, which slightly
Effects of Desiccation Treatment On:

Fig. 1 - RNAse Activity - Embryo Axis.

Fig. 2 - RNA Content - Embryo Axis.

Fig. 3 - DNA Content - Embryo Axis.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-25
enhanced this content. The reduction in histone content became less by increasing periods of desiccation treatment.

**RNAase Activity:**

RNAase Activity of embryo axis (25.1) of seedlings of 48 hours of germination was suppressed by all periods of desiccation treatment and the suppression was maximum with 24 hours of treatment and it became less and less with increasing periods of desiccation treatment. In the seedlings of 120 hours of germination, the same suppressive effect of desiccation treatment as in the 48 hours germinated seedlings was observed; however, 120 hours of desiccation treatment stimulated the enzymic activity.

**RNA Content:**

RNA Content of embryo axis (25.2) of seedlings of 48 hours of germination was lowered equally by all periods of desiccation treatment. In the seedlings of 120 hours of germination also the RNA content was lowered by all periods of desiccation treatment. 24 hours of desiccation treatment caused the maximum reduction of RNA content and the reduction became less and less with increasing periods of
Effects of Desiccation Treatment On:

Fig. 1 - RNAase Activity - Endosperm.

Fig. 2 - RNA Content - Endosperm.

Fig. 3 - DNA Content - Endosperm.
Wheat Var: Kalyan Sona

GERMINATION HOURS
PLATE-26
desiccation treatment. But again, 120 hours of desiccation treatment caused greater reduction of RNA content.

**DNA Content:**

DNA Content of embryo axis (25.3) of seedlings of 48 hours and 120 hours of germination was lowered by all periods of treatment. 24 hours of desiccation treatment caused the maximum lowering effect and 120 hours of treatment caused the minimum lowering. Thus DNA content increased with increasing periods of treatment.

**RNase Activity:**

RNase Activity of endosperm (26.1) was suppressed by all periods of desiccation treatment in the seedlings of 48 hours and 120 hours of germination. With increasing periods of desiccation treatment the suppression of RNase activity was reduced.

**RNA Content:**

RNA Content of endosperm (26.2) of seedlings of 48 hours of germination was lowered equally by all periods of desiccation treatment. RNA content was also lowered in the endosperm of seedlings of 120 hours of germination, where
Table (8)  "Overall Effect" of Different Periods of Desiccation Treatment on the Metabolic Changes in the Germinated Wheat Seedlings in Comparison with the Controlled (Undesiccated) Seedlings Germinated in E.W.

<table>
<thead>
<tr>
<th>Growth Parameters &amp; Biochemical Estimations</th>
<th>24 hours of desiccation treatment</th>
<th>48 hours of desiccation treatment</th>
<th>72 hours of desiccation treatment</th>
<th>96 hours of desiccation treatment</th>
<th>120 hours of desiccation treatment</th>
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<tbody>
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<td>Desiccated Weight</td>
<td>I Max.</td>
<td>I Max.</td>
<td>I Max.</td>
<td>I Max.</td>
<td>I Min.</td>
</tr>
<tr>
<td>Per cent (%)</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L Max.</td>
</tr>
<tr>
<td>Catalase Activity</td>
<td>I Min.</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L Max.</td>
</tr>
<tr>
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<td>L</td>
<td>L</td>
<td>I Min.</td>
<td>I Min.</td>
<td>I Min.</td>
</tr>
<tr>
<td>Non-Reducing Sugar Content</td>
<td>I Min.</td>
<td>L</td>
<td>I Min.</td>
<td>I Min.</td>
<td>I Min.</td>
</tr>
<tr>
<td>Total Sugar Content</td>
<td>E</td>
<td>L</td>
<td>I Min.</td>
<td>I Min.</td>
<td>I Min.</td>
</tr>
<tr>
<td>Protease Activity</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L Max.</td>
</tr>
<tr>
<td>Protein Content</td>
<td>I</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Histone Content</td>
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<td>L Max.</td>
<td>L Max.</td>
<td>L Max.</td>
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<tr>
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<td>L Max.</td>
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</tr>
</tbody>
</table>

*I* = Increase  
*I* Max. = Maximum Increase  
*I* Min. = Minimum Increase  
*E* = Equal  
*L* = Lowering  
*L* Max. = Maximum Lowering  
*L* Min. = Minimum Lowering
Table (8) "Overall Effect" of Different Periods of Desiccation Treatment on the Metabolic Changes in the Germinated Wheat Seedlings in Comparison with the Controlled (Undesiccated) Seedlings Germinated in S.W.

**Endosperm**

<table>
<thead>
<tr>
<th>Growth Parameters &amp; Biochemical Estimation</th>
<th>24 hours of desiccation treatment</th>
<th>48 hours of desiccation treatment</th>
<th>72 hours of desiccation treatment</th>
<th>96 hours of desiccation treatment</th>
<th>120 hours of desiccation treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>48 hours of germination</td>
<td>120 hours of germination</td>
<td>48 hours of germination</td>
<td>120 hours of germination</td>
<td>48 hours of germination</td>
</tr>
<tr>
<td></td>
<td>120 hours of germination</td>
<td>48 hours of germination</td>
<td>120 hours of germination</td>
<td>48 hours of germination</td>
<td>120 hours of germination</td>
</tr>
<tr>
<td>Desiccated Weight</td>
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<td>I Max.</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Per cent (%)</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
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<td>Moisture Loss</td>
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<td>L</td>
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</tr>
<tr>
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<td>I Min.</td>
<td>L Max.</td>
<td>I</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Peroxidase Activity</td>
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<td>L Min.</td>
<td>I</td>
</tr>
<tr>
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<td>L</td>
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<td>L Min.</td>
<td>L Min.</td>
<td>L Max.</td>
</tr>
<tr>
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<td>I Min.</td>
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<tr>
<td>Invertase Activity</td>
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<td>L Max.</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Reducing Sugar Content</td>
<td>L</td>
<td>L Max.</td>
<td>L</td>
<td>E</td>
<td>L Min.</td>
</tr>
<tr>
<td>Non-Reducing Sugar Content</td>
<td>L</td>
<td>L Max.</td>
<td>E</td>
<td>L Min.</td>
<td>E</td>
</tr>
<tr>
<td>Total Sugar Content</td>
<td>L</td>
<td>L Max.</td>
<td>E</td>
<td>L Min.</td>
<td>E</td>
</tr>
<tr>
<td>Protein Activity</td>
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<td>L Min.</td>
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<td>E</td>
<td>L</td>
</tr>
<tr>
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<td>L Min.</td>
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<td>I</td>
</tr>
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<td>RNAse Activity</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>RNA Content</td>
<td>L</td>
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<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>DNA Content</td>
<td>L Max.</td>
<td>L Max.</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

I = Increase  
E = Equal  
L = Lowering  
I Max. = Maximum Increase  
I Min. = Minimum Increase  
L Max. = Maximum Lowering  
L Min. = Minimum Lowering
the maximum lowering was by 24 hours of desiccation treatment and the minimum by 120 hours of treatment.

**DNA Content:**

DNA Content of endosperm (26.3) of the seedlings of 48 hours and 120 hours of germination was lowered by all periods of desiccation treatment. 24 hours of treatment caused the maximum lowering effect and 120 hours of treatment caused the least.

The "Overall Effect" of different periods of desiccation treatment on the metabolic changes in the germinated wheat seedlings in comparison with the controlled (undesiccated) seedlings germinated in D.W. is presented in Table (B).

**Statistical Analysis of the Results (Table II):**

The results of these experiments have been analyzed statistically by the "Method of Analysis of Variance" for RNAase Activity, RNA Content, DNA Content, Protease Activity, Protein Content, Histone Content, Invertase Activity, Reducing Sugar Content, Total Sugar Content, Non-Reducing Sugar Content, Catalase Activity, Peroxidase Activity,
<table>
<thead>
<tr>
<th>Source</th>
<th>A.E.</th>
<th>%a</th>
<th>%b</th>
<th>%c</th>
<th>%d</th>
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<tr>
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<td>MSS</td>
<td></td>
<td></td>
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<tr>
<td>Replicate 1</td>
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<td>0.9169</td>
<td>0.0925</td>
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<td>9</td>
<td>0.1006</td>
<td>0.0168</td>
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<td>1®</td>
</tr>
<tr>
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<td>Source M.</td>
<td>KSS</td>
<td>MSS</td>
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<tr>
<td>Replicate 1</td>
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<tr>
<td>Error</td>
<td>9</td>
<td>0.0084</td>
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<td>Total</td>
<td>1®</td>
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<td></td>
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<td>Replicate 1</td>
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<td>0.0951</td>
<td>0.00303</td>
<td>9.0000</td>
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<td>0.00003</td>
<td>Total</td>
<td>1®</td>
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<tr>
<td>Replicate 1</td>
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<td>0.10005</td>
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<tr>
<td>Error</td>
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<td>0.10005</td>
<td>0.0903</td>
<td>Total</td>
<td>1®</td>
</tr>
</tbody>
</table>

* Significant at %. ** Highly significant. Others = not significant at .05.
Amylase Activity and Starch Content in Embryo Axis and Endosperm separately taking the effect of Controlled (Undesiccated) seedlings germinated in D.W. as the standard in each case. Degrees of Freedom, Mean Sum of Squares and F-Values for Germination Hours, Desiccation Periods, Replicates and interactions between Germination Hours and Desiccation Periods are presented in summarised form in Table II; for the results of all the above biochemical estimations. The significance of the various treatment effect have been tested at 1% and 5% levels.

A. In the case of Embryo Axis, the following conclusions are arrived at:

1. The effect of the treatments under consideration, viz. Germination Hours, Desiccation Periods, Replicates and interaction between Germination Hours and Desiccation Periods on all of the observed variables are "Highly Significant".

B. In the case of Endosperm, the following conclusions are arrived at:

1. The effect of the treatments under consideration, viz.
Germination Hours, Desiccation Periods, Replicates and interactions between Germination Hours and Desiccation Periods on most of the observed variables are "Highly Significant".

2. The effect of Germination Hours on DNA Content is "Not Significant at all".

3. The effect of Desiccation Periods on DNA Content is "Not Significant at all".

4. The effect of interactions between Germination Hours and Desiccation Periods on DNA content is "Not Significant at all".

Experiment III

Effect of Low Temperature on the Metabolic Changes and Enzymic Activities in the Germinated Wheat Seedlings.

The results of this experiment are presented in Plates 35-42. The statistical analysis of the results is given in Table III, and is discussed after the presentation of the "Experimental Findings".
Graded and Certified seeds of Wheat (*Triticum aestivum* L.) (Var. Kalyan Sona) were germinated in sterilized petridishes of (9.0 cm. diameter) lined with sterilized filter paper (Whatman No. 1) for a period of 120 hours at room temperature (28 ± 2°C) in normal daylight in D.W. 5 ml. of D.W. were pipetted in and pipetted out daily (twice a day) and the filter papers were changed once in two days, so as to prevent fungal contaminations. The 48 hours and 120 hours germinated seedlings were transferred to clean, dry, sterilized petridishes lined with a dry, sterilized filter paper (Whatman No. 1) and these petridishes were kept in a refrigerator, the inside temperature of which was maintained at a constant temperature of 10°C. The seedlings were kept for 120 hours. After every 24 hours, some of these seedlings were taken out and the Embryo Axis and Endosperm were separated and analyzed for the following biochemical estimations.

The data on the effect of periods of low temperature treatment have been compared with controlled (untreated) seedlings. Following observations were found:
PLATE – 35

Effects of Low Temperature Treatment On:

Fig. 1 – Catalase Activity – Embryo Axis.

Fig. 2 – Peroxidase Activity – Embryo Axis.

Fig. 3 – Amylase Activity – Embryo Axis.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-35
Catalase Activity:

Catalase Activity of embryo axis (35.1) of the seedlings germinated for 48 hours and 129 hours behaved differently. In the case of seedlings germinated for 48 hours there was an increase in catalase activity, which increased as the periods of low temperature treatment increased. But catalase activity of the embryo axis of seedlings germinated for 120 hours was suppressed by all periods of low temperature treatment and the suppression was almost equal for all periods.

Peroxidase Activity:

Peroxidase Activity of embryo axis (35.2) of the seedlings germinated for 48 hours and 120 hours was suppressed by all periods of low temperature treatment. 24 hours of low temperature treatment caused the maximum inhibition of the activity. The inhibitory effect was more or less equal for all other periods of low temperature treatment. In the case of 120 hours of germinated seedlings low temperature treatment of all periods caused inhibition. But greater inhibition was observed by 24 hours and 72 hours of low temperature treatment.
Effects of Low Temperature Treatment On:

Fig. 1 - Catalase Activity - Endosperm.

Fig. 2 - Peroxidase Activity - Endosperm.

Fig. 3 - Amylase Activity - Endosperm.

Fig. 4 - Starch Content - Endosperm.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-36
Amylase Activity:

Amylase Activity of embryo axis (35,3). It was seen that low temperature treatment had greatly suppressed the activity in the seedlings of 48 hours and 120 hours of germination. Maximum suppression was caused by 120 hours of low temperature treatment in the case of seedlings of 48 hours of germination. The activity was suppressed by all periods of low temperature treatment in the seedlings of 120 hours of germination.

Catalase Activity:

Catalase Activity of endosperm (36,1) of the seedlings of 48 hours and 120 hours of germination behaved differently with low temperature treatment periods. In the seedlings of 48 hours of germination, the activity was stimulated by the low temperature treatment, which slightly increased with the increasing period of treatment. On the contrary, in the 120 hours germinated seedlings, the low temperature treatment suppressed the activity considerably.

Peroxidase Activity:

Peroxidase Activity of endosperm (35,2) of the seedlings of 48 hours of germination was suppressed by 24 hours and
48 hours of low temperature treatment and the suppression was greater by 24 hours of treatment and the treatment periods greater than 24 hours stimulated the activity. In the case of seedlings of 120 hours of germination, all periods of low temperature treatment suppressed this enzymic activity and the maximum suppression was caused by 24 hours of treatment followed by 120 hours of treatment and the least suppression was by 96 hours of treatment.

Amylase Activity

Amylase Activity of endosperm (36,3) was depressed by low temperature treatment in the seedlings of 48 hours and 120 hours of germination. The maximum suppression was caused by 24 hours and 120 hours of low temperature treatment and the minimum by 48 hours of treatment in the seedlings of 48 hours of germination while 72 and 96 hours of low temperature treatment also caused suppression which was lesser than 120 hours. But in the seedlings of 120 hours germination, the activity was more or less equally inhibited by all periods of treatment.
Starch Content:

Starch Content of endosperm (36.4) of seedlings of 48 hours of germination was substantially lowered by low temperature treatment. With the increase in the treatment period, there was greater depletion of starch content. In the seedlings of 120 hours of germination, the low temperature treatment showed more starch content from 24 hours to 72 hours of treatment. By treatment periods beyond 72 hours, the content was lowered and the maximum lowering was by 120 hours of treatment.

Invertase Activity:

Invertase Activity of embryo axis (37.1) was suppressed by all periods of low temperature treatment in the 48 hours and 120 hours germinated seedlings. Suppressive effects were more or less equal, in the seedlings of 48 hours of germination where 24 hours of low temperature treatment caused the maximum suppression. Further there was a greater suppression of this enzymic activity in the seedlings of 120 hours of germination than 48 hours of germination by low temperature treatment.
Effects of Low Temperature Treatment on

Fig. 1 - Invertase Activity - Embryo Axis.

Fig. 2 - Reducing Sugar Content - Embryo Axis.

Fig. 3 - Non-Reducing Sugar Content - Embryo Axis.

Fig. 4 - Total Sugar Content - Embryo Axis.
Reducing Sugar Content:

Reducing Sugar Content of embryo axis of seedlings of 48 hours of germination was lowered by low temperature treatment and there was a progressive reduction with the increase of low temperature treatment. The reducing sugar content of embryo axis of seedlings of 120 hours germination showed no relatable variation with the duration of low temperature treatment. Maximum reduction was caused by low temperature treatment of 24 hours and the minimum by 48 hours of low temperature treatment.

Non-Reducing Sugar Content:

Non-Reducing Sugar Content of embryo axis (37,3) behaved differently in the seedlings of 48 hours and 120 hours of germination. In the case of former seedlings, this sugar content was lowered during 24 hours to 72 hours of low temperature treatment, the maximum being caused by 24 hours of treatment and the minimum by 72 hours of treatment. 96 and 120 hours of low temperature treatment enhanced this sugar content and the enhancement was more by 120 hours of treatment than by 96 hours of treatment. In the seedlings of 120 hours of germination, all low temperature treatment caused reduction which was at a maximum by 24 hours of
However, with increase of low temperature treatment periods, the reduction decreased so that 96 and 120 hours of treatment showed the least reduction.

**Total Sugar Content:**

Total Sugar Content of embryo axis (37.4) was lowered up to 96 hours of low temperature treatment in the case of seedlings of 48 hours germination. But 120 hours of treatment did not produce much effect. There was more or less equal decrease in the sugar content up to 72 hours of treatment in the case of seedlings of 120 hours germination. The maximum decrease was observed at 24 hours of treatment. 48 and 72 hours of treatment had an equal lowering effect and 96 and 120 hours of treatment also had an equal effect in decreasing this sugar content but this sugar content was increased when compared with 48 hours and 72 hours of treatment.

**Invertase Activity:**

Invertase Activity of endosperm (38.1) of the seedlings of 48 hours and 120 hours of germination was suppressed by all periods of low temperature treatment. The maximum
PLATE - 38

Effects of Low Temperature Treatment On:

Fig. 1 - Invertase Activity - Endosperm.

Fig. 2 - Reducing Sugar Content - Endosperm.

Fig. 3 - Non-Reducing Sugar Content - Endosperm.

Fig. 4 - Total Sugar Content - Endosperm.
suppression was observed in these two seedlings at 24 hours of low temperature treatment. With the increase in the period of treatment the suppression was less evident. In fact from 72 to 120 hours of low temperature treatments, this activity was little affected.

Reducing Sugar Content:

Reducing Sugar Content of endosperm (38.2) of the seedlings of 48 and 120 hours of germination was decreased by all periods of low temperature treatment and the effect was more or less equal. In the case of 120 hours germinated seedlings, there was a greater fall of this sugar content when compared with the seedlings of 48 hours of germination. In the case of seedlings of 48 hours of germination, all treatments lowered the sugar content which increased with the treatment period. But the decline of this sugar content was not as much in the case of seedlings of 120 hours of germination.

Non-Reducing Sugar Content:

Non-Reducing Sugar Content of endosperm (38.3) of the seedlings of 48 hours and 120 hours of germination was
decreased by all low temperature treatments and the
decrease was less as periods of treatment increased, i.e.
24 hours of treatment caused the maximum lowering of sugar
content and 120 hours the minimum.

**Total Sugar Content:**

Total Sugar Content of endosperm (38.4) was lowered
by all low temperature treatments in the seedlings germin-
ated for 48 hours and 120 hours. 24 hours of treatment
caused the maximum lowering of this sugar content and with
the increase in the period of low temperature treatments
there was less reduction.

**Protease Activity:**

Protease Activity of embryo axis (39.1) was suppressed
in the seedlings of 48 hours and 120 hours of germination
and in both the seedlings the maximum suppression was caused
by 24 hours of low temperature treatment and the minimum by
120 hours of low temperature treatment. Effects of other
periods of treatment were more or less equal in the
suppression of the activity.
Wheat Var: Kalyan Sona

Germination Hours

PLATE-39
Protein Content:

Protein Content of embryo axis (39.2) of seedlings of 48 hours of germination as well as 120 hours of germination was lowered by all low temperature treatments. The lowering effect increased with the duration of treatments in the seedlings of 48 hours of germination where 120 hours of treatment caused the maximum reduction. In the case of 120 hours germinated seedlings, 48 to 72 hours of low temperature treatments caused more or less an equal reduction. There was a greater fall in protein content of the seedlings of 120 hours germination as compared with the decline in the seedlings of 48 hours of germination.

Histone Content:

Histone Content of embryo axis (39.3) was lowered by all low temperature treatments in the seedlings of 48 hours and 120 hours of germination. 24 hours of low temperature treatment caused the maximum reduction in both the seedlings of 48 hours and 120 hours of low temperature treatment. In the case of seedlings of 48 hours of germination, the reduction was almost equal from 48 to 96 hours of low temperature treatment and was less than that of 24 hours of
Effects of Low Temperature Treatment On

Fig. 1 - Protease Activity - Endosperm.

Fig. 2 - Protein Content - Endosperm.

Fig. 3 - Histone Content - Endosperm.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-40
treatment. 120 hours of low temperature treatment caused the least change in the amount of Histone. In the case of 120 hours germinated seedlings, 48 hours of low temperature treatment caused the minimum reduction and the effect of other treatments were more or less equal.

Protease Activity:

Protease Activity of endosperm (40.1) of seedlings germinated for 48 hours was lowered by all low temperature treatments. 24 hours of low temperature treatment caused greater reduction of the activity; all other treatments caused suppression more or less to the same extent. The activity was also suppressed in the seedlings of 120 hours of germination. 24 hours of low temperature treatment caused the least suppression and all other treatments caused more or less an equal suppression which was more than that of 24 hours of treatment.

Protein Content:

Protein Content of endosperm (40.2) was lowered by low temperature treatment in the seedlings of 48 hours and 120 hours of germination. The fall in protein content by the low temperature treatment was more in the seedlings of 120
hours of germination than in the seedlings of 48 hours of germination. 72 hours of low temperature treatment caused least reduction in the 48 hours and 120 hours germinated seedlings.

Histone Content:

Histone Content of endosperm (40.3) of seedlings germinated at 48 hours was lowered by all low temperature treatments and the effect was at a maximum by 24 hours of treatment and the subsequent treatments caused less reduction of Histone content. There was a fluctuation in histone content of endosperm of seedlings of 120 hours germination with respect to the low temperature treatments. Although, all low temperature treatments lowered the histone content, 24 hours of treatment caused the maximum reduction. 48 hours of treatment caused the minimum followed by 72 hours, 96 hours and 120 hours of treatment.

RNAse Activity:

RNAse Activity of embryo axis (41.1) of the seedlings of 48 hours and 120 hours of germination was suppressed by all low temperature treatments and the greater suppression was by the shorter low temperature periods than longer
Effects of Low Temperature Treatment On1

Fig. 1 - RNAase Activity - Embryo Axis.

Fig. 2 - RNA Content - Embryo Axis.

Fig. 3 - DNA Content - Embryo Axis.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-41
With the increasing treatment period, there was less suppression in the seedlings of 48 hours and 120 hours of germination. The suppression was less with increasing period of low temperature treatment and the effect of different treatment periods were almost equal.

RNA Content:

RNA content of embryonic axis (41.2) of the seedlings of 48 hours and 120 hours of germination was lowered by all low temperature treatments. In the case of seedlings of 48 hours of germination, an inconsistency was observed. But in the case of 120 hours of germinated seedlings, the decrease in RNA content increased with the duration of treatment period. In the seedlings of 48 hours of germination, the maximum decrease was seen at 24 hours of low temperature treatment. The decrease became less up to 72 hours of treatment. Again at 96 hours of treatment the decrease was more than at 72 hours of treatment but less than that at 24 hours and 48 hours of treatment. At 120 hours of treatment there was a fall in the RNA content which was less than that at 24 hours of treatment but more than that at other treatment periods.
Effects of Low Temperature Treatment On:

Fig. 1 - RNAse Activity - Endosperm.

Fig. 2 - RNA Content - Endosperm.

Fig. 3 - DNA Content - Endosperm.
Wheat Var: Kalyan Sona

GERMINATION HOURS

PLATE-42
But in the seedlings of 120 hours germination all low temperature treatments from 24 hours up to 96 hours caused an equal decrease of RNA content, while the 120 hours of treatment caused the maximum decrease.

**DNA Content:**

DNA Content of embryo axis (41.3) of the seedlings of 48 hours and 120 hours of germination was almost equally lowered by all periods of low temperature treatments.

**RNAse Activity:**

RNAse Activity of endosperm (42.1) was more or less equally suppressed by all low temperature treatments in the seedlings of 48 hours and 120 hours of germination. However, the fall in the RNAse activity was very substantial in the case of 120 hours of germinated seedlings.

**RNA Content:**

RNA Content of endosperm (42.2) of the seedlings of 48 hours and 120 hours of germination was lowered by all low temperature treatments. But the responses were different; 96 hours and 120 hours of treatment caused maximum decrease of RNA content in the seedlings of 48 hours of germination.
followed by 24 and 48 hours of treatment. 72 hours of low temperature treatment caused the minimum decrease. In the seedlings of 120 hours of germination, all low temperature treatments decreased the RNA content. 24 hours of treatment caused the maximum decrease. 48 hours to 96 hours of treatment caused less decrease in RNA content. But again at 120 hours there was a fall in content which was less than that at 24 hours of treatment but more than at that at other treatment periods.

**DNA Content:**

DNA Content of endosperm (42, 3) of the seedlings of 48 hours and 120 hours of germination was lowered by all low temperature treatments. Periods from 24 hours to 72 hours of treatment in the case of seedlings germinated at 48 hours and 24 to 96 hours of treatment in the case of seedlings germinated at 120 hours showed the same rate of decline in the DNA content. 120 hours of low temperature treatment caused the maximum reduction in DNA content.

"Overall Effect" of different periods of low temperature treatment on the metabolic changes and enzymic activities in the germinated wheat seedlings in comparison with the
Table (C) "Overall Effect" of Different Periods of Low Temperature Treatment on Various Metabolic Changes in Germinated Wheat Seedlings in Comparison with Controlled (Untreated) Seedlings Germinated in D.W.

Embryo Axis

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<thead>
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<th>Biochemical Estimations</th>
<th>24 hours of Low temperature</th>
<th>48 hours of Low temperature</th>
<th>72 hours of Low temperature</th>
<th>96 hours of Low temperature</th>
<th>120 hours of Low temperature</th>
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<td>120 hours 48 hours</td>
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<td>of germination</td>
<td>of germination</td>
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<td>of germination</td>
<td>of germination</td>
</tr>
</tbody>
</table>

I = Increase
I Max. = Maximum Increase
I Min. = Minimum Increase
L = Lowering
L Max. = Maximum Lowering
L Min. = Minimum Lowering
Table (C): "Overall Effect" of Different Periods of Low Temperature Treatment on Various Metabolic Changes in Germinated Wheat Seedlings in Comparison with Controlled (Untreated) Seedlings Germinated in D.W.

<table>
<thead>
<tr>
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<th>24 hours of Low Temperature</th>
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I = Increase
I Max. = Maximum Increase
I Min. = Minimum Increase
L = Lowering
L Max. = Maximum Lowering
L Min. = Minimum Lowering
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* Significant at 5% level  ** Highly Significant  Note: Not Significant at all.
controlled (untreated) seedlings germinated in D.W. is presented in Table (C).

**Statistical Analysis of the Results (Table III):**

The results of these experiments have been analyzed statistically, by the "Method of Analysis of Variance" for RNAse Activity, RNA Content, DNA Content, Protease Activity, Protein Content, Histone Content, Invertase Activity, Reducing Sugar Content, Total Sugar Content, Non-Reducing Sugar Content, Catalase Activity, Peroxidase Activity, Amylase Activity and Starch Content in Embryo Axis and Endosperm separately, taking the effect of controlled (untreated) seedlings germinated in D.W. as the standard in each case. Degrees of Freedom, Mean Sum of Squares and F-Values for Germination Hours, Low Temperature Periods, Replicates and interactions between Germination Hours and Low Temperature Periods are presented in summarised form in Table III; for the results of all the above biochemical estimations. The significance of the various treatment effects have been tested at 1% and 5% levels.

A. In the case of Embryo Axis, the following conclusions are arrived at:
1. The effect of the treatments under consideration, viz., Germination Hours, Low Temperature Periods, Replicates and interactions between Germination Hours and Low Temperature Periods on most of the observed variables are "Highly Significant".

2. The effect of Germination Hours on Protease Activity is "Not Significant at all".

B. In the case of Endosperm, the following conclusions are arrived at:

1. The effect of Germination Hours on DNA Content is "Not Significant at all".

2. The effect of Germination Hours on Protease Activity is "Not Significant at all".

3. The effect of Low Temperature Periods on DNA Content is "Significant" at 5% level.

4. The effect of interactions between Germination Hours and Low Temperature Periods on DNA Content is "Not Significant at all".