Experiment No. 3 A (1) : Growth data (wheat) :

Plant height (Fig. 20) data show three distinct phases of initial lag phase which is exhibited up to 40 days and then the growth enters the log phase (period of grand growth) and after 80 days the plant enters senescence phase. Seed sizes (LC and SC) do not show significant differences during the life cycle. No treatment could increase the height significantly, rather distilled water and GI III (foliar sprays of GA at vegetative, flowering and fruiting stages in large seeds and all treatments in small size were slightly lower than the untreated control plants (LC) throughout (Fig. 20).

Plant dry weight (Fig. 20) increases and shows likewise three distinct phases of growth as shown in case of plant height in both the seed sizes. Total plant weight, on the whole, is lower in foliar sprayed sets (GI to GI II and KI to KIII). Distilled water in both the cases proves to be slightly inhibitory. GA as a presoaking was always superior to all other treatments in large seed. Same was the case with KIN presoaking treatment in small seeds.
FIG. 20 GROWTH-DAYS.

WHEAT CV NP 718

PLANT DRY WT-g

SMALL

LARGE

STEM HEIGHT - Cm

GROWTH-DAYS
Root dry weight (Fig. 21) also shows dynamic phases of dry matter production. Foliar sprays were not very beneficial. Distilled water was inhibitory and presoaking treatments with GA (Large seeds) and KIN (Small seeds) were beneficial almost at all stages of growth. There is no much difference as far as the final root weights of both the seed sizes are concerned.

Stem dry weight (Fig. 22) also shows three phases (lag, log and senescence). Dry weight of stem increases with the growth period. Foliar sprays are not very beneficial, however, pretreatments produced more dry matter at every given stage of the life cycle. Distilled water was slightly inhibitory. Final stem dry weight is more or less same in both the cases (LC and SC).

Leaf dry weight (Fig. 22) increases manifold during the first 60 days followed by a slow growth and again finally appreciable leaf dry matter increase is seen. Foliar sprays are not very promotive both in large (GI to GIII) and small (KI-KIII) seeds. Presoaking treatment with GA and KIN were the best. Distilled water again failed to show any appreciable growth over the controls rather it proved to be inhibitory. Foliar sprays (GI and GII and KI and KIII) showed better leaf dry weight during early growth (40 days after sowing). There is no significant difference except presoaking treatment with GA and KIN as far as leaf dry matter production is concerned.

Number of leaves (Fig. 23) on main axis are more or less same
TOTAL NUMBER OF LEAVES / PLANT

FIG. 21 GROWTH - DAYS

WHEAT CV NP 718

ROOT DRY WT - 9

SMALL

LARGE

2 PRE SOAKED - DW (5%)
2 PRE SOAKED - W (LOW)
PRE SOAKED - DA (LW)
PRE SOAKED - DA (61)
1 PRE SOAKED - KIN (25)
1 PRE SOAKED - KIN (5)
KL SPRAY (FLOWERING) (61)
KL SPRAY (FLOWERING) (25)
KL SPRAY (FLOWERING) (5)
KL SPRAY (FLOWERING) (2)}
FIG. 22 GROWTH - DAYS

WHEAT CV NP 71G

SMALL

LARGE

STEM DRY Wt.-g

LEAF DRY Wt.-g

UNTREATED CONTROL (SC)
PRE SOAKED - DW (PSDW)
PRE SOAKED - KIN (SK)
KIN SPRAY (VEGETATIVE FI)
KIN SPRAY (FLOWERING II)
KIN SPRAY (FRUITING III)

0 10 20

0 10 20

1 2 3 4 5 6

1 2 3 4 5 6

20 40 60 80 100

20 40 60 80 100

23456

23456

FIG. 22 GROWTH - DAYS
FIG. 23 GROWTH - DAYS

WHEAT CV NP. 718

1. UNTREATED CONTROL
2. PRE SOAKED - ORMULIN
3. PRE SPRAY - ORMULIN
4. ORMULIN SPRAY (FLOWING)
5. ORMULIN SPRAY (FOOD)
6. ORMULIN SPRAY (FUSION)

SMALL
LARGE

NO. OF LEAVES - TILLERS

NUMBER OF LEAVES - MAIN AXIS

GROWTH - DAYS
in both the seed sizes. Presoaking treatments (LG and SK) also could not produce more leaves except that they show emergence of more leaves during early growth. Same was the case with foliar sprays (GI - GIII and KI - KIII). Distilled water, though inhibitory, on the whole, could initiate more leaves per plant (Fig. 21) on the main axis as seen in the early growth (20 days after sowing). Plants showed sufficient number of leaves 40 days onwards. Leaf initiation process on the tillers (Fig. 23) can be observed even at 100 days after sowing, when actually senescence sets in. Foliar spray with GA (GI) is quite beneficial during the 60 days, afterwards there is no significant emergence of extra leaves. Foliar sprays are comparable to untreated and distilled water controls. Presoaking with GA initiates more leaves per plant. In case of small seeds foliar sprays also do not increase number of leaves (Fig. 21). Presoaking with KIN leads to more leaves. Distilled water is comparable to untreated controls.

Majority of the total tillers (Fig. 24) per plant are added between 40 to 80 days. Foliar sprays are no good in case of large seeds while in case of small seeds foliar sprays with KIN initiate slightly more tillers per plant. Presoaking treatments like other parameters also increase total tillers per plant in both the cases (LG and SK).
Distilled water (DW) does not modify the total numbers of tillers per plant in both the cases (LDW and SDW). Foliar sprays except GI in large seeds produce less fertile tillers as compared to large controls. Presoaking with GA and KIN results in very high numbers of fertile tillers. KIN foliar spray is superior to GA foliar spray as far as total fertile tillers are concerned (Table 3). Sterile tillers (Table 3) increase in foliar sprays in both the cases. GA and KIN presoaking also favour slightly more sterile tillers as compared to controls. Distilled water (DW) in case of large seeds gives more sterile tillers while distilled water in small seeds reduces the tendency of more sterile tillers per plant.

Dry weight of the main spike (Fig. 25) is finally more in GA foliar sprayed plants as compared to large controls. Presoaking was not very beneficial. In the case of small seeds foliar sprays were superior finally and presoaking with KIN was beneficial. Distilled water (DW) was comparable to untreated controls. Dry weight of main spike was generally higher in large seeds as compared to small seeds. However this difference was not much evident when one compares dry weight of the spike. Dry weight of extra spikes is finally more in large pretreated with GA as compared to large control. In the case of small seeds presoaking with KIN was superior
Number of fertile and sterile tillers at the time of final growth data (100 days) Wheat cv. N.P. 718

<table>
<thead>
<tr>
<th>Treatments</th>
<th>No. of fertile tillers/plant</th>
<th>No. of sterile tillers/plant</th>
<th>No. of total tillers/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC</td>
<td>10.6</td>
<td>2.0</td>
<td>12.6</td>
</tr>
<tr>
<td>LDW</td>
<td>9.7</td>
<td>2.9</td>
<td>12.6</td>
</tr>
<tr>
<td>LG</td>
<td>14.2</td>
<td>2.7</td>
<td>16.9</td>
</tr>
<tr>
<td>GI</td>
<td>7.3</td>
<td>4.3</td>
<td>11.6</td>
</tr>
<tr>
<td>GII</td>
<td>8.7</td>
<td>1.0</td>
<td>9.7</td>
</tr>
<tr>
<td>GIII</td>
<td>8.0</td>
<td>2.7</td>
<td>10.7</td>
</tr>
<tr>
<td>SC</td>
<td>10.3</td>
<td>2.0</td>
<td>12.3</td>
</tr>
<tr>
<td>SDW</td>
<td>10.5</td>
<td>1.8</td>
<td>12.3</td>
</tr>
<tr>
<td>SK</td>
<td>12.6</td>
<td>2.8</td>
<td>15.4</td>
</tr>
<tr>
<td>KI</td>
<td>10.7</td>
<td>1.3</td>
<td>11.3</td>
</tr>
<tr>
<td>KII</td>
<td>9.7</td>
<td>3.3</td>
<td>13.0</td>
</tr>
<tr>
<td>XIII</td>
<td>9.7</td>
<td>4.7</td>
<td>14.4</td>
</tr>
</tbody>
</table>
finally. Dry weight of extra spikes was generally higher in large seeds as compared to small seeds. There is no difference in the dry weight of spikes of large seeds GA pretreated (LG) and small seeds pretreated with KIN (PK) finally (Fig. 25).

Experiment No. 3 A (ii) : Leaf area, Growth indices and Chlorophyll contents (wheat):

Leaf area is more in plants raised from the small seeds when compared with large controls. Distilled water is slightly inferior to controls. Presoaking with GA leads to more leaf area as compared to any other treatment. Foliar sprays do not increase leaf area both in large and small seeds during the life cycle. Presoaking treatment with KIN is also not effective (Fig. 26). 

RGR (Relative growth rate): (Figs. 27) Generally the relative growth rate of the root increases from vegetative to flowering phase and during senescence the relative growth rate of the root declines significantly. The relative growth rate is slightly higher in plants raised from small seeds than the plants raised from the large seeds in all the phases of growth. Pretreatments and foliar sprays are also superior in case of plants raised from the small seeds.
FIG. 27

WHEAT CV. NP. 718

SMALL

LARGE

STEM-REG

ROOT-REG

GROWTH PERIOD

GROWTH PERIOD

0 123456 123456
(V) (FL)

0 123456 123456
(FL) (FR)

0 123456 123456
(FR) (V)

0 123456 123456
(FL) (V)
RGR of the stem is slightly higher in the pretreated seeds in both the cases. Foliar sprays surprisingly give more or less same values in both the cases during vegetative growth. It is more or less same during flowering and fruiting in both the cases. Foliar sprays are quite beneficial especially during flowering phase (Fig. 27).

RGR of the leaf (Fig. 27) is very high during the vegetative phase the same declines considerably during flowering stage and one notices extremely low values during fruiting stage. RGR of the leaf of the plants raised from the small seeds is comparable to the plants raised from the seeds of large size both in case of pretreatments as well as foliar sprays during the vegetative growth. During flowering phase values are more or less same in all the cases.

On the whole higher values of RGR for whole plant are seen during the vegetative phase. These values decrease with the advancement of growth i.e. till the maturation of grains (senescence phase). There is no such significant difference in the RGR of small and large seeded plants (Fig. 27).

Net assimilation rate (NAR) (Fig. 28) is higher likewise during the vegetative growth followed by flowering and NAR is minimum during fruiting stage. Pretreatments and foliar sprays increase NAR in both the cases during flowering. However, during fruiting stage only pretreatments are effective.
FIG. 28 GROWTH-PERIOD

WHEAT CV NP718

LWR

FR

FL

NA R

(FL)

(V)

GROWTH-PERIOD

SMALL

LARGE

WHEAT CV NP718

PRE SOAKED - D(WLDM)

PRE SOAKED - G(A L6)

6A SPRAY (FLOM) (VI)

6A SPRAY (FLOM) (VI)

UNTREATED CONTROL (SC)
Leaf weight ratio (LWR) (Fig. 28) is likewise higher during the vegetative growth. Seed size and hormonal treatments effects are not clearly seen at various stages of the life cycle. However, pretreatments and foliar sprays are slightly better during flowering and fruiting phases in both the cases. Chlorophyll 'a' shows increasing trend right from the beginning. Pretreatment with GA and KIN generally show higher values throughout the period of growth except LG during fruiting. Small seeds and the pretreatment with KIN generally show higher levels of chlorophyll 'a' as compared to LG and LC (table 4).

Experiment No. 3 A (iii) : Stomatal studies (Wheat) :

Stomata in large and small seeded plants of wheat are typically graminaceous with a lenticular pore bounded by dumble shaped guard cells flanked by dome shaped subsidiary cells. The stomata are distributed in longitudinal files parallel to the long axis of the leaf. The orientation of the stomata is mostly parallel (Fig. 29-34). There are distinct stomatiferous and nonstomatiferous areas i.e. in other words the stomata are restricted to the intercostal region and absent from the costal region.

Epidermis - The leaves in both the large and small seeded
Chlorophyll (mg/g) during vegetative flowering and fruiting phases in wheat cv. N.P. 718

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Vegetative</th>
<th>Flowering</th>
<th>Fruiting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'a'</td>
<td>'b'</td>
<td>'a'</td>
</tr>
<tr>
<td>LC</td>
<td>6.2</td>
<td>7.2</td>
<td>5.9</td>
</tr>
<tr>
<td>LG</td>
<td>7.4</td>
<td>8.2</td>
<td>7.6</td>
</tr>
<tr>
<td>SC</td>
<td>7.4</td>
<td>7.2</td>
<td>8.9</td>
</tr>
<tr>
<td>SK</td>
<td>9.3</td>
<td>9.1</td>
<td>9.1</td>
</tr>
</tbody>
</table>

LC = Large untreated control
LG = Large GA pretreated
SC = Small untreated control
SK = Small kinetin pretreated
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large untreated control (LC)</td>
<td>1. Leaf upper</td>
</tr>
<tr>
<td></td>
<td>2. Leaf lower</td>
</tr>
<tr>
<td>Large distilled water pretreated (LDW)</td>
<td>3. Leaf upper</td>
</tr>
<tr>
<td></td>
<td>4. Leaf lower</td>
</tr>
<tr>
<td>Large GA pretreated (LG)</td>
<td>5. Leaf upper</td>
</tr>
<tr>
<td></td>
<td>6. Leaf lower</td>
</tr>
</tbody>
</table>
Study of stomata - wheat cv. N.P. 718

Vegetative phase

Fig. 30.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Surface</th>
<th>Treatment</th>
<th>Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small untreated control (SC)</td>
<td>7. Leaf upper</td>
<td>Small distilled water pretreated (SDW)</td>
<td>9. Leaf upper</td>
</tr>
<tr>
<td></td>
<td>8. Leaf lower</td>
<td></td>
<td>10. Leaf lower</td>
</tr>
<tr>
<td>Small KIN pretreated (SK)</td>
<td>11. Leaf upper</td>
<td></td>
<td>12. Leaf lower</td>
</tr>
</tbody>
</table>
plains are amphistomatac. The epidermal cells are elongated and arranged parallel to the long axis of the leaf (Figs. 29 to 34). The anticlinal epidermal walls are mostly straight and thick. The epidermal cells may be short or long. Cork cells and silica cells have been observed. Bicellular microhairs and unicellular macrohairs are also seen.

Stomatal frequency - Stomatal frequency per unit area for large and small seeded plants is counted from the middle of the upper and lower surfaces of the leaf at the vegetative, flowering and fruiting stages for large untreated control, (LC), large distilled water control (LDW), large GA treated (LG), small untreated control (SC), small distilled water control (SDW) and small KIN treated (SK) plants.

Large-upper surface - Stomatal frequency remains constant from vegetative to fruiting stage in untreated controls while it is maximum at fruiting stage in GA treated plants. In GA treated plants there is a gradual increase in stomatal frequency from vegetative to fruiting stage (Table 5) (Figs. 29, 31 and 33).

Large lower surface - The stomatal frequency shows similar results from vegetative to fruiting stage in untreated controls, distilled water controls and GA treated plants.
Study of stomata - wheat cv. N.P. 718

Flowering phase

Fig. 31.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Leaf Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large untreated control (LC)</td>
<td>13. Leaf upper</td>
</tr>
<tr>
<td></td>
<td>14. Leaf lower</td>
</tr>
<tr>
<td>Large distilled water pretreated</td>
<td>15. Leaf upper</td>
</tr>
<tr>
<td>(LDW)</td>
<td>16. Leaf lower</td>
</tr>
<tr>
<td>Large GA pretreated (LG)</td>
<td>17. Leaf upper</td>
</tr>
<tr>
<td></td>
<td>18. Leaf lower</td>
</tr>
</tbody>
</table>
Study of stomata - wheat cv. N.P. 718

Flowering phase

Fig. 32.

Small untreated control (SC)  19. Leaf upper surface
20. Leaf lower surface

Small distilled water pretreated (SDW)  21. Leaf upper surface
22. Leaf lower surface

Small KIN pretreated (SK) 23. Leaf upper surface
24. Leaf lower surface
Maximum stomatal frequency at fruiting stage is seen in all the cases. (Table 5) (Figs. 29, 31 and 33).

**Small-upper surface** - The stomatal frequency is same at vegetative, flowering and fruiting stages in untreated controls. Stomatal frequency is maximum at the fruiting stage in distilled water controls and KIN treated plants (Table 5) (Figs. 30, 32 and 34).

**Small lower surface** - Stomatal frequency is maximum at the vegetative in untreated controls; at the fruiting stage in distilled water controls and at the flowering stage in KIN treated plants (Table 5) (Figs. 30, 32 and 34).

**Stomatal Index** - Stomatal index per unit area for large and small seeded plants is counted from the middle of the upper and lower surface of the leaf at vegetative, flowering and fruiting stages of large untreated controls (LG), large distilled water controls (LDW), large GA treated (LG), small untreated controls (SG), small distilled water controls (SDW) and small KIN (SK) treated plants (Table 5).

**Large-upper surface** - There is a gradual increase in the stomatal index from vegetative to fruiting stage in untreated controls. The stomatal index is maximum at the flowering stage in the distilled water controls and at the fruiting stage in GA treated plants (Table 5).
**Study of stomata - wheat cv. N.P. 718**

**Fruiting phase**

*Fig. 33.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Leaf Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large untreated control (LC)</td>
<td>25. Leaf upper surface</td>
</tr>
<tr>
<td>Large distilled water pretreated (LDW)</td>
<td>26. Leaf lower surface</td>
</tr>
<tr>
<td>Large GA pretreated (LG)</td>
<td>27. Leaf upper surface</td>
</tr>
<tr>
<td></td>
<td>28. Leaf lower surface</td>
</tr>
<tr>
<td></td>
<td>29. Leaf upper surface</td>
</tr>
<tr>
<td></td>
<td>30. Leaf lower surface</td>
</tr>
</tbody>
</table>
FIG. 33
Study of stomata - wheat cv. N.P. 718

Fruiting phase

Fig. 34.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>31. Leaf upper surface</th>
<th>32. Leaf lower surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small untreated control (SC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small distilled water control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small KIN pretreated (SK)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Large-lower surface - Stomatal index is maximum at the fruiting stage in untreated controls, distilled water controls and GA treated plants (Table 5).

Small-upper surface - The stomatal index is maximum at the vegetative stage in distilled water controls and at the fruiting stage in KIN treated plants (Table 5).

Small-lower surface - The stomatal index is maximum at the vegetative stage in untreated controls. In distilled water controls there is a gradual increase at the fruiting stage. There is a gradual decrease in stomatal index from vegetative to fruiting stage in KIN treated plants (Table 5).

In conclusion it may be stated that there is no correlation of values of stomatal index between the upper and lower surface of large and small seeded plants in all the three treatments of large and small seeded plants.

Frequency of Epidermal cells: Frequency of epidermal cells per unit area for large and small seeded plants is counted from the middle of the upper and lower surface of the leaf at the vegetative, flowering and fruiting stages for large untreated controls (LC), large distilled water control (LCW), large GA treated (LG), small untreated controls (SC), small distilled water controls (SDW) and small KIN (SK) treated plants (Table 5).
Large-upper surface - There is a gradual increase in the frequency of epidermal cells from vegetative to fruiting stage in untreated controls. The frequency of epidermal cells is maximum at the flowering stage in distilled water controls and in GA treated plants (Table 5).

Large-lower surface - There is a gradual increase in the frequency of epidermal cells from vegetative to fruiting stage in untreated controls. The frequency of epidermal cells is maximum at the flowering stage and almost same at the vegetative and fruiting stage in GA treated plants (Table 5).

Small-upper surface - The frequency of epidermal cells is maximum at the flowering stage in untreated controls. There is a gradual increase in the frequency of epidermal cells from vegetative to fruiting stage in distilled water control and KIN treated plants (Table 5).

Small-lower surface - The frequency of epidermal cells is maximum at the fruiting stage in untreated controls and KIN treated plants, while it is constant from vegetative to fruiting stage in distilled water control (Table 5).

The comparative data of the values of the frequency of epidermal cells also show similar results.
Size of stomatal aperture: Large upper surface - The length of the stomatal aperture is maximum during vegetative phase in all the cases except large untreated control. In this highest length is noted during fruiting stage.

Breadth of stomatal aperture is maximum at vegetative and flowering stage in all the cases. Large distilled water controls show higher breadth of stomatal aperture at vegetative stage. The breadth of stomatal aperture is lowest during fruiting stage in all the cases (Table 5).

Large lower surface - (Table 5) The length of the stomatal aperture is maximum during vegetative stage. Large distilled water control show higher length at flowering and fruiting stage.

Breadth of stomatal aperture is maximum at vegetative and flowering stage. It is almost same in all the cases at vegetative and flowering stage. Decrease in breadth of aperture is noted at fruiting stage in all the cases (Table 5).

Small upper surface - The length of the stomatal aperture is maximum at flowering and fruiting stage in small IT treated plants. Minimum length of stomatal aperture is noted at vegetative stage in all the cases (Table 5).

Breadth of stomatal aperture is maximum at vegetative stage. There is slight decrease in breadth of aperture at
Table - 5

Stomatal frequency, stomatal index, frequency of epidermal cells and size of stomatal aperture of Wheat cv. N.P. 718

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Stomatal frequency per mm²</th>
<th>Stomatal index per mm²</th>
<th>Frequency of epidermal cells per mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vegetative</td>
<td>Flowering</td>
<td>Fruiting</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td>L</td>
<td>U</td>
</tr>
<tr>
<td>LC</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>LDW</td>
<td>48</td>
<td>32</td>
<td>48</td>
</tr>
<tr>
<td>LG</td>
<td>48</td>
<td>32</td>
<td>48</td>
</tr>
<tr>
<td>SC</td>
<td>32</td>
<td>48</td>
<td>32</td>
</tr>
<tr>
<td>SDW</td>
<td>48</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>SK</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

LC = Large untreated control,  
LDW = Large pretreated distilled water  
LG = Large pretreated - GA  
SC = Small untreated control  
SDW = Small pretreated - Distilled water  
SK = Small pretreated - Kinetin  
U = Leaf upper surface  
L = Leaf lower surface  
L = length  
w = width
<table>
<thead>
<tr>
<th>Treatments</th>
<th>Size of stomatal aperture in μ</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vegetative U</td>
<td>L</td>
<td>Flowering U</td>
<td>L</td>
<td>Fruiting U</td>
</tr>
<tr>
<td>LC</td>
<td>52 4.6 53 4.6 59 4.6 49 4.6 60 1.8 49 1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDW</td>
<td>52 5.6 56 4.2 44 4.6 53 4.6 48 0.74 58 0.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LG</td>
<td>52 4.6 57 4.6 47 4.6 48 4.6 46 0.46 50 0.46</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC</td>
<td>50 4.6 54 4.6 54 3.2 54 3.5 60 0.5 53 0.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDW</td>
<td>45 4.6 59 4.6 45 3.5 54 3.0 50 0.5 53 0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SK</td>
<td>47 3.5 47 4.6 60 3.2 50 4.6 60 0.5 50 0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
flowering stage whereas a remarkable decrease is noted during fruiting stage in all the cases (Table 5).

**Small lower surface** - The length of aperture is maximum at vegetative and flowering stage. Higher length of aperture is seen in small distilled water control at vegetative stage. Breadth of stomatal aperture is maximum at vegetative stage and values are same in all the cases. There is slight decrease in breadth of aperture at flowering stage while significant decrease is seen in all the cases at fruiting stage (Table 5).

Comparing upper and lower surface of leaf it may be stated that length and breadth of stomatal aperture is slightly higher at upper surface than that of lower surface in both large and small seeded plants.

**Experiment No. 3 B (1) : Growth data (mung) :**

Stem height (Fig. 35) - increases slowly up to 20 days, then there is very active stem elongation right up to the 60 days in all the cases. This is followed by senescence phase. Plants raised from the small seeds (SC) are comparable in height to the plants raised from large seeds (LC). Pre-soaking with DW (distilled water) does not influence the plant height significantly at various stages of growth. But finally plant height is slightly more at 30 days in large pretreated with
distilled water and lesser in the untreated controls. GA and KIN are also not very effective as pretreatments except GA which gives the tallest plant (LG). Foliar sprays with GA result in taller plants while foliar spray with KIN on the other hand decreases plant height in small seeds.

The plants raised from the large seeds produce higher dry matter (Fig. 35) especially during the first 60 days after sowing. However at later stages of growth the plants raised from the small seeds narrowed down the difference and finally the plants raised from the small seeds are comparable with the plants raised from large seeds. However in all other treatments large plants produce higher dry matter production as compared to small seeds. Pretreatment with DW, GA and KIN are slightly superior only during the later stages of growth. Same is the case with the foliar sprays with GA. Foliar sprays with KIN exhibit higher plant dry weight only during the senescence phase. Foliar spray at vegetative phase (GI and KI) shows higher dry matter as compared to the other foliar sprays (Fig. 35).

No significant effects of seed size and hormones are generally seen in the number of leaves on main axis. Same is the case with the number of leaves on lateral (Fig. 36) branches and the total number of leaves per plant (Fig. 37). Root dry weight - Large seeds generally produce plants with heavier roots. Pretreatments with distilled water and KIN
MUNG CV S-8

SMALL

LARGE

X-TOTAL NUMBER OF LEAVES/PLANT

ROOT DRY Wt.-g

GROWTH - DAYS

FIG. 37
are effective during the later stages of growth. Foliar sprays with GA are effective during the later stages while KIN given as foliar spray is not very effective (Fig. 37).

**Stem dry weight** (Fig. 38) - Large seeds generally produce plants with heavier stems. Pretreatments are effective in large seeds only during the later stages. Same is the case with foliar sprays.

**Leaf dry weight** (Fig. 38) is like wise generally higher in large seeds. Pretreatments and foliar sprays are quite effective during the later stages of growth.

**Number of lateral branches per plant** are slightly more in large seeds especially with pretreatments and foliar sprays with GA, while in case of small seeds significant differences are not observed (Fig. 39).

**Emergence of total number of flowers per plant** increase with the growth period. Pretreatments and foliar sprays generally increase the number of flowers both as a results of presoaking application and foliar sprays. Same trend is seen in case of fertilized flowers (Fig. 39).

**Dry weight of the flowers** (Fig. 40) is slightly higher at 60 days in small seeds in all the pretreatments. However, the difference is narrowed down at 80 days. Pretreatments and foliar sprays are not very effective.
MUNG CV S-8

**SMALL**

- Untreated Control (SD)
- Pre Soaked - DW (Low)
- Pre Soaked - DW (High)
- Pre Soaked - GA Spray (Low)
- Pre Soaked - GA Spray (High)

**LARGE**

- Untreated Control (LC)
- Pre Soaked - DW (Low)
- Pre Soaked - DW (High)
- Pre Soaked - GA Spray (Low)
- Pre Soaked - GA Spray (High)

**FIG. 38** GROWTH - DAYS

STEM DRY WT - g

LEAF DRY WT - g

0 20 40 60 80 100 120

0 2 4 6 8 10
MUNG CV S-8

SMALL

LARGE

TOTAL NUMBER OF FLOWERS/PLANT

GROWTH - DAYS

FIG. 39
MUNG CV S-8

SMALL

1. UNTREATED CONTROL (SC)
2. PRE SOAKED - ON (SW)
3. PRE SOAKED - KIN (SK)
4. KIN SPRAY (VEG)
5. KIN SPRAY (FLOWER)
6. KIN SPRAY (FRUITING)

FLOWERS-DRY WT-g

LARGE

1. UNTREATED CONTROL (LG)
2. PRE SOAKED - DW (LOW)
3. PRE SOAKED - GA (LG)
4. GA SPRAY (VEG)
5. GA SPRAY (FLOWER)
6. GA SPRAY (FRUITING)

PODS-DRY WT-g

FIG. 40 GROWTH-DAYS

123 456 123 456 123 456
40 60 80 40 60 80
Dry weight of the pods (Fig. 40) increase with the growth. Pretreatments are generally beneficial. Finally in large plants foliar sprays with GA (I and II) is also effective. On the whole large seeds produces pods with higher weight.

Experiment No. 3 B (ii) : Leaf area, Growth indices and Chlorophyll contents (mung):

Total leaf area is generally more in the plants raised from large seeds as compared to the plants raised from the small seeds. Pretreatments and foliar sprays especially with NPK increases leaf area, while GA given as foliar sprays are not effective (Fig. 41).

Relative growth rate (RGR) of the root is generally higher in large seeds as compared to small ones. Control plants show appreciable higher rates of root RGR both in large and small plants during the vegetative growth (Fig. 42). Foliar sprays and pretreatments are effective during later stages of growth.

RGR of the stem (Fig. 42) increases upto flowering stages in both the types of seeds and this is followed by a decline during fruiting phase. Pretreatments do not show higher RGR. Same is case with the foliar sprays in both the cases. However, during flowering, pretreatments and foliar sprays takeover as compared to untreated controls. One can also find
FIG. 41 GROWTH - DAYS
MUNG CV S-8

1 UNTREATED CONTROL (LC)
2 PRE SOAKED - DW (SDW)
3 PRE SOAKED - KIN (SK)
4 KIN SPRAY (VEGE) (KI)
5 KIN SPRAY (FLOW) (KII)
6 KIN SPRAY (FRUITING) (KIII)

FIG. 42 GROWTH - PERIOD

ROOT-RGR

LARGE

1 UNTREATED CONTROL (LC)
2 PRE SOAKED - DW (SDW)
3 PRE SOAKED - GA (LG)
4 GA SPRAY (VEGE) (G)
5 GA SPRAY (FLOW) (GII)
6 GA SPRAY (FRUITING) (GIII)

FIG. 42 GROWTH - PERIOD

STEM-RGR
similar effect in small seeds. Small seeds wipe out the initial differences and show appreciable higher rates in small seeds.

**RGR of leaf** (Fig. 43) is slightly higher in foliar sprayed plants with KIN. Pretreatments are not very effective in both the cases during vegetative growth period. However, during flowering and fruiting phases, foliar sprays and pretreatments takeover in both the types of seeds.

**RGR of the whole plant** (Fig. 43) is also generally higher in large seeds as compared to small seeds. RGR of the plant declines towards the flowering stages and it decreases further considerably during fruiting periods. During fruiting period RGR of the whole plant of the small seeds is comparable with the large seeds.

**Net assimilation rate (MAR)** (Fig. 44) is generally higher in large seeds especially as a result of pretreatments. Foliar sprays are effective with KIN during the vegetative growth. MAR increases during the flowering and fruiting in all the cases as compared to untreated controls in both the cases.

**Leaf weight ratio (LWR)** (Fig. 44) is higher in untreated controls during the vegetative and flowering phases. Pretreatments and foliar spray with KIN show higher values during fruiting. No such trend is seen in large seeds.
FIG. 43 GROWTH - PERIOD

PLANT-RGR

MUNG
CV. S-8

LEAF-RGR

SMALL

LARGE

MUNG SPRAY (FLOW) (K)
KIN SPRAY (FLOW) (K)
KIN SPRAY (VEE) (K)
PRE SOAKED - KIN (SK)
PRE SOAKED - DO (L)
UNFERTILIZED CONTROL (UC)

GA SPRAY (FLOW) (G)
GA SPRAY (VEE) (G)
PRE SOAKED - GA (LG)
UNFERTILIZED CONTROL (UC)
MUNG CV S-8

SMALL

1 UNTREATED CONTROL (SC)
2 PRE SOAKED - DW (SDW)
3 PRE SOAKED - KIN (SK)
4 KIN SPRAY (VEGE) (KI)
5 KIN SPRAY (FLOW) (KII)
6 KIN SPRAY (FRUITING) (KIII)

LARGE

1 UNTREATED CONTROL (LC)
2 PRE SOAKED - DW (LDW)
3 PRE SOAKED - GA (LG)
4 GA SPRAY (VEGE) (GI)
5 GA SPRAY (FLOW) (GII)
6 GA SPRAY (FRUITING) (GIII)

FIG. 44 GROWTH PERIOD
Chlorophyll - Amount of chlorophyll 'a' is generally higher in the plants raised from the large seeds as compared to the plants raised from the small seeds. Pretreatment with GA does not increase the levels of chlorophyll 'a', but surprisingly chlorophyll 'a' is inhibited in the plants raised from the large seeds at all stages of life cycle, while pretreatment with KII helps in having more amount of chlorophyll 'a' as compared to untreated controls during the vegetative and flowering stages. The amount of chlorophyll 'a', decreases towards flowering in the plants raised from large seeds while in the plants raised from small seeds, on the other hand, the content increases from vegetative to flowering (Table 6).

Chlorophyll 'b', content likewise in the plants raised from large seeds is higher during the vegetative growth as compared to small controls (SC). Kinetin is effective in increasing chlorophyll 'b' content, while GA is ineffective. Chlorophyll 'b', content decreases from vegetative to flowering in the plants raised from the large seeds (both treated and untreated) while in the plants raised from the small seeds the content increase from vegetative to flowering (Table 6).
**Table - 6**

Chlorophyll (mg/g) during vegetative, flowering and fruiting phases in mung cv. S-8

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Vegetative</th>
<th>Flowering</th>
<th>Fruiting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'a'</td>
<td>'b'</td>
<td>'a'</td>
</tr>
<tr>
<td>LC</td>
<td>10.1</td>
<td>10.0</td>
<td>8.8</td>
</tr>
<tr>
<td>LG</td>
<td>8.8</td>
<td>9.9</td>
<td>5.1</td>
</tr>
<tr>
<td>SC</td>
<td>8.0</td>
<td>7.4</td>
<td>8.1</td>
</tr>
<tr>
<td>SK</td>
<td>10.5</td>
<td>11.7</td>
<td>10.6</td>
</tr>
</tbody>
</table>

LC = Large untreated control
LG = Large pretreated GA
SC = Small untreated control
SK = Small pretreated kinetin
Experiment No. 3 R (iii) - Stomatal studies (mung) :

Stomata in large and small seeded plants are predominantly paraectylic i.e. the two kidney shaped guard cells are flanked by either equal or unequal two parallel subsidiary cells which are either continuous or noncontiguous at one or both poles. Stomata are uniformly and unevenly distributed over the leaf surfaces (Figs. 45-50). There is no definite pattern of orientation of stomata.

Epidermis - The leaves in both the size are amphistomatic. The epidermal cells are polygonal either isodiometric or elongated irregularly in any direction. The anticlinal epidermal cell walls are thin either enlarged or sinuous.

Stomatal frequency: Stomatal frequency per unit area for large and small seeded plants are counted from the middle of upper and lower surface of the leaf at the vegetative, flowering and fruiting stages for large untreated control (LC), large distilled water control (LDW), large GA pretreated (LG), small untreated control (SC), small distilled water control (SDW) and small kinetin pretreated (SK) (Table 7).

Large-upper surface: Stomatal frequency per unit area is maximum at flowering stage in untreated control, while in distilled water control there is a gradual increase from vegetative to fruiting stage and is almost the same at
Study of stomata - mung cv. S-8
Vegetative phase

Fig. 45.

Large untreated control (LC) 1. Leaf upper surface 2. Leaf lower surface
Large distilled water pretreated (LDW) 3. Leaf upper surface 4. Leaf lower surface
Large GA pretreated (LG) 5. Leaf upper surface 6. Leaf lower surface
Study of stomata - mung cv. S-8

Vegetative phase

Fig. 46.

<table>
<thead>
<tr>
<th>Description</th>
<th>Surface Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small untreated control (SC)</td>
<td>7. Leaf upper surface</td>
</tr>
<tr>
<td></td>
<td>8. Leaf lower surface</td>
</tr>
<tr>
<td>Small distilled water pretreated (SDW)</td>
<td>9. Leaf upper surface</td>
</tr>
<tr>
<td></td>
<td>10. Leaf lower surface</td>
</tr>
<tr>
<td>Small KIN pretreated (SK)</td>
<td>11. Leaf upper surface</td>
</tr>
<tr>
<td></td>
<td>12. Leaf lower surface</td>
</tr>
</tbody>
</table>
vegetative flowering and fruiting stage in GA treated plants (Table 7) (Figs. 45, 47, and 49).

Large-lower surface: Frequency of stomata per unit area is maximum at the flowering stage as is the case in upper surface in untreated control. In distilled water control stomatal frequency is maximum at the fruiting stage. Similarly in GA treated plants it is maximum at the fruiting stage (Table 7) (Figs. 45, 47 and 49).

Small-upper surface - Frequency of stomata is maximum at the vegetative and fruiting stage in the KIN treated plants, in the distilled water control it is maximum at the fruiting stage while in KIN treated plants it is same at vegetative and fruiting stage, and lowest at the flowering stage (Table 7) (Figs. 46, 48 and 50).

Small-lower surface - Stomatal frequency is maximum at the flowering stage in untreated control. The same thing is true for distilled water control. In KIN treated plants stomatal frequency is same at vegetative and fruiting stage and lowest at flowering stage as is the case in the upper surface. In comparison of the large and the small seeded plants the stomatal frequency of the upper and lower surface of the leaf show similarity in untreated control of large and KIN treated plants of small seeded plants (Table 7) (Figs. 46, 48 and 50).
Study of stomata - mung cv. S-8

Flowering phase

Fig. 47.

Large untreated control (LC) 13. Leaf upper surface
14. Leaf lower surface

Large distilled water pretreated (LDW) 15. Leaf upper surface
16. Leaf lower surface

Large GA pretreated (LG) 17. Leaf upper surface
18. Leaf lower surface
Study of stomata - mung cv. S-8

Flowering phase

Fig. 48.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>19. Leaf upper surface</th>
<th>20. Leaf lower surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small untreated control (SC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small distilled water pretreated (SDW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small KIN pretreated (SK)</td>
<td>21. Leaf upper surface</td>
<td>22. Leaf lower surface</td>
</tr>
<tr>
<td></td>
<td>23. Leaf upper surface</td>
<td>24. Leaf lower surface</td>
</tr>
</tbody>
</table>
FIG. 48
Stomatal Index: Stomatal index per unit area for large and small seeded plants is counted from the middle of the upper and lower surface of the leaf at the vegetative, flowering, and fruiting stages of large untreated control, large distilled water control, large GA treated, small untreated control, small distilled water control, and small KIN treated plants (Table 7).

Large-upper surface - Stomatal index is maximum at the flowering and fruiting stage in untreated control and there is a gradual increase from vegetative to fruiting stage in distilled water control and GA treated plants (Table 7).

Large-lower surface - The stomatal index is maximum at the vegetative stage in untreated controls, distilled water controls, and GA treated plants. The stomatal index is lowest at the flowering stage in all the three treatments.

Small-upper surface - The stomatal index is maximum at the vegetative stage in the KIN treated plants, at the fruiting stage in untreated and distilled water control. Stomatal index is lowest at the flowering stage in all the cases (Table 7).

Small-lower surface - Stomatal index is maximum at the fruiting stage in untreated controls, and at the vegetative
Study of stomata - mung cv. S-8

Fruiting phase

Fig. 49.

| Large untreated control (LG) | 25. Leaf upper surface |
| Large distilled water pretreated (LDW) | 26. Leaf lower surface |
| Large GA pretreated (LG) | 27. Leaf upper surface |
| | 28. Leaf lower surface |
| | 29. Leaf upper surface |
| | 30. Leaf lower surface |
Study of stomata - mung cv. S-8

Fruiting phase

Fig. 50.

Small untreated control (SC) 31. Leaf upper surface 32. Leaf upper surface

Small distilled water pretreated (SDW) 33. Leaf upper surface 34. Leaf lower surface

Small KIN pretreated (SK) 35. Leaf upper surface 36. Leaf lower surface
stage in distilled water controls and KIM treated plants. At flowering stage it is lower and almost same in all the cases (Table 7).

Large-upper surface - The frequency of epidermal cells is maximum at the vegetative stage in distilled water controls. There is a gradual increase in the frequency of epidermal cells from vegetative to fruiting stage, in distilled water controls; values are almost same at all the stages in GA treated plants except at flowering stage where value is little higher.

Large-lower surface - The frequency of the epidermal cells is maximum at the fruiting stage in untreated controls, distilled water controls in GA treated plants maximum frequency of epidermal cells is noted during vegetative stage (Table 7).

Small-upper surface - The frequency of epidermal cells is maximum at the flowering stage in KIM treated plants and in distilled water controls; in untreated controls maximum during vegetative (Table 7).

Small-lower surface - The frequency of the epidermal cells is maximum at the vegetative stage in untreated controls and at the flowering in distilled water controls and in KIM treated plants it is maximum during fruiting stage. Highest
value is noted during fruiting in KIN treated plants (Table 7).

The values regarding the frequency of epidermal cells of the upper and lower surface show some similarities.

In conclusion it may be stated that the values regarding frequency of stomata and epidermal cells, and stomatal index in large and small seeded plants show some similarities in the upper and lower surface as pointed out earlier.

**Size of stomatal aperture**: *Large-upper surface* - Length of the stomatal aperture is maximum during flowering stage in large distilled water control and large GA treated plants. It remains constant in all the cases at vegetative and fruiting stage (Table 7).

Breadth of the stomatal aperture is maximum in large GA treated and large distilled water control at vegetative and flowering stage. At fruiting stage breadth of the stomatal aperture is minimum in all the cases (Table 7).

**Large lower surface** - The length of the stomatal aperture is maximum at vegetative stage in all the cases. There is slight decrease in length of stomatal aperture from vegetative to fruiting stage in all the cases. The length of stomatal aperture is higher in large distilled water control during vegetative stage (Table 7).

The breadth of the stomatal aperture is maximum during flowering stage in large GA treated plants. Minimum breadth of
stomatal aperture is noted during fruiting stage in all the cases (Table 7).

**small-upper surface** - The length of the stomatal aperture is maximum during flowering and fruiting stage in most of the cases and is almost same in all the cases. During vegetative stage small treated with KIN show maximum length of stomatal aperture (Table 7).

Breadth of stomatal aperture is maximum during flowering stage in small untreated controls. Increase in breadth of stomatal aperture is noted from vegetative to flowering stage. Decrease in breadth of stomatal aperture is noted in all the cases during fruiting stage (Table 7).

**small-lower surface** - The length of the stomatal aperture is maximum at vegetative stage in all the cases. But little higher length is noted in small untreated control during vegetative stage. There is a gradual decrease in length of stomatal aperture from vegetative to fruiting stage except small distilled water control (Table 7).

Breadth of the stomatal aperture is maximum during flowering stage in all the cases. The breadth of stomatal aperture is maximum in small KIN treated during vegetative stage and in small untreated control during flowering stage. At fruiting stage minimum breadth of stomatal aperture is noted in all the cases. (Table 7).
Table - 7

Stomatal frequency, stomatal index, frequency of epidermal cells and size of stomatal aperture of mung cv. S-8

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Stomatal frequency per mm²</th>
<th>Stomatal index per mm²</th>
<th>Frequency of epidermal cells per mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vegetative</td>
<td>Flowering</td>
<td>Fruiting</td>
</tr>
<tr>
<td></td>
<td>U  L</td>
<td>U  L</td>
<td>U  L</td>
</tr>
<tr>
<td>LC</td>
<td>96 160</td>
<td>144 240</td>
<td>112 192</td>
</tr>
<tr>
<td>LDW</td>
<td>80 128</td>
<td>112 144</td>
<td>128 224</td>
</tr>
<tr>
<td>LG</td>
<td>96 128</td>
<td>80 112</td>
<td>96 176</td>
</tr>
<tr>
<td>SC</td>
<td>80 128</td>
<td>80 144</td>
<td>96 128</td>
</tr>
<tr>
<td>SDW</td>
<td>80 128</td>
<td>80 160</td>
<td>112 128</td>
</tr>
<tr>
<td>SK</td>
<td>112 192</td>
<td>80 192</td>
<td>112 192</td>
</tr>
</tbody>
</table>

LC = Large untreated control, LDW = Large distilled water pretreated
LG = Large pretreated - GA  SC = Small untreated control
SDW = Small distilled water pretreated  SK = Small pretreated - KIN
U = Leaf upper surface  L = Leaf lower surface  L = length  W = width
### Table - 7 (Contd.)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Size of stomatal aperture in $\mu$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vegetative</td>
<td>Flowering</td>
</tr>
<tr>
<td></td>
<td>$U$</td>
<td>$L$</td>
</tr>
<tr>
<td>LC</td>
<td>24</td>
<td>4.2</td>
</tr>
<tr>
<td>LDW</td>
<td>24</td>
<td>4.6</td>
</tr>
<tr>
<td>LG</td>
<td>25</td>
<td>7.0</td>
</tr>
<tr>
<td>SC</td>
<td>22</td>
<td>5.6</td>
</tr>
<tr>
<td>SDW</td>
<td>22</td>
<td>6.0</td>
</tr>
<tr>
<td>SK</td>
<td>26</td>
<td>4.6</td>
</tr>
</tbody>
</table>
Comparing upper and lower surface it may be stated that the length and breadth of the stomatal aperture is more at the upper surface than lower surface at all stages in all the cases.
Experiment No. 3 (i) (A & B):

**DISCUSSION**

Neither the seed size nor the various treatments could increase plant height rather distilled water (Dt) and IIII (foliar sprays of GA at vegetative, flowering and fruiting) in large seeds and presoaking and foliar sprays in small seeds, on the other hand, reduced plant height in wheat as compared to untreated large controls (Fig. 20). In mung, however, small seeds (SC) show stem height comparable to large seeds (LG). Distilled water pretreated large seeds increase height slightly (Fig. 35) while other pretreatments except GA (LG) which gives taller plant. M increases plant height. It is very interesting to note that presoaking treatments and foliar sprays in wheat do not increase in plant height while GA is quite promotive in mung. Effects of GA on stem elongation in literature are well documented (Phillips, 1971). It is further interesting to note that seedlings raised from small seeds and which were showing better seedling length, wipe over their differences during growth under field conditions. In mung the height is increased by GA of the large seeds, which otherwise exhibit taller plants are not allowed to express under the influence of kinetin. This once again support the contention that small
seeds may be rich in endogenous gibberellins while large seeds may possess more endogenous cytokinins. We do not expect any significant increase in plant height when plants are foliar sprayed at flowering (floral initiation) stage as vegetative growth in almost completed by that time.

Foliar sprays (GI to GIII and KI to KIII) do not enhance dry matter production of the whole plant in wheat (Fig. 20) situation is more or less the same as discussed under plant height as foliar sprays at flowering and fruiting may not be very effective as major vegetative growth is over and thus the influence of the hormone may have its own limitations while expressing the action of hormones. On the other hand presoaking treatments especially with GA (LG) and KIN (SK) were always effective. Presoaking treatments are well known to stimulate germination, enhance vegetative growth and finally produce increased yields (Sanckel, 1964; Heydecker, 1973; Saxena, 1974, 1979). In sun the small seeds (SC) could narrow down the differences and finally these were comparable with large seeds (LG) (Fig. 35). However all other treatments in large plants produced higher dry matter production as compared to small seeds. Presoaking treatments are also beneficial. Foliar sprays at vegetative phase (GI and KI) results in higher dry matter production.

As discussed earlier it is in close agreement with the opinion
that foliar sprays at vegetative growth increase dry matter production.

Foliar sprays were not beneficial as far dry weights of root, stem and leaf are concerned in wheat (Fig. 21 and 22). Presoaking treatments gave higher dry weight of root, stem and leaf. Seed size effects are not much different (Fig. 21 and 22). In mung (Fig. 37 and 38) large seeds produce plants with higher dry weights of the root, stem and leaf. Pretreatments and foliar sprays are generally beneficial in root, stem and leaf during later stages of the life cycle. Effects of foliar sprays at flowering and fruiting stages are difficult to explain as how increase in dry matter can be accounted when active phase of vegetative growth is over as physiological processes are geared towards floral differentiation.

Presoaking treatments and foliar sprays could not increase the number of leaves on the main axis in wheat (Fig. 23) but pretreatments (LG and SK) show emergence of more leaves during early growth. Presoaking with GA and KII lead to more leaves per plant (Fig. 21) and foliar sprays are not much effective. In mung no significant effects of seed size and hormones could be observed on leaves on main axis, number of leaves on lateral branches and total number of leaves per plant (Fig. 36 and 37).

Foliar sprays (G1 to GIII) do not add to the number of total tillers in wheat (Fig. 24) but KII foliar spray
initiate slightly more tillers per plant. Partly it may be due to the initiation of tillers even in senescence phase. Presoaking treatments increase number of total and fertile tillers per plant in both the cases (LG and SK). Dry weight of the main spike is finally more in GA sprayed plants as compared to controls (LG). Foliar sprays were superior finally in small seeds and KIS presoaking was also beneficial. On the whole, dry weights of the main spike and extra spikes were generally higher in large seeds compared to small seeds. Pretreatment effect is not much pronounced in LG and SK as far final weight of the extra spikes is concerned (Fig. 25).

In large number of lateral branches per plant are slightly more in large seeds pretreated or foliar sprayed with GA, while small seeds do not show any significant difference. Pretreatments and foliar sprays generally increase number of total flowers as well as fertilized flowers. However dry weight of flowers is not influenced significantly. Large seeds produce more heavier pods. Pretreatments and GI and GII (large seeds) foliar sprays are generally beneficial (Fig. 40).

GA in case of large seeds (LG) and KIS in case of small seeds could modify many vegetative and reproductive parameters. Foliar sprays have not been very beneficial in case of vegetative growth while presoaking treatments were very effective in increasing vegetative and reproductive growth. In mung small seeds could match growth of large seeds as far
as dry matter production is concerned. We shall return to this
discussion under experiment no. 4 when statistically analysed
data will throw light. It appears that wheat and mung, (due
to different food reserves) behave differently during growth
and development.

Kirichek and Tsenchenko (1976) showed that correlation
between seed yield and seed characters were determined in
55 pea cultivars, yields were negatively correlated with seed
size and protein content. Ries and Everson (1973) showed that
seed size appears to influence the seedling establishment and
gram yield depending upon the protein content of the seeds.
Seeds with higher protein content produce more vigorous
seedlings and higher grain yield. But wheat is exception to
this. The present data demonstrates that seed size effect in
wheat is not such pronounced in the dry weight of the root,
stem, leaf (Fig. 21 and 22) and other characters. We are
inclined to believe, Breachley (1923), who supported the
erlier conclusions for short lived annual plants and
reported that in seasons very suitable for the growth of
cereals the benefit of increased crop yields from larger
seeds was not always demonstrated. Sinha and Kailasanathan
(1976) showed that maximum number of shoot per m² were
obtained from the very small sized seeds of wheat where as
the largest size seed produced lesser shoots. However there
was little difference in the dry matter production. Kaufmann and McFadden (1960) concluded that the studies showed that the large seeds gave slightly more height, more tillers, higher number of grains and greater grain and straw yields, when grown on equal number of seed basis under competition. Hicks and Dabney (1896) showed that larger or heavier seeds excelled in vigour, height, stem diameter, number of branches and pods per plant, dry weight, grain yield and in producing lesser number barren plants. But the tap root length was reported to be longer in seedlings produced by small seeds.

It appears that these differences will exist due to duration of crop as pointed out by many workers (see: Dhillon and Kler, 1976). Ultimately growth is a function of genotype, environments and agronomic practices.

Experiment No. 3 (ii) A & B : It is interesting to note that leaf area is more in wheat plants raised from small seeds and when compared with large controls (Fig. 26). Foliar sprays are not effective and presoaking with GA increases leaf area. In mung (Fig. 41) however, the leaf area is more in large seeded plants as compared to small seeded plants. Presoaking treatments and foliar sprays with KIN are effective there appears operation of two separate mechanisms as GA increases leaf area in wheat. Friend et al. (1962) has also reported increased leaf area in wheat with GA while KIN is effective in mung. RGR of the plant as well as of different
organs is generally higher during vegetative growth in wheat (Fig. 27) and seed size effects are not pronounced. Small seeds along with presoaking treatments and foliar sprays show higher RGR of the root (Fig. 27) and to some extent in stem (Fig. 27) while in leaf (Fig. 27) small seeded plants show RGR comparable with large seeded plants in pretreated and foliar sprayed plants. In mung RGR of the wheat plant (Fig. 43) is higher in large seeds, but finally at senescence RGR is comparable in both the seeds. RGR of root is generally higher in large seeds. Pretreatment and foliar sprays are effective during later growth (Fig. 42) small seeds without initial differences in RGR stem (Fig. 42). Pretreatments and foliar sprays are not effective RGR leaf (Fig. 43) is higher in KIN sprayed plants. Pretreatments and foliar sprays are effective only during the late phase of the life cycle.

NAR and LWFR are higher in wheat (Fig. 28) during vegetative growth. Pretreatments and foliar sprays increase NAR during flowering while pretreatments are effective only during fruiting phase. Seed size and hormonal treatment effects are not clearly seen though pretreatments and foliar sprays exert their influence during the later stages. In mung (Fig. 44) NAR increases in large seeds as a result of pretreatment. It increases during later growth while LWR is higher in SC and LC during vegetative and flowering phases (Fig. 44). Pretreatments and foliar sprays with KIN (small seeds) increase LWR. Pretreatments with GA and KIN
increase amount of chlorophyll 'a' in wheat (Table 4). SC and KIN pretreated seeds show higher levels of chlorophyll 'b' as compared to LG and LC. In mung (Table 6) amount of chlorophyll 'a' 'b' are generally higher in large seeds. Pretreatments with KIN results in more chlorophyll 'a' and 'b'. In small seeds of wheat (Table 4) and mung (Table 6) chlorophyll 'b' increases from vegetative to flowering phases.

Krishnamurthy et al. (1973) reported that larger seed size contributed for a higher NAR which favoured higher dry matter accumulation per plant. There was, however, no proper trend in RGR due to variations in seed size in maize but it showed a slightly higher RGR due to bigger seed size as compared to other seed sizes. No trend was observed in NAR and RGR due to split application of nitrogen. Krishnamurthy et al. (1973) further showed that chlorophyll content of leaves was found to vary significantly with the genotypes in sorghum in both the seasons. It was concluded that final yield is a result of complementary action of many physiological growth components. The main factors seem to both photosynthetic leaf area exposed and the photosynthetic efficiency or NAR in sorghum. Watson (1956), Nichiporovich (1960) and Milthorpe (1962) have also concluded that leaf area variation was more an influential factor for variations in total dry matter production in both genotypic and species comparison rather than NAR.
In our studies it appears that small seeds (especially in wheat) try to utilize their resources at full rate and thus increase leaf area, chlorophyll contents and growth indices comparable with large seeds. Pretreatments and foliar sprays do modify these parameters and in mung there seems to be a slight shifting for some of these parameters in favour of large seeds but hormonal manipulations (either as pretreatment or foliar spray) tend to shift this pattern. We need some more critical studies including some more growth indices like CGR, LAI and LAD so that one gets better in sight in this area, which otherwise has not enabled research workers to arrive at some generalizations.

Experiment No. 3 (iii) : Observing the data critically of wheat (Table 5) and mung (Table 7) one may conclude that there is no correlation of values of stomatal index between the upper and lower surface of large and small seeded plants in all the three treatments. The comparative data of the values of the frequency of epidermal cells also show similar results and finally it may be stated that length and width of stomatal aperture is slightly higher at upper surface than that of lower surface in both large and small seeded plants (Table 5).

Marx and Sachs (1977) however showed that stomatal frequency is three times greater on the lower than on the upper side of the leaf; the minimal distance between stomata
is greater than on lower side, even though size of epidermal cells is the same in *Anagallis*. It may be due to short period of stomatal initiation on the upper side. Residual effect is minimum (expression of inhibitory effect) of a store on the formation of additional stomata in its immediate neighborhood. Thus inhibition of stomata development plays a minor role. Jain (1978) and Shah et al. (1980) have extensively studied stomata in many families. Salisbury (1927) pointed out that variations in stomata may be attributed to the plasticity in the epidermal structures which may perhaps be related to the environment. Hence, the value of these characters in systematics is limited. Several stomatal abnormalities observed in taxa (Inamdar, 1969a,b; Patel and Inamdar, 1971) is considered again by Rao and Ramnayya (1967) is not of any phylogenetic significance but it may be significant morphologically. It is possible that abnormal stomata arise possibly due to a momentary disturbance in the factors controlling the normal stomatal development. Shatia and Malik (1980) have discussed biochemical basis of mechanism(s) leading to stomatal action in *Phaseolus surngo*. The studies on stomata behaviour will enable us to understand the role of seed size on growth, development and productivity and it appears that studies on stomatal index, frequency and opening area will throw more light. It is evident that seed size and hormonal manipulations do not shift the ratios too drastically. It will be very interesting to study the hormonal regulation in relation to seed size in seeds with diverse food reserves.