RESULTS
RESULTS

Experiment I: Study of growth and yield contributing characters

I. Growth analysis

A. A mature Solanum khasianum plant grown in field condition is represented in Plate - 1.

Data for growth characters namely height, leaf number, primary and secondary branches, total number of berries and yellow berries per plant are presented in Plates - 2 and 3 respectively.

A.1 Height

The heights of control and treated plants up to two and half months of plant growth after transplantation remained without a change. However soon after a remarkable difference in plant height was observed (Plate 2 A). The maximum height was attained by plants which had received the foliar spray of AA + H₂O₂ followed by AA and H₂O₂ solutions respectively. DW sprayed plants did not show any appreciable change in their heights over that of control. No increase in the plant height was recorded after 7 months of plant growth in both the control and treated plants. A linear pattern in the height of curve in the control and treated plants depicts a constant phase of growth.
SOLANUM KHASIANUMUM CLARKE

PLATE-1
Legend to plates 1 - 29

1. Mature field grown plant of *Solanum khasianum* Clarke (Var. BBL-20-2) displaying the morphological characteristics.

2. Changes in the plant height (cm), leaf number, primary and secondary branch number at biweekly intervals in five treatments (A - D).

3. Changes in the formation of total and yellow berries at biweekly intervals in five treatments (A - B).


5. Fresh weights of root, mainstem, leaf, branch and berry including whole plant weight recorded at bimonthly intervals in five treatments (A - F).

6. Dry weights of root, mainstem, leaf and branch recorded at bimonthly intervals in five treatments (A - D).

7. Dry weight of total berries and whole plant recorded at bimonthly intervals in five treatments (A - B).

8. Berry diameter (cm) and death of the plants (percent) evaluated on harvest in five treatments (A - B).
9. Various yield contributing characters like plant height (cm), total number of berries and yellow berries, fresh and dry weights of root, main stem, leaf, branch and berry including whole plant recorded at harvest in five treatments (A - D).

10. Defoliated Solanum khasianum plants bearing fruits in five treatments (1 - 5).

11. Six different stages (I - VI) of developing flower, in which biochemical analyses were carried out in five treatments.

12. Changes in the free ascorbic acid content (mg/g.fr.wt.) percent ascorbic acid utilization and ascorbigen (mg/g.fr.wt.) during different stages of flower development and corresponding leaf in five treatments (A - C).

13. Peroxidase (O.D./min./g.fr.wt.), AA-PR peroxidase (O.D./20 min./g.fr.wt.) and catalase (O_2 evolved/min/g.fr.wt.) activities during different stages of flower development and corresponding leaf in five treatments (A - C).

14. Protein content (mg/g.fr.wt.) and protease activity (mg tyrosine produced/hr./g.fr.wt.) during different stages of flower development and corresponding leaf in five treatments (A - B).
15. Reducing sugars (mg./g.fr.wt.) and total sugars (mg./g.fr.wt.) and activity of invertase (mg glucose produced/30 min./g.fr.wt.) during different stages of flower development and corresponding leaf in five treatments (A - C).

16. RNA (mg./g.fr.wt.), and DNA (mg./g.fr.wt.) contents and α-Nase activity (mg ribose sugar produced/30 min./g.fr.wt.) during different stages of flower development and corresponding leaf in five treatments (A - C).

17. Solasodine (mg./g.fr.wt.) and total nitrogen (percent on dry wt. basis) contents during different stages of flower development and corresponding leaf in five treatments (A - B).

18. Eight different stages of developing berry, in which biochemical analyses were carried out in five treatments.

19. Longitudinal section of Solanum rhosianum berry showing its different parts i.e. berry wall and fruit pulp in which biochemical analyses were carried out in five treatments.

20. Ascorbic acid content (mg./g.fr.wt.) and ascorbic acid utilization (percent) in berry wall and fruit pulp during different stages of berry development in five treatments (A - D).
21. Ascorbigen content (mg/g.fr.wt.) in berry wall and fruit pulp during different stages of berry development in five treatments (A - B).

22. Peroxidase (U.D./min./g.fr.wt.) and AA-FR peroxidase (0.0D./20 min./g.fr.wt.) activities in berry wall and fruit pulp during different stages of berry development in five treatments (A - D).

23. Catalase activity (O2 evolved/min./g.fr.wt.) in berry wall and fruit pulp during different stages of berry development in five treatments (A - B).

24. Protein content (mg/g.fr.wt.) and protease activity (mg tyrosine produced/hr./g.fr.wt.) in berry wall and fruit pulp during different stages of berry development in five treatments (A - D).

25. Reducing sugars (mg/g.fr.wt.) and total sugars (mg./g.fr.wt.) in berry wall and fruit pulp during different stages of berry development in five treatments (A - D).

26. Invertase activity (mg glucose produced/30 min./g.fr.wt.) in berry wall and fruit pulp during different stages of berry development and in five treatments (A - B).
27. Nucleic acid contents (mg/g.fr.wt.) and RNase activity (mg ribose sugar produced/30 min./g.fr.wt.) in berry wall and fruit pulp during different stages of berry development in five treatments (A - D).

28. Solasodine content (mg/g.fr.wt.) in berry wall and fruit pulp, solasodine content in dry berry (mg/g.dry wt.) and total nitrogen (percent on dry wt. basis) during different stages of berry development in five treatments (A - D).

29. Logistic curves for height, leaf number, branch number, total berry number and yellow berry number versus growth period in five treatments (A - E).
A.2 Leaves

The total number of leaves formed also showed a similar pattern as that of height up to 2½ months of growth. The control and DW treated plants showed an exactly similar trend in the appearance of leaves. The maximum number of leaves were formed by 5 months of growth (Plate 2 B), where as in AA, H2O2 and AA + H2O2 treated plants, the largest number of leaves were observed by 7 months. The AA, H2O2 and AA + H2O2 spraying increased the number of leaves as compared to control and DW treatment. However, the number of leaves was significantly high in AA + H2O2 treatment as compared to AA and H2O2 treatments separately.

A.3 Primary branches

There was no significant difference in the total number of primary branches formed in the control and untreated plants up to two and half months of plant growth. In the control and DW treated plants, the number of leaves formation was almost same throughout the study. In AA, H2O2 and AA + H2O2 treatments, the number of primary branches increased significantly as compared to control and DW sprayed plants. However, there was no marked difference in the number of primary branches in plants, subjected to AA, H2O2 and AA + H2O2 spraying. But the primary branch formation took place 15 days earlier in AA + H2O2 and H2O2 treated
plants as compared to other plants. The rate of formation of primary branches was maximum during initial growth period leading to maximum branch formation at 4½ months. In all the plants (control and treated), the formation of primary branches showed a sigmoid curve (Plate 2 C).

A.4 Secondary branches

The rate of secondary branch formation was high up to 2½ months of plant growth in all the treatments and control plants. Thereafter, the number of secondary branches increased in DW, $\text{H}_2\text{O}_2$, AA and AA + $\text{H}_2\text{O}_2$ treatments over control. The maximum number of secondary branches was observed in AA + $\text{H}_2\text{O}_2$ treated plants, followed by AA, $\text{H}_2\text{O}_2$ and DW sprayed plants. Moreover, the formation of secondary branches was one month earlier in AA + $\text{H}_2\text{O}_2$ treatment than the other treatments and control plants (Plate 2 D).

A.5 Berries

The flowering started in the month of October and maximum flowering was attained in the months of January and February in all the plants (Plate 4 A). The total number of flowers per plant was significantly high in AA + $\text{H}_2\text{O}_2$ and AA treated plants respectively (Table - 2). On the other hand, a greater berry yield (both total + yellow berries) was recorded in the month of April. The total number of berries increased in plants sprayed with DW, AA and AA + $\text{H}_2\text{O}_2$.
107

treatments respectively over control. The treatment
AA + H₂O₂ showed two fold increase in the berry yield
between 6-8 months of plant growth when compared to
control plants (Plate 3 A). Foliar spray of DW was not much
effective as far as growth components were concerned but
it had an effect on berry yield.

A-6 Yellow berries

A similar pattern was observed in the case of yellow
berries of both the control and treated plants (Plate 3 B)
as that of total berries. The phenomenon of yellowing
started 3½ months earlier in AA + H₂O₂ treatment than that
of other treatments and control berries. The ripening was
significantly delayed in AA + H₂O₂ treatment followed by AA,
DW and H₂O₂ treatments respectively. No significant
difference was observed in the process of fruit ripening in
DW and H₂O₂ treatments. Control plants depict faster rate
of fruit ripening throughout the plant growth.

B. Meteorological studies

Overall productivity (berry yield) in all the treatments
in relation to changing environmental temperature and
humidity was worked out. The formation of flowers increases
very slowly up in the month of September and October but
thereafter the increase was rapid, attaining the maximum flowering in the month of February. The formation of flowers showed a declining trend after February and it was completely stopped in the month of April. In all the treatments and control plants, berry formation started in the month of October, increased continuously and reached to its maximum in the month of April. No increase in the berry number was recorded in the month of May (Plate 4 A). Ripening phenomenon showed a close parallelism with the berry formation. The yellowing of berries started in the month of November and all the berries on a plant get ripened in the month of May. Low temperature and relative humidity favoured the formation of flowers and increased temperature and relative humidity resulted in better fruit development and ripening (Plate 4 B). During the entire period of crop growth, the mean maximum and minimum temperatures were 34°C and 21.2°C respectively. The mean relative humidity recorded was 60.04 percent.

C. Fresh weight accumulation

C-1 Root

A continuous increase in the fresh weight of roots of control plants was observed during the entire growth period and maximum root growth was achieved at 6th month. Comparatively less fresh weight for roots was recorded in DW treated plants than the control ones at the 2nd month. An increase in
SOLANUM KHASIANUM CLARKE

A

B

PLATE-4
fresh weight shoots up significantly at 4th month and similar to control plants, it accumulated maximum fresh weight at the 8th month. The H₂O₂ treatment significantly increased the root fresh weight during initial growth period when compared with DW treated and control plants and it maintained it up to 6th month but root growth was significantly inhibited over DW treated roots at the later phase of plant growth. AA treated plants always showed higher fresh weight of roots, at every stage of growth when compared with other treatments and untreated ones. The increase in the fresh weight accumulation of root was more significant at 4th and 8th month. Maximum fresh weight of the roots was recorded in the plants throughout the life cycle which had received the foliar spray of AA in combination with H₂O₂. The increase in the root fresh weight was highly significant in AA + H₂O₂ treatment at all the growth periods when compared to the controls and respectively treated plants (Plate 5 A).

C-2 Main stem

The main stem fresh weight increased with corresponding increase in growth period reaching to maximum at the 8th month in all the treatments and control plants. The fresh weight accumulation of main stem was significantly low in control plants when compared with other treatments. The H₂O₂
SOLANUM KHASIANUM CLARKE

PLATE-5
treatment showed an inhibition in mainstem freshweight than that of the DW sprayed plants at the initial growth period (2nd and 4th month) but at 6th month, there was an insignificant increase. Maximum fresh weight accumulation was obtained only at maturity. No significant difference was observed in the fresh weight accumulation among the treated plants at 2nd month of plant growth but all treatments showed a significant increase over control. The AA + H_2O_2 sprayed plants showed the highest fresh weight accumulation during entire growth period followed by AA treatment. The significant accumulation in fresh weight was observed at 4th, 6th and 8th month of growth in AA + H_2O_2 and AA treated plants when compared with other treatments and control plants (Plate 5 D).

C-3 Leaves

The fresh weight of leaves increased with the increase in growth period and attained the maximum accumulation at 4th month in control plants. Thereafter it decreased and maintained the trend similar up to maturity. While in all other treatments, except H_2O_2, the peak value of fresh weight accumulation was obtained at 6th month. The fresh weight of leaves decreased significantly at maturity. The H_2O_2 treatment showed an increased trend up to the 8th month. The maximum leaf fresh weight accumulation was observed in
AA + $\text{H}_2\text{O}_2$ treatment throughout the growth period followed by AA treatment. The increase in leaf fresh weight accumulation was significantly higher in all the treated plants when compared with control at all the time intervals (Plate 5 C).

**Branches**

The fresh weight of the branches of the plants in all the treatments and control plants increased with the corresponding increase in the growth period. Maximum fresh weight of branches was recorded at maturity in all the treatments and control plants. An increase in branch fresh weight was observed in the DW treatment when compared with control plants but it was not very significant. At the initial stages of growth period (at 2nd month), treatments did not show significant difference in branch fresh weight accumulation over control but a remarkable difference was noticed at the later phase of growth and at maturity. The $\text{H}_2\text{O}_2$ treatment showed an increase in branch-fresh weight over DW treated plants at 4th and 6th month of plant growth but the fresh weight accumulation was inhibited at 2nd month and this inhibition was highly significant at maturity. Maximum fresh weight of branches was recorded in the AA + $\text{H}_2\text{O}_2$ sprayed plants during entire growth period followed by AA treatment. In both these treatments, the increase was highly
significant when compared with control, DW and \( \text{H}_2\text{O}_2 \) treatments respectively (Plate 5 D).

C-5 Berries

The fresh weight of the berries showed a gradual increase with the increase of growth period reaching to maximum at maturity (8th month) in all the treatments and control plants. In the DW sprayed plants, the increase in fresh weight of berries was recorded over control at 2nd, 4th and 8th month of growth while an insignificant decrease was observed at 6th month. No significant increase in berry fresh weight was observed in \( \text{H}_2\text{O}_2 \) treatment over DW sprayed plants at 2nd month of growth but a comparative rise in fresh weight was observed during later phase of the growth period. Maximum berry fresh weight was recorded in the AA + \( \text{H}_2\text{O}_2 \) treatment during entire period of plant growth followed by AA treated plants. In both those treatments, the increase was highly significant at 4th, 6th and 8th month of growth when compared with control, \( \text{H}_2\text{O}_2 \) and DW treatments (Plate 5 E).

C-6 Whole plant weight

A pattern similar in the whole plant weight was recorded as that of other growth components, i.e. continuously increase with corresponding increase in growth period and reaching to maximum at maturity. The AA + \( \text{H}_2\text{O}_2 \) treated
plants accumulated maximum fresh weight followed by AA treatment during entire period of plant growth. The increase in whole plant fresh weight was highly significant at 6th and 8th month when compared with respective H₂O₂ and DW sprayed plants and control ones. No significant difference was observed in plant fresh weight in DW and H₂O₂ treatments at the 2nd and 8th month of the growth period (Plate 5 F).

The effect of foliar application of different treatments on fresh weight production of different growth components and productivity (berry yield) is well augmented in the present study.

D  Dry weight accumulation

D-1  Root

The dry weight of roots of the control plant increased with the progressive increase in growth period and maximum dry matter accumulation was recorded at the maturity. Similar pattern in the dry matter accumulation was observed in all other treatments. A comparative increase in root dry matter accumulation was noticed in DW, H₂O₂ and AA sprayed plants over control at 2nd month of plant growth but no significant difference was observed with these treatments. The DW sprayed plants showed more root dry matter accumulation over control at 2nd, 4th and 8th month but at 6th month of plant growth, the root dry weight became an analogue to that of control one.
The \( H_2O_2 \) treatment inhibited the root dry matter production at the beginning of the growth period and also at maturity when compared with DW treatment. Although, the dry weights of roots were more at 4th and 6th month of growth in \( H_2O_2 \) treatment but these were not very significant. The AA + \( H_2O_2 \) and AA treatments showed a significant increase in the dry matter accumulation of roots over control, DW and \( H_2O_2 \) sprayed plants during entire period of plant growth except at 2nd month where AA sprayed plants did not record any appreciable increase but on the other way, root weight was significantly low as compared to AA + \( H_2O_2 \) treatment (Plate 6 A).

D-2 Main stem

Main stem dry weight showed an increasing trend on corresponding increase in growth period reaching to maximum at maturity in all the treatments and control plants. The DW sprayed plants showed an increment in dry matter production during entire period of growth when compared with control plants. No significant difference was observed in dry matter accumulation of main stem in DW and \( H_2O_2 \) sprayed plants throughout the life cycle. Maximum main stem dry matter accumulated by AA + \( H_2O_2 \) treatment followed by AA which was highly significant when compared with control,
SOLANUM KHASIANUM CLARKE

PLATE-6
DW and $\text{H}_2\text{O}_2$ sprayed plants at all the intervals of the growth period (Plate 6 B).

D-3 Leaves

The leaf dry weight in control and DW sprayed plants increased with the increase in growth period. Maximum leaf dry matter accumulated at the 6th month of plant growth in both control and DW sprayed plants thereafter a decline was observed at maturity. The $\text{H}_2\text{O}_2$ treatment showed a continuous increase in leaf dry weight, reaching to maximum at maturity. Initially, no significant effect of the DW and $\text{H}_2\text{O}_2$ treatment was observed on the dry matter production of leaf over control but the increase became more prominent at the later phase of the plant growth. The leaves of the plants sprayed with AA + $\text{H}_2\text{O}_2$ and AA respectively accumulated maximum dry weight over control, DW and $\text{H}_2\text{O}_2$ sprayed plants and the increase in dry matter was highly significant during the entire period of plant growth (Plate 6 C).

D-4 Branches

The dry weight of the branches, in all the treatments and control plants increased with the increase in the growth period as that of other growth components and in all the cases, maximum dry matter production was attained at crop maturity. The treatments did not show any significant
effect on the branch dry weight, among themselves or over control at the initial plant growth but this difference became much more prominent at the later phase of the plant growth. The DW sprayed plants showed an increase over control but it was not significant. In case of \( H_2O_2 \) treatment, the branch dry matter accumulation was inhibited at 4th month of plant growth, and this inhibition was highly significant at maturity when compared with DW sprayed and control plants. Maximum dry weight of branches was recorded in AA + \( H_2O_2 \) sprayed plants followed by AA treatment throughout the course of study (Plate 6 B).

D-5 berries

A progressive increase in the plant growth, increased the berry dry matter production and its peak values were obtained at maturity in all the treatments and control plants. There was no significant increase in dry matter accumulation of berries by DW spraying over control but it was significant in case of \( H_2O_2 \) treatment at 6th and 8th month of plant growth. The highest accumulation of dry matter of berries was observed in AA + \( H_2O_2 \) spraying followed by AA respectively throughout the plant growth. The increase in the dry matter accumulation of berries was highly significant in both these treatments when compared with control, DW and \( H_2O_2 \) sprayed plants (Plate 7 A).
The increase in whole plant dry weight in different treatments and control plants showed a trend similar to other growth components i.e. progressively increase reaching to maximum at maturity. The DM sprayed plants showed a comparative increase in whole plant dry weight when compared with control plants but the increase was meagre. The H$_2$O$_2$ treatment inhibited the dry matter production when compared with DM spraying during entire period of plant growth except at 6th month where a little increase was discernible. The AA + H$_2$O$_2$ sprayed plants showed the highest dry matter accumulation followed by AA treatment throughout the course of study when compared with control, DM and H$_2$O$_2$ sprayed plants. The increase in both these treatments was highly significant when compared with other treatments and untreated plants at all the intervals of plant growth (Plate 7 B).

**B Growth indices**

Mean values of relative growth rate of a whole plant indicate an increased growth during entire period of life cycle and maximum mean values of RGR were recorded in AA + H$_2$O$_2$ sprayed plants followed by control, AA and DM treatments. The H$_2$O$_2$ sprayed plants showed the minimum RGR value. The RGR values in AA + H$_2$O$_2$, AA and control plants were highly
significant when compared with $H_2O_2$ and DW treated plants.

Net assimilation rate generally decreases with the plant age, however, under AA and AA + $H_2O_2$ treatments, it maintained higher mean values as compared to control plants. The DW and $H_2O_2$ treated plants showed the least NAR values respectively (Table 3). The highest leaf weight ratio was recorded in the control plants which was comparatively decreased in DW and $H_2O_2$ treatments. The AA and AA + $H_2O_2$ treated plants showed the least LWR values respectively and the decrease in LWR values in both these treatments were highly significant as compared to the LWR values of control plants.

**F Harvest data**

On maturity of the crop, the effect of the treatments on the growth and productivity is elucidated by harvest data analysis.

**F-1 Berry diameter**

The average size of the berries occurring most commonly in class A of the different treatments showed an increase over control except in $H_2O_2$ treated plants where a decrease was discernible and it was not significantly different to that of control berries. Maximum berry size in class A was recorded in the AA + $H_2O_2$ (2.15 cm) and AA (2.04 cm)
treated plants respectively which was highly significant over control (1.71 cm).

The average size of the berries occurring most commonly in class 3 of the AA + H₂O₂ and AA treated plants was 3.04 cm and 2.81 cm respectively which were higher when compared with the control berries (2.59 cm). The H₂O₂ treatment showed an inhibition in berry size of class-3 where it was least (2.57 cm) with respect to other treatments and control berries. The berries of AA + H₂O₂ sprayed plants showed the maximum average size both in Class-A and Class-3 when compared with other treatments and control plants (Plate 8 A).

F-2 Survival value

Death of the plants occur due to their much susceptibility to viral infection. In the plot of the control plants, 18% of the plants died due to the viral infection while the death rate was significantly increased in DW and H₂O₂ treatments. Minimum plants died in the plots where AA and AA in combination with H₂O₂ solution was sprayed. Both these treatments showed 4 and 6 percent of plant death respectively. Besides taking all control measures, viral infection spread more in control and DW sprayed plants while H₂O₂ treatment showed lethal effects by burning the leaves of the plants. No definite reasons could be assigned to these findings but plants in AA + H₂O₂ and AA treatments were more healthy
SOLANUM KHASIANUM CLARKE

A

1 = CONTROL
2 = DW
3 = H₂O₂
4 = AA
5 = AA + H₂O₂

BERRY DIAMETER - cm

PERCENT DEATH

PLATE-8
thereby less susceptible to diseases and rendering highest survival values as revealed by growth analysis (Plate 8 B).

F-3 Plant height at maturity

Maximum plant height was attained by AA + H$_2$O$_2$ treated plants followed by AA, H$_2$O$_2$ and DW treatments respectively. Control plants showed minimum height at maturity. The increase in plant height was highly significant in the AA + H$_2$O$_2$ and AA spraying when compared with other treatments and control plants (Plate 9 A).

F-4 Total number of berries and yellow berries

The total number of berries recorded on average in the control plants was 160 which was the minimum production followed by H$_2$O$_2$ sprayed plants (150 berries/plant). The DW, AA and AA + H$_2$O$_2$ treatments showed an enhancement in the fruit production. Maximum berries per plant was recorded in the AA + H$_2$O$_2$ treated plants followed by AA spraying. The increase in yield was highly significant in AA + H$_2$O$_2$ and AA treatments respectively.

Exactly similar pattern was observed in the yellow fruit number and highest number was recorded in the AA + H$_2$O$_2$ treatment followed by AA spraying. No significant difference was observed in the yellow fruit number in control, DW and H$_2$O$_2$ treated plants. The H$_2$O$_2$ treatment
SOLANUM KHASIANUM CLARKE

A

B

C

D

PLATE-9
comparatively inhibited the yellowing process when compared with the DW sprayed plants. An increase in the ripened fruit number was highly significant in AA + H₂O₂ and AA treatments when compared with DW and H₂O₂ spray as well as control plants (Plate 9 B).

F-5 Fresh weight of different plant organs at maturity

Foliar application of AA + H₂O₂ and AA alone has an enhancing effect upon the growth of the plants which is clearly reflected on harvest. The plants receiving the AA + H₂O₂ and AA treatment showed the highest fresh weight of root, stem, leaves, branches, berries, including whole plant when compared with the corresponding organs in the other treatments and control plants (Plate 9 C). No significant difference in the root and stem fresh weight was observed in the treatments and control plants except AA + H₂O₂ treatments which showed a comparative increase only. The fresh weight of the branches significantly decreased by H₂O₂ treatment when compared with other treatments and control plants. An enhancement in branch fresh weight was observed in DW treated plants over control but it was not very significant. All the treatments increased the leaf and fruit fresh weight over control but fruit fresh weight was comparatively decreased when compared with DW sprayed plants.
A similar pattern was observed in the whole plant fresh weight accumulation as that of fruit in the different treatments and control plants.

F-6  Dry weight of different plant organs at maturity

Similar to the fresh weights of the different organs, in different treatments, the maximum dry matter production was observed in the AA + H₂O₂ treatment followed by AA spraying. Control plants showed the minimum dry matter accumulation of different organs e.g. root, stem, branches, leaves, berries and whole plant dry weight. No significant increase in dry matter accumulation of different organs was observed in DW and H₂O₂ treated plants but it was comparatively higher when compared with control plants. The dry weight of root, stem, leaves, and branches of DW treated plants did not show much difference when compared with the corresponding organs of the H₂O₂ treatment. The branch dry weight was significantly reduced by H₂O₂ treatment when compared with significantly reduced by H₂O₂ treatments. A similar inhibition in root and whole plant dry weight was also observed in H₂O₂ treatment when compared with DW treated plants. The DW sprayed plants showed promotion in root, stem, branches, leaves, fruit and whole plant dry weight over control. This promotion was highly significant in all the organs in AA + H₂O₂ and AA sprayed plants when compared with other treated and untreated plants (Plate 9 D).
F-7  Plants bearing fruits in different treatments on harvest

The treated and untreated plants were uprooted carefully, placed into the earthen pots and photographed from the same distance after removing the leaves on harvest. Plate - 10 clearly shows the enhancing effect on the fruit production as affected by the treatments over control.

Table - 2: Mean of periodic flowering (recorded five times in a month) of 10 plants from each treatment in Solanum khasianum Clarke

<table>
<thead>
<tr>
<th>Month</th>
<th>Control</th>
<th>DW</th>
<th>H₂O₂</th>
<th>AA</th>
<th>AA + H₂O₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>October</td>
<td>-</td>
<td>00.13</td>
<td>00.10</td>
<td>-</td>
<td>00.03</td>
</tr>
<tr>
<td>November</td>
<td>11.28</td>
<td>16.84</td>
<td>21.09</td>
<td>27.93</td>
<td>30.40</td>
</tr>
<tr>
<td>December</td>
<td>21.73</td>
<td>30.30</td>
<td>30.49</td>
<td>50.55</td>
<td>51.66</td>
</tr>
<tr>
<td>January</td>
<td>27.81</td>
<td>35.03*</td>
<td>32.57</td>
<td>58.61*</td>
<td>74.63</td>
</tr>
<tr>
<td>February</td>
<td>30.77*</td>
<td>31.97</td>
<td>33.74*</td>
<td>46.84</td>
<td>77.36*</td>
</tr>
<tr>
<td>March</td>
<td>17.92</td>
<td>22.73</td>
<td>27.71</td>
<td>38.28</td>
<td>66.07</td>
</tr>
<tr>
<td>April</td>
<td>07.34</td>
<td>12.92</td>
<td>18.96</td>
<td>20.69</td>
<td>37.10</td>
</tr>
</tbody>
</table>

* denotes maximum number of flowers
Table 3: Effect of different foliar treatments on mean Relative Growth Rates, Net Assimilation Rates and Leaf Weight Ratios in Solanum khasianum Clarke

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>Dm</th>
<th>H$_2$O$_2$</th>
<th>AA</th>
<th>AA + H$_2$O$_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGR</td>
<td>0.5609</td>
<td>0.4844</td>
<td>0.4700</td>
<td>0.5496</td>
<td>0.5643</td>
</tr>
<tr>
<td>NAR</td>
<td>1.8114</td>
<td>1.5698</td>
<td>1.5614</td>
<td>2.2290</td>
<td>2.4967</td>
</tr>
<tr>
<td>LWR</td>
<td>0.3354</td>
<td>0.3199</td>
<td>0.2952</td>
<td>0.2421</td>
<td>0.2120</td>
</tr>
</tbody>
</table>

Experiment II: Biochemical analyses during floral and berry development

A. Biochemical analyses during floral development

The activities of enzyme peroxidase, AA-PR-peroxidase, catalase, protease, invertase, RNase and the metabolites ascorbic acid and its utilization, ascorbigen, protein, sugars, nucleic acids, nitrogen and solasodine were estimated from the different stages of flower (Plate 11, Stages I to VI) and corresponding leaves in control and treated plants.

A-1 Ascorbic acid metabolisms

(a) Ascorbic acid (AA) content

There was a decrease in the concentration of ascorbic
SOLANUM KHASIANUM CLARKE
DIFFERENT STAGES OF DEVELOPING FLOWER

I  YOUNG BUD
II  DEVELOPING BUD
III  DIFFERENTIATING BUD
IV  DEVELOPING FLOWER
V  UNFERTILIZED FLOWER
VI  FERTILIZED FLOWER
acid in all the stages and corresponding leaves as compared to the young and developing buds in untreated plants, where free AA level was almost same. Treatment with DW resulted in a decline in the levels of AA in the stages I, II, IV and V of the floral development, whereas in all other stages, an increase was observed. There was an overall increase in the AA concentrations after H₂O₂ spraying in all the stages. The increase was very significant in the fertilized flower. The trend was more or less same in all the stages after treatment with AA alone as well as AA + H₂O₂. However, an increase was prominent after combined treatment with AA + H₂O₂ then H₂O₂ and AA treatments when sprayed alone especially in the stages III, V and VI and corresponding leaves (Plate - 12 A).

(b) Ascorbic acid utilization (AAU)

There was a gradual increase in AAU from stage I to III, thereafter a decline was observed during further floral development in control. DW spraying brought about an overall decrease in AAU except in the stages I, IV and V as corresponding leaves where an enhanced utilization of AA occurred as compared to the corresponding control stages. A fall in AAU was noticed after H₂O₂ treatment in the stages II, III, IV and V whereas in the stages I and VI as well as in corresponding leaves, the percentage of utilization increased significantly. Spraying with AA resulted in an
overall enhancement in the rate of AAU in all the stages except in the stages II and IV. This rate of AAU was more pronounced in the stages I, V and VI and in the corresponding leaves. The combined treatment with AA and H₂O₂ elevated the rate of AAU throughout the floral development and the leaves (Plate 12 B).

(c) Ascorbigen (ASG) content

The young bud had the highest amount of ascorbigen as compared to the other floral stages in control plants. DW treatment did not show any significant effect on the ASG levels except in the stage I and VI and in the leaves where a marked decline was noticed. The treatment with H₂O₂ and AA alone or in combination also brought about an overall decline in ASG content throughout the floral maintenance (Plate 12 C).

(d) Peroxidase activity

The young bud stage had more peroxidase activity as compared to the other stages in the control group. DW treatment brought about an overall increase in the enzyme activity except in the stage I. An increase was very significant in the corresponding leaves. In the H₂O₂ spraying plants, the trend in the enzyme activity was the same in all the floral stages as that of DW treated plants. However, an increase in the enzyme activity was much more significant
in \( \text{H}_2\text{O}_2 \) treatment then DW. The treatment with AA alone or with \( \text{H}_2\text{O}_2 \) also resulted in an overall elevation in the peroxidase activity throughout the floral development (Plate 13 A).

(e) AA-FR-peroxidase activity

In the control plants, the AA-FR-peroxidase activity increased gradually from stage I to III and the activity dropped in stage IV and again there was a gradual increase in the activity in stage V and VI of flower development. The corresponding leaves had the lowest activity. The treatment with DW, \( \text{H}_2\text{O}_2 \), AA and AA + \( \text{H}_2\text{O}_2 \) enhanced the activity in all the floral stages and in the corresponding leaves as compared to control values except in stage I of \( \text{H}_2\text{O}_2 \) treated plants and stage II and III of DW treated plants wherein a decline in the activity was noticed. The maximum activity was recorded in the fertilized flower in all the treatments. In the developmental stages of flower as well as corresponding leaves, the maximum enzyme activity was observed after \( \text{H}_2\text{O}_2 \) treatment (Plate 13 B).

(f) Catalase activity

In the control plants, a gradual decline was observed during the floral development. On the contrary, the highest activity was found in the corresponding leaves. DW treatment resulted in an enhancement in the catalase activity except
H₂O₂ spraying brought about an increase in the activity except in stage II and corresponding leaves. In AA and AA + H₂O₂ treated plants, the catalase activity increased significantly in all the stages of floral development and corresponding leaves. Among all the stages of floral development, the maximum activity was recorded in stage I by AA + H₂O₂ treatment (Plate 13 C).

A.2 Protein metabolism

(a) Protein content

The level of protein decreased from stage I to IV but increased in the stage V and again declined in stage VI of the control plants. The corresponding leaves had the highest concentration of protein. The treatment with DW elevated the protein levels in the stage I of floral development and the corresponding leaves in comparison to respective control values. In stage V and VI, a decrease in protein concentration was observed, which was very significant in stage V. When all the six stages of the floral development in DW treatment are compared for their protein content, the trend was more or less similar to that of control plants. H₂O₂ spraying resulted in an increase in the protein levels of the stage I, II and corresponding leaves whereas in the other stages, there was steep decline. In the AA sprayed
plants, the protein concentration increased in stage I and corresponding leaves whereas it declined in the stages II, III and V, but the values were almost the same as the control in the stages IV and VI. After the combined treatment with AA + H₂O₂, the protein content in the first four stages (stages I to IV) and corresponding leaves was almost same as the respective control values, thereafter a significant decline was observed. In all these treatments, the trend in the protein levels was almost same i.e. the concentrations decreased from stage I to IV with their elevation in stage V and a decline in stage VI were observed (Plate 14 A).

(b) Protease activity

The protease activity progressively decreased from floral stage I to IV and again an increase was observed in stage V with a decrease in stage VI of control plants. Corresponding leaves showed the highest protease activity. DW spraying enhanced the protease activity in stages II, III and VI when compared to the corresponding floral stages in control plants. A decrease in the protease activity was observed in stages I, IV and V with the decrease in corresponding leaves. H₂O₂ treatment significantly increased the protease activity in flower stage I when compared to the corresponding stage in all other treatments except in
SOLANUM KHASIANUM CLARKE

A

STAGES OF DEVELOPING FLOWER

PROTEASE ACTIVITY-MG TYROSINE PRODUCED/HP/GW RV

PLATE-14
AA + H₂O₂ spraying. The activity showed a decline in stage II with an increase in stage III and again it decreased on further floral development. The enzyme activity in the stages IV, V and VI maintained almost the same level. Corresponding leaves showed minimum enzyme activity when compared with all other treatments. There was a continuous increase in the protease activity from stages I to IV and VI, except a decline in stage V in AA treatment. The highest protease activity was recorded in the stages IV, V and VI of AA treatment when compared with other treatments and control. The corresponding leaves showed a significant decline in protease activity when compared with AA + H₂O₂, control group and DW sprayed plants. The highest protease activity was recorded in the stage I of the AA + H₂O₂ treatment, which significantly decreased in stage II followed by an increase in the stages III and V respectively. In the stage IV, the AA + H₂O₂ treatment showed the minimum protease activity. The protease activity in stage VI was at the same level as that of in stage II. The maximum protease activity was recorded in corresponding leaves of the AA + H₂O₂ treated plants (Plate 14 B).

A-3 Sugar metabolism

(a) Reducing sugar content

The levels of reducing sugars dropped in the stage III of the flower development which again increased in the
stages IV, maintained an almost the same level in the stage V and rapidly declined in the stage VI of the control plants. However, the highest concentration was noted in the corresponding leaves of the control plants. The DW treatment reduced the sugar levels in the stages I, II, III, V, and VI of flower as well as corresponding leaves when compared with the control plants. On the contrary, the concentration was very high in stage IV as compared to control value. The H₂O₂ treatment resulted in a decline in the stage I and II whereas a significant elevation was noted in the stage III. In the stages IV and V, the levels were almost same as that of control values. Minimum content of reducing sugars was observed in the stage VI of the H₂O₂ treatment when compared to the other floral stages as well as treatments. Ascorbic acid spraying did not alter the levels of reducing sugars in the first two stages of flower (young bud and developing bud) from the control levels. On the other hand, in the stages III to V, the concentration of reducing sugars increased over control and a peak value was obtained in the stage IV of the floral development. The content of reducing sugars showed a significant decline from stage IV to VI. The AA + H₂O₂ treatment reduced the levels of reducing sugars in the floral stage I and II when compared with control but soon after it increased attaining the maximum value in the stage IV. Similar to AA treatment, it showed a
significant decline from stage IV to VI. All the treatments brought about remarkable decline in sugar levels of the corresponding leaves when compared with control. The corresponding leaves of AA, H₂O₂ and DW treated plants showed a respective decrease over control. Minimum reducing sugar content was recorded in the leaves of the AA + H₂O₂ treatment. When looked into the graph (Plate 15 A), the content of reducing sugars in different stages of flower showed a general trend in all the treatments and control ones i.e. the reducing sugars increased from stage I to IV and then declined. The increase was maximum in the stage IV in all the treatments.

(b) Total sugar content

Exactly, a similar pattern was observed in the content of total sugar at various stages of floral development and corresponding leaves as that of reducing sugar in all the treatments and control plants. In the control plants, a decrease was noted in the level of total sugars from stage I to III and then its concentration increased in the stage IV with a decline in the stages V and VI respectively. The highest concentration of total sugar was noticed in the corresponding leaves of the control plants. The DW treatment decreased the sugar content in the stages I, III, V and VI of the flower whereas a steep rise in the content was
SOLANUM KHASIANUM CLARKE

PLATE-15
observed from stage III to IV. The increase was highly significant over control. The H₂O₂ spraying brought about a drop in the content of total sugar in the stages I, II and VI when compared with the corresponding stages of control plants. The decrease was highly significant in the stage II and VI. In other stages, the levels of total sugar were almost equal to that of control values. At the initial floral stages (stage I and II), the total sugar content decreased by AA spraying with a similar follow up in the stage V and VI as compared to control values. In other stages, it was either elevated and remained same as control values. The combined treatment with AA and H₂O₂ brought about a drop in the total sugar content only in the first two stages of flower (young bud and developing bud) whereas in all other stages, there was an increase. All the treatments, significantly reduced the total sugar content in the corresponding leaves, being the minimum in AA + H₂O₂ treatment. There was a general increase in the sugar content in all the treatments from stage I reaching to maximum in the stage IV (Developing flower) and followed by a fall reaching to minimum in the fertilized flower. The increase was very steep from stage III to IV and a significant decline was discernible from stage IV to VI in general (in all the treatments and control plants) (Plate 15 B).
(c) Invertase activity

Maximum invertase activity was recorded in the stages IV and VI followed by V in control plants. Stage II and III showed the same level in the enzyme activity whereas minimum activity was recorded in flower stage I of the control plants. The corresponding leaves of the control plants also showed the minimum enzyme activity. There was an increase in the activity of invertase from stage I to II in DW sprayed plants followed by a significant decrease in the stage III. A continuous increase in the enzyme activity was observed from stage III to VI but the overall activity was less when compared with control plants. The increase in the activity was very significant in the stage I and II as well as corresponding leaves with respective to control stages. \( \text{H}_2\text{O}_2 \) treatment showed a gradual increase in the enzyme activity from stage I to stage IV with the decline in the stages VI and V respectively. The increase was very significant in the stages I, II and III when compared with the corresponding stages of control plants. The corresponding leaves in the \( \text{H}_2\text{O}_2 \) treated plants showed a significant increase over other treatments and control plants but not when compared with DW treated leaves. There was an upsurge in the activity of enzyme in the stage II of AA treatment than the stage I. The activity was decreased in
the stage III which maintained the same level in the stage IV and V. Although there was an increase in the enzyme activity in the stage VI of AA treated plants over control but it was not very significant. The corresponding leaves of AA treated plants showed a similar activity as that of DW treatment, but it was highly significant over control. AA + H₂O₂ treatment showed a significant increase in the enzyme activity in the floral stage II when compared with the stage I and corresponding stages of control plants. A consecutive increase in the enzyme activity was observed from stage II to IV with a simultaneous decrease up to stage VI. There was significant decrease in the stage IV of AA + H₂O₂ treated plants when compared with the H₂O₂ treatment and control stage respectively. The combined treatment of AA and H₂O₂ showed a more or less similar pattern in the enzyme activity throughout the floral development as that of AA treatment. The enzyme activity in the leaves of AA + H₂O₂ treatment and H₂O₂ sprayed plants did not differ much from each other similar to that of DW and AA treatments but increase was highly significant when compared with the control plants (Plate 15 C).

A-4 Nucleic acid metabolism

(a) RNA content

An increase in the RNA content was observed from stage
I to stage III, thereafter it showed a progressive decline up to stage VI. The increase in the RNA content was highly significant in the stage III and corresponding leaves. DW treatment showed a significant decline in RNA content in the stages I, III, IV and V when compared with the corresponding stages of control plants. Although there was an increase in the RNA content of stage II over that of corresponding control stage but this increase was highly significant in the fertilized flower. The RNA content was higher in the corresponding leaves of DW treated plants when compared with control plants. H$_2$O$_2$ treatment showed a significant decline in the stages I, III, IV and VI of the floral development and corresponding leaves when compared with the corresponding stages and leaves in different treatments and untreated ones. Although stage II and V registered an increase in the RNA content over corresponding stages of H$_2$O$_2$ and DW treatment, but it was not significant. The RNA content decreased from stage I to stage II, thereafter a rapid increase was observed reaching to maximum in the stage III (differentiating bud). AA treated plants showed higher levels of RNA content in the stage III, IV, V and VI of flower when compared with the corresponding stages of control, DW and H$_2$O$_2$ treated plants. The increase in RNA content was highly significant in the floral stage II to III. Maximum levels of RNA content
were recorded in all the floral stages of $AA + \text{H}_2\text{O}_2$ treatment. Similarly, the leaves corresponding to flowers in $AA + \text{H}_2\text{O}_2$ and AA treatment showed the maximum RNA content respectively. The leaves in DW sprayed plants, although showed a comparative increase in the RNA content over control but it was very significant in $AA + \text{H}_2\text{O}_2$ and AA treatments. The $\text{H}_2\text{O}_2$ treated plants showed the minimum RNA content in the leaves. The pattern of changes in RNA content during floral development of control plants was very similar to that of DW trend while $AA + \text{H}_2\text{O}_2$ treatment showed much more resemblance in the trend of RNA content as that of AA treatment. Looking into the RNA curves, it was observed that there was a increase in general from stage I and a peak value was attained in the stage III, there after a general decline was noticed. The enhancing effect on RNA content are well documented in $AA + \text{H}_2\text{O}_2$ and AA treatments (Plate 16 A).

(b) DNA content

A decrease in the DNA content was observed from stage I to stage III and followed by a sharp rise reaching maximum in unfertilized flower of the control plants. The DNA content was significantly decreased on fertilization of flower (stage VI). The DNA content in the floral stages of DW sprayed plants showed an exactly opposite trend when compared with control stages. The DNA content in the stages
SOLANUM KHASIANUM CLARKE

PLATE-16
I, II, IV and V of DW sprayed plants showed lower levels when compared with the corresponding stages of control plants. The increase was highly significant in the stage III and VI of DW treatment over control. The $H_2O_2$ treatment showed a trend in the DNA content which was very similar to that of DW treated plants. An enhancement in the DNA content was observed by $H_2O_2$ spraying in all the floral stages when compared with the corresponding stages of control plants and DW treatment. DNA trend in $H_2O_2$ treatment was exactly opposite when compared with the DNA contents of control plants. A gradual increase was observed in the DNA content of floral stages of AA treated plants, reaching maximum in fertilized flower. The DNA contents were higher at almost all the stages of floral development when compared with the $H_2O_2$, DW and control plants in general. The increase in DNA as affected by AA treatment was highly significant in the stages III, IV and VI over corresponding stages of control plants. A close similarity in the trend of DNA content was observed with that of $H_2O_2$ and DW treated plants. The DNA content increased rapidly from stage I to stage III with a sharp decline in the stage IV of the $AA + H_2O_2$ treatment. The $AA + H_2O_2$ treated plants maintained the highest DNA levels throughout the course of floral development when compared with other treatments and control plants. The increase in DNA level was highly significant at
stage III (differentiating bud) in particular. In the stage VI, the DNA content as affected by AA spraying showed marginal increase over combined treatment but it was not very significant. No significant difference was observed in the DNA content of the leaves of H₂O₂ and DW treated plants, but both these treatments showed an increase in DNA content over control. Similar to this, the DNA content in the leaves of AA and AA + H₂O₂ treatments did not show any variation but the DNA contents were significantly higher when compared with the DNA content of H₂O₂ and DW treated as well as control plants. Viewing the DNA trends in every case, it has been observed that treated plants attained the higher DNA levels earlier which is delayed in the control plants. In general, the DNA concentrations were higher in the differentiating bud and fertilized flower except in control plants which showed an abnormal behaviour (Plate 16 B).

(c) RNase activity

Control plants showed the minimum RNase in the stages I, II and III of flower when compared with the corresponding stages of other treatments. No significant difference was observed in the enzyme activity in the stages I to IV of the control plants but the activity was maximum in the stages V and VI over all other treatments. Minimum enzyme activity was recorded in the corresponding leaves of the control plants with respective to other treatments. The enzyme
activity in the floral stages of DW sprayed plants showed a wavy trend i.e. alternate decrease and increase. There was significant increase in the enzyme activity at all the floral stages by foliar application of DW when compared with control plants. DW treated leaves showed the maximum enzyme activity when compared with control and other treatments. The maximum levels of Mase activity was recorded in the stages I, II, III and IV of the H₂O₂ treated plants when compared with other treatments and control set. The H₂O₂ spraying showed minimum enzyme activity in the stage V. There was an increase in the activity from floral stage V to VI but it was only marginal. The enzyme activity was significantly higher in the leaves of H₂O₂ treated plants when compared with control. The AA treatment showed a gradual decline in the enzyme activity from stage I to V reaching to minimum in the stage VI (fertilized flower). The activity was significantly higher in the stages I to IV when compared with corresponding stages of control plants except in the stages V and VI where activity was significantly decreased. The activity in the corresponding leaves was significantly higher when compared with control plants but not with the treatments. A marked increase was observed in the enzyme activity in the stage I and II of the AA + H₂O₂ treatment when compared with the corresponding stages of control plants. The activity was decreased in the stage III and came down to
the same level in the stage IV as that of control plants. Again, an enhancement in the enzyme activity was recorded from stage V to VI but it was significantly low when compared with the corresponding stages of control plants. The AA + H₂O₂ treatment influenced the enzyme activity in the leaves significantly over control set. No significant difference in the enzyme activity was observed when compared with AA and H₂O₂ treatment but it was significantly low over DW treatment. On comparison of the enzyme activity among the stages of the treatments, initial stages of flower maintained higher levels of enzyme activity when compared with the later stages of floral development (Plate 16C).

A-5 Solasodine content

The solasodine content increased from stage I to II with a rapid increase in the stage III, thereafter it maintained an almost the same level in control plants. The solasodine content was significantly higher in the later stages (stage III to VI) of floral development. The corresponding leaves of control plants showed a significant increase over AA + H₂O₂, H₂O₂ and AA treatments. The highest solasodine content was recorded in the corresponding leaves of DW sprayed plants. DW sprayed plants showed a progressive increase in the solasodine content, reaching to maximum in the stage IV, thereafter a highly significant decline was observed from stage V to VI. The stage IV and V
showed the maximum solasodine content when compared with the other stages of the same treatment. No significant difference was observed in the content of solasodine when compared with the control stages. The H2O2 treatment showed an abnormal trend in the solasodine content when compared with the trends of other treatments and untreated ones. The solasodine content slightly increased from stage I to II thereafter it was decreased significantly in the stages III and IV. Again, an increase in the content of solasodine was recorded in stage V following a decline in stage VI. Minimum solasodine content was observed in the stage III and IV of the H2O2 treatment when compared with the other stages, other treatments and control plants except in the stage VI where DW sprayed plants showed the minimum content of solasodine. The solasodine content decreased significantly in the corresponding leaves by H2O2 treatment when compared with control and DW sprayed plants. The H2O2 and AA treated leaves did not show significant difference in their solasodine content. A gradual increase in the content of solasodine was observed in the initial stages of floral development, reaching to maximum in the stage IV (developing flower) thereafter it was significantly decreased in the stage V with a marginal rise up in the stage VI (fertilized flower). The AA treated leaves showed a significant decrease in solasodine content over DW sprayed and control plants. The
AA + H₂O₂ treated leaves recorded the minimum solasodine content. The solasodine content progressively increased from stage I to IV and a peak value was obtained in the stage IV when compared with the corresponding stages of other treatments and control plants. The increase in the solasodine content was very significant in the stages I to IV when compared with the corresponding stages of control and DW sprayed plants. The solasodine content was rapidly decreased in the stage V with a marginal increase in the stage VI. A gradual increase in the solasodine content was observed from stage I to stage IV in all the treatments and control plants except in the H₂O₂ treatment which showed an inverse trend. The treatments AA + H₂O₂ and AA enhanced the solasodine production in the initial stages of floral development respectively while these treatments have an inhibiting effect in case of leaves. This inhibition was much more significant in the later part of the floral development of H₂O₂ treatment (Plate 17 A).

A-6 Nitrogen content

The percentage of nitrogen content decreased gradually and reached to the minimum in the stage VI of the control plants. The stage I depicted the highest nitrogen content when compared with the other treatments and untreated ones. More or less similar pattern was observed in the content of nitrogen in DW treatment as that of control
SOLANUM KHASIANUM CLARKE

PLATE-17
plants except that the decrease in nitrogen was highly
significant in the stages IV, V and VI when compared with
the corresponding stages of control plants. No significant
difference was observed in the content of nitrogen in the
_corresponding leaves of control and DM sprayed plants. The
$H_2O_2$ treatment showed a progressive increase in the nitrogen
content from stage I, reaching to maximum in the stage VI.
The depicted trend of the nitrogen in the $H_2O_2$ treatment
was exactly opposite in the initial stages of floral development
(stages I to IV) when compared with the corresponding stages
of other treatments and control plants. The $H_2O_2$ treated
leaves showed an increase in the nitrogen content over
control but this increase was not very significant. No
significant difference was observed in the content of nitrogen
in the leaves of $H_2O_2$ and AA + $H_2O_2$ treatments. The nitrogen
content in the initial stages (stages I to III) of floral
development of AA treatment showed a marked inhibition over
that of control but it proceeded more or less in the similar
fashion as that of control plants at the later stages. A
significant decrease in the nitrogen content of leaves was
observed by AA spraying when compared with other treatments
and control plants. The levels of nitrogen were low in
the stage I then compared with the control stage and corres-
ponding stages of DW and AA sprayed plants respectively.
Minimum levels of nitrogen were recorded in the $H_2O_2$ treatment.
On progressive floral development i.e. in the stages II, III, IV and VI, the levels of nitrogen were significantly dropped down in comparison to other treatments and control plants.

To review the overall impact on the nitrogen content by treatments, there was a decline in nitrogen levels starting from stage 1 to VI in all the treatments and control plants except $H_2O_2$ treatment where an increase was discernible at the initial stages of flower. The treatments $AA$ and $AA + H_2O_2$ showed an inhibition in the content of nitrogen at the initial stages of floral development when compared to the control and $DW$ treated plants. This inhibiting effect continued in $AA + H_2O_2$ treatment on onward floral development while it had been shifted to higher levels in the $AA$ treatment. The levels of nitrogen were always higher in the corresponding leaves than that of their contents in the floral stages of the corresponding treatments (Plate 17 B).

B. Biochemical analyses during berry development

The activities of enzyme peroxidase, $AA-PR$ peroxidase, catalase, protease, invertase, RNase and the metabolites ascorbic acid and its utilization, ascorbigen, protein, sugars, nucleic acid, nitrogen and solasodine were estimated from the different stages of berry (Plate 18, stage 1.0 cm to 3.0 cm/20-90 days after fertilization) and berry parts (Plate 19, berrywall and fruit pulp) in control and treated plants.
DEVELOPING BERRIES OF SOLANUM KHASIANUM

PLATE-18
B-1 Ascorbic acid metabolism

(a) Ascorbic acid (AA) content

No clear trend was observed in the content of AA in the berry wall at different stages of berry in control plants. The AA contents were at higher levels at 40, 60, 80 and 90 days of berry growth. Maximum content of AA was recorded in young berry walls of DW treated plants which suddenly dropped to minimum level at 30 days. Again an upsurge in the AA content was observed at 40 days, which was decreased in fully developed green berries. At the commencement of the berry's maturity, the AA content increased rapidly and reached to the maximum at 90 days. The contents of AA were significantly higher at 20, 40, 50, 70, 80 and 90 days of berry growth when compared with corresponding stages of control berries. The AA content increased in the berry wall of the H₂O₂ treatment and attained the higher value at 40 days of berry growth thereafter it showed a gradual decline reaching to lower level at 70 days. The maximum level of AA content was recorded in the ripening yellow berries (80 days old). The H₂O₂ treated berry walls of the berries at various stages registered the over all lower contents of AA when compared with other treatments and control berries. The AA content in the berry walls of the AA and AA + H₂O₂ sprayed plants did not show any significant change at all the stages of berries. Both these treatments, maintained
The AA content increased significantly higher at 70 and 80 days of berry growth in both these treatments when compared with other treatments and control berries (Plate 20 A). In general, higher levels of AA content were recorded at the stage when berry becomes fully matured. The AA content in the fruit pulp was significantly high in the young stages in all the treatments reaching to minimum at the stage (diameter - 3.0 cm/turning yellow/70 days old) from where the phase of maturation starts. Once again the content of AA increased and attained a peak value in the fruit pulp of the fully matured yellow berries. A decline was observed in the content of AA in over ripened berry (90 days old) in all the treatments. There was no significant difference in the trends of AA content in different treatments before maturation but at the onset of ripening divergences were clearly discernible. Higher values of AA content were attained by DW treated berries followed by H$_2$O$_2$, AA + H$_2$O$_2$, and AA respectively over control at 80 days of fruit growth. The rate of declination of AA content was very fast in AA + H$_2$O$_2$ and AA treated plants respectively.
when compared with other treatments except control plants. The decline in the content of AA in the stages of control berries was highly significant (Plate 20 B).

(b) Ascorbic acid utilization (AAU)

The utilization of AA was very high in young berry walls generally in all the treatments which rapidly decreased and reached to the minimum in fully ripened yellow berries of 80 days of age. Thereafter, a marginal increase was recorded in the utilization of AA in overmatured berries (golden yellow/90 days old). The utilization rate was very high in young berry walls of AA + H₂O₂ and AA sprayed plants respectively. A close resemblance was observed in the utilization trend of AA + H₂O₂, AA and H₂O₂ treatments while DW treatment showed more similarity with the control. Berries of control plants showed minimum AA utilization throughout the berry development (Plate 20 C).

The ascorbic acid utilization increased in the fruit-pulp with the berry age and attained the higher values in mature green and turning yellow berries in DW, AA + H₂O₂ and AA sprayed plants respectively. The utilization again shoots up in the golden berries after a fall in the yellow ones (80 days old) and in the above treatments (Plate 20 D). The rate of utilization of AA was minimum and very slow in control plants during berry development. When compared with other treatments. The DW, AA + H₂O₂ and AA sprayed plants
showed the maximum AA utilization respectively. At the stages where low levels of ascorbic acid content were recorded, always indicated the higher utilization. The content of AA and its utilization are thus negatively related during berry development.

(c) Ascorbigen (ASG) content

The highest ascorbigen content was recorded in the young berry walls in all the treatments. Maximum ASG content was found in the berry walls of AA + H₂O₂ treated and control berries followed by AA and H₂O₂ treated plants. No ascorbigen was recorded in the 20 days old DW treated berries. Similarly, 30 and 40 days old berries of control plants did not show any amount of ascorbigen. The content of ascorbigen increased significantly in the 70 days-turning yellow berries which marked the beginning of the saturation phase. Control berries showed a continuous decline on further maturation. A balanced turnover of ascorbigen was noted in the berry walls of the DW treated plants throughout berry development. The higher content of ascorbigen was recorded in the very young berry walls (20 days old) of H₂O₂ treatment which was decreased and maintained a same level in 30 and 40 days old berries. No ascorbigen content was recorded at 50, 60, 70 and 80 days of berry growth but it was significantly increased in over ripened (golden yellow berries). Maximum content of ascorbigen was recorded at two
stages of berry development in AA treated plants i.e. one at just after berry formation (20 days young berry) and another just at the stage from where phase of ripening begins (70 days-turning yellow berry). The ascorbigen content significantly decreased up to the 50 days of berry growth and it acquired the higher values just before and after the phase of maturation starts i.e. at 60 and 70 days of berry growth. Further maturation marked a comparative decrease in the ascorbigen content. Young berry wells of AA + H₂O₂ treated plants showed the highest ascorbigen content which declined in 30 and 40 days of berry growth. Again a significant increase in the content observed at 50 days and thereafter it decreased and maintained almost the same level. Minimum ascorbigen content recorded in the over ripened berries (goldent yellow) when compared with the other stages of the same treatment (Plate 21 A). No ascorbigen content recorded in the fruit pulp of 20, 50, 80 and 90 days old berries in control plants. Fully mature green berries showed the maximum ascorbigen content in the fruit pulp which decreased in ripening berries. The fruit pulp of the berries (20 days to 80 days old) did not mark any ascorbigen content except that a marginal increase in the golden yellow berry (90 days old). The young fruit pulp of the 20 days old berry and the berry which had started the ripening (turning yellow) showed a maximum ascorbigen content in H₂O₂ treated plants. The stages other than these two did not record any ascorbigen
SOLÀNUM KHASIANUM CLARKE

A

BERRY WALL

STAGES OF DEVELOPING BERRY

PLATE-21

B

FRUIT-PULP

STAGES OF DEVELOPING BERRY

PLATE-21
content. AA treatment affected the production of ascorbigen and it was observed that the content was higher in young fruit pulp and other stages maintained the same level of ascorbigen content. No content of ascorbigen was recorded in the fruit pulp of 30 and 40 days of old berries. The content of ascorbigen increased with the age of the berry and attained the two peak values at the age of 40 and 60 days in AA + H₂O₂ spraying. No remarkable difference was observed in the content of ascorbigen in the stages of ripening berries (yellow and golden yellow) but it was declined significantly when compared with the turning yellow berry (70 days old). The AA + H₂O₂ treated plants showed the maximum ascorbigen content in the fruit pulp throughout the berry development. Ascorbigen content in berry wall can be negatively correlated with that of fruit pulp in the corresponding stages and treatments (Plate 21 B).

(d) Peroxidase activity

Higher levels of peroxidase activity were recorded in the berry walls of young berries (20 days old) in all the treatments with faster decline in fully matured (yellow-80 days old) and over matured berries (golden-90 days old). Maximum activity of enzyme was observed in the young berry walls of the AA + H₂O₂ treated plants followed by AA, H₂O₂ control and DH treated plants, respectively (Plate 22 A). Maturing stages of berry showed lower levels of enzyme
activity in the treatments when compared with control stages. The increase in the enzyme activity was highly significant in the young berry walls of 20, 30 and 40 days of old berries of AA + H$_2$O$_2$ treated plants when compared with control plants. The treatments did not affect much the enzyme activity at saturation stages when a comparison was made among them. More or less the same level in the enzyme activity was observed at all the stages of berry in control plants. The AA + H$_2$O$_2$ and AA treatments showed the highest rate of declination in the enzyme activity and reached to the minimum in the turning yellow (80 days old) and golden yellow (90 days old) berries. H$_2$O$_2$ treated plants showed more similarity in the trend of enzyme activity with that of DW treatment throughout the berry development.

Similarly to the pattern of enzyme activity in the berry wall at different stages of berry, the higher levels of enzyme activity were recorded in the fruit-pulp of the young berries (20, 30 and 40 days old) in all the treatments. The levels further rapidly declined and reached to the minimum at saturation i.e. in the turning yellow, yellow and golden yellow berries. Exception to this, there was an increase in the enzyme activity from 20 to 30 days old berry which decreased to the minimum at the age of 50 and a continuous and significant rise up in the activity was observed up to complete maturation. AA + H$_2$O$_2$ and AA
treated plants showed the maximum enzyme activity in the fruit-pulp of the young berries when compared with the other treatments and control stages. Although a decline was discernible in the enzyme activity of the fruit pulp of DW and H₂O₂ treated plants similar to other treatments but it showed two peak values in the enzyme activity at the age of 60 and 70 days respectively. This increase was significantly higher when compared with corresponding stages of AA and AA + H₂O₂ treatments but not by control. AA + H₂O₂ treatment showed more close affinity in the trend of the enzyme activity to that of AA treatment while DW treated plants with that of H₂O₂ treatment. Similarly when a overall comparison was made in the enzyme activity of the treatments, the berry wall activity could be matched to that of fruit pulp except that of control plants (Plate 22 B).

(e) AA-FR-peroxidase activity

In berry wall, the AA-FR-peroxidase activity increased with the progressive berry development reaching to maximum in the fully matured ripened berry (80 days old) in all the treatments as well as control stages. The activity was decreased in over matured berries (golden-yellow-90 days old). The enhancement in the activity of the enzyme was observed at maturation phase then the prematuration stages in general i.e. in all the possible critieries (Plate 22 C). The maximum activity of the enzyme was observed in the berry
wall at the age of 20, 30, 40 and 50 days berry in AA treatment followed by control, \( AA + H_2O_2 \) and DW treatments. \( H_2O_2 \) treated plants showed the minimum enzyme activity at all these stages. The increase in the activity was significantly higher in AA treatment when compared with control stages and other treatments. The spraying by \( AA + H_2O_2 \) and AA indicated the higher enzyme activity in the yellow berry followed by control, DW and \( H_2O_2 \) treatments. The increase in the enzyme activity was very steep when berry turned from green to yellow.

The enzyme activity increased in the fruit pulp with the increase in berry age and generally attained the peak values in the one or two stages (30 and 40 days) prior to the completion of the fruit growth in the \( AA + H_2O_2 \), AA and DW treated plants. While an uneven trends in the activity of enzyme were observed in the control stages and in the stages of \( H_2O_2 \) treated plants. No definite conclusions could be made except that the activity was significantly enhanced by the \( AA + H_2O_2 \) and AA spraying and higher levels of the activity were maintained throughout the berry development. The activity in the over matured berries (90 days old) decreased generally in all the treatments (Plate 22 D).

(f) Catalase activity

Maximum catalase activity was recorded in the young berry walls (20 days old) generally in all the treatments.
and control plants. The enzyme activity was rapidly decreased and reached to the minimum in the fully developed green berries. No enzyme activity was recorded during the phase of ripening (Plate 23 A). When a treatment wise comparison made, the 20 days old DW treated berries showed the highest catalase activity followed by $\mathrm{H}_2\mathrm{O}_2$; AA and control plants. $\mathrm{AA} + \mathrm{H}_2\mathrm{O}_2$ treated plants showed the minima in the enzyme activity. The rate of decline in the enzyme activity was highly significant and steep during 20 to 40 days of berry growth. Similar to the berry wall activity, the enzyme activity in fruit pulp showed its highest levels in the 20 days old berries, rapidly decline at the age of 30 and thereafter maintaining more or less the same level, it was suddenly increased and attained the peak value just before the phase of ripening starts in all treatments and control stages (Plate 23 B). In the fruit pulp of the youngest berry, the DW treated plants showed a marked enhancement in the enzyme activity followed by $\mathrm{H}_2\mathrm{O}_2$; AA treatments and control stages, minimum enzyme activity was recorded in the $\mathrm{AA} + \mathrm{H}_2\mathrm{O}_2$ treated plants. A marked inhibition was observed in the activity of enzyme by $\mathrm{AA} + \mathrm{H}_2\mathrm{O}_2$ spraying throughout the berry development. The $\mathrm{H}_2\mathrm{O}_2$ spraying also depicted the same pattern in enzyme activity. At the stage (fully developed green berry) just before the beginning of the ripening phase, the DW treated plants showed the maximum
SOLANUM KHASIANUM CLARKE

A

BERRY WALL

CATALASE ACTIVITY - ML2 evaporated/min. DAIRY WT

DIAMETER 1.0 1.5 2.0 2.5 3.0 3.5 CM

COLOUR G G G TY Y GY

STAGES OF DEVELOPING BERRY

FRUIT - PULP

CATALASE ACTIVITY - ML2 evaporated/min. DAIRY WT

DIAMETER 10 15 20 25 30 35 40 CM

COLOUR G G G TY Y GY

STAGES OF DEVELOPING BERRY

PLATE-23
enzyme activity followed by $H_2O_2$ and DW treatments respectively. Minimum enzyme activity was observed in the AA and combined treatment of AA with $H_2O_2$. Based on the stage wise comparison, the maturing stages (yellow, turning yellow and golden yellow) showed the minimum levels of enzyme activity.

3-2 Protein metabolism

(a) Protein content

The maximum protein content was recorded in the walls of the young berries (20 days old) in all the treatments. The protein content decreased rapidly with the increase in the berry age reaching to minimum in the fully matured yellow berries (60 days old) in all the treatments. A comparative increase in the protein content was observed in the walls of the over matured (golden) berries. At the young stage, the treatments significantly inhibited the protein content when compared with control. The highest protein content was shown by the control stages followed by DW, $H_2O_2$ and AA + $H_2O_2$ treatments. AA treated young berries recorded the minimum protein content. The rate of decline in the protein content was very steep in $H_2O_2$, AA and AA + $H_2O_2$ treated plants respectively. The changes in the protein content during different stages of berry development of DW treated plants showed a more or less the same pattern as that of control while AA treated berries
showed more similarity with the \( \text{H}_2\text{O}_2 \) treatment (Plate 24 A). The changes in the protein content by \( \text{AA} + \text{H}_2\text{O}_2 \) spraying registered an intermediate trend. No significant changes in the protein content were observed among the stages of the age 60, 70 and 80 days of the same treatment and untreated berries except that treated plants showed significantly lowest levels of protein when compared with control and DM treated plants.

An exactly opposite trend was observed in the protein content in the fruit pulp to that of berry wall in general i.e. in all the treatments. The protein content was at lower levels in the fruit pulp of the young berries which increased rapidly with age and reached to the maximum in fully matured yellow berries (80 days old) in all the treatments. The protein content was decreased in the fruit pulp when berry turned golden yellow (80 days to 90 days).

The spraying by AA and \( \text{H}_2\text{O}_2 \) separately showed significant decrease in the protein content of the fruit pulp over control and DM treated plants but when combined treatment was given, the protein levels increased significantly and the highest levels of protein were maintained by \( \text{AA} + \text{H}_2\text{O}_2 \) treatment at all the stages of berry development (Plate 24 B). The trend of protein content in AA was more close to the trend of \( \text{H}_2\text{O}_2 \) while DM treated berries showed close affinity with the control trend. The increase in the protein content
SOLANUM KHASIANUM CLARKE

PLATE-24
was significantly high in the AA + H₂O₂ spraying when compared with other treatments and control stages.

(b) Protease activity

Young berry wall (30 days old) showed the maximum protease activity which was decreased in 40 and 50 days old berries with a rise up in 60, 70 and 80 days of berry growth in control plants. The least enzyme activity was recorded by fully ripened yellow berries. Control stages experienced the lower levels of enzyme activity when compared with the activity of other treatments. Treatment by AA and H₂O₂ separately did not affect much the enzyme activity except at the age of 40 days, where the activity was tremendously increased by H₂O₂ spraying.

DW treated plants showed a comparative increase in the enzyme activity of berry wall at various stages when compared with H₂O₂ and AA treated plants. Maximum enzyme activity was recorded in the berry walls of AA + H₂O₂ treated plants throughout the berry development when compared with other treatments and control stages (Plate 24 C). The enzyme activity increased in the fruit pulp with the increase in the age and reached to the maximum in the fully matured yellow berries (80 days old) thereafter a decline was observed in the golden yellow berries (90 days old) in all the treatments. The lower levels of enzyme activity were
discernible at all the stages of the berry growth in the control and \( \text{H}_2\text{O}_2 \) treated plants except during ripening and at the stage of yellow berry where \( \text{H}_2\text{O}_2 \) spraying enhanced the activity significantly. A significant increase was observed in the enzyme activity of the fruit pulp generally at all the stages of berry development by \( \text{AA} \) spraying when compared with the control stages. Although lower levels of the enzyme activity were shown by \( \text{AA} \) and \( \text{H}_2\text{O}_2 \) treatments when sprayed separately, but when combined, the activity was tremendously increased and the highest levels of enzyme activity in the fruit pulp was observed at all the stages of berry growth in the \( \text{AA} + \text{H}_2\text{O}_2 \) treatments and these levels of the enzyme activity were maintained throughout the berry development (Plate 24 D). When a comparison was made among the fruit parts, a negative correlation in the enzyme activity of berry wall to that of fruit pulp was observed generally in all the treatments.

B-3 Sugar metabolism

(a) Reducing sugars

The content of reducing sugars in the berry wall increased with the berry age and reached to the maximum in the matured and over matured berries generally in all the treatments. Exception to this, \( \text{AA} + \text{H}_2\text{O}_2 \) and \( \text{AA} \) spraying increased the content of reducing sugars in the berry wall.
of 20 days old berries which was decreased in 30 and 40 days old berries in AA and up to 50 days in AA + H₂O₂ treatments thereafter it showed an increase. The increase was very steep during the phase of ripening in all the treatments. The turnover of the reducing sugar contents was more balanced in case of combined treatment of AA and H₂O₂ (Plate 25 A). At complete maturity, i.e. at the stage of golden yellow berries (90 days old), H₂O₂ treated plants showed the maximum sugar content followed by AA, DW and control stage. Minimum sugar content was recorded in the plants sprayed by AA solution in combination with H₂O₂. The increase in the sugar content was highly significant in the AA + H₂O₂ treatment at three different phases of berry growth i.e. in young stage (20 days old), fully developed green berries (60 days old) and fully matured yellow berries (80 days old) when compared with any of the treatments and control stages.

More or less the same pattern was observed in the content of reducing sugars of the fruit pulp generally at all the growth stages and in all the treatments as that of berry wall. The sugar content increased with the fruit age and reached to the maximum at 80 days of berry growth (yellow) thereafter it showed a decline in golden yellow berries (90 days of age). Contrary to this, AA + H₂O₂ and AA spraying increased the content of reducing sugars in the
SOLANUM KHASIANUM CLARKE

PLATE-25
fruit pulp at young stage (20 days old) which was decreased on further berry development and a minima was obtained at the age of 50 days. The highest content of reducing sugars was obtained at the young stage of berry in AA + H$_2$O$_2$ treated plants followed by AA, control and DW treatments. Minimum sugar content was recorded in the corresponding stage of H$_2$O$_2$ treatment. In general i.e. in all the treatments, maximum accumulation of reducing sugars was noticed in the fully matured yellow berries and it was maximum in the AA + H$_2$O$_2$ spraying followed by AA when compared with other treatments and corresponding stage of control plants (Plate 25 B). When a comparison was made among the fruit parts, the changes in the content of reducing sugar of berry wall showed a positive correlation with that of fruit-pulp. Further it was found, that higher was the mobilization of the reducing sugar at the young stage, higher was the accumulation in the fully matured yellow berries and the treatments by AA and AA in combination with H$_2$O$_2$ were best suited to this condition. In the similar fashion as reported in case of other criterias, a general decline in the content of reducing sugar was observed in over matured berries (golden yellow - 90 days old).

(b) Total sugars

Exactly a similar pattern in the changes of total sugar content of berry wall at different stages of berry
Development was observed as that of content of reducing sugar in berry wall in all the treatments and control stages. The total sugar increased gradually from the young stage (20 days old) and accumulated to its maximum in matured berries. The increase in total sugar content was very steep during maturation (Plate 25 C). A balanced turnover of sugar was observed in the combined treatment of AA and H$_2$O$_2$. The content of total sugar in the fruit pulp at various stages of berry closely resembled with the content of reducing sugars of berry wall (Plate 25 D). The highest rate of sugar mobilization concomitant to its accumulation in the fully matured yellow berries was effected by AA + H$_2$O$_2$ treatment.

(c) Invertase activity

The higher levels of invertase activity were recorded throughout the berry development and in all the treatments in the berry wall (Plate 26 A) and activity was significantly high when compared with the control stages. Matured stages of berries in DW treated plants always showed higher invertase activity when compared with the young stages. The berry walls of the H$_2$O$_2$ treated berries marked a significant decrease at the initial stages i.e. 20 days to 50 days old berries thereafter it registered a steep increase reaching to the maximum at the stage of turning yellow (70 days old). Fully matured yellow berries showed a decline in the enzyme activity while in the over ripened berries the activity of this
SOLANUM KHASIANUM CLARKE

**A**

**Berry Wall**

- Diameter (cm): 10, 15, 20, 25, 30, 30, 30, 30

**INVERTASE ACTIVITY-MG GLUCOSE PRODUCED/GM FRUIT PER HRT**

**B**

**Fruit-Pulp**

- Diameter (cm): 10, 15, 20, 25, 30, 30, 30, 30

**PLATE-26**
hydrolytic enzyme again increased. Similar to \( \text{H}_2\text{O}_2 \) treatment, AA treated berries also depicted the decline in the enzyme activity and reached to its minimum at the age of 40 days. The highest enzyme activity was recorded at the stage (60 days old) just prior to the beginning of the ripening phase. The activity was decreased during the phase of maturation. A decline in the enzyme activity was discernible from the young berry walls and it was reached to its minimum at 50 days. Although fully matured green berries showed a rise up in the enzyme activity but increase in the enzyme activity of berry walls was highly significant during the phase of ripening and reached to its maximum in the over matured berries (golden yellow) in case of combined treatment of AA with \( \text{H}_2\text{O}_2 \). It could be clearly indicated from the graph that a marked increase in the enzyme activity was, may be due to the ripening process. The enzyme activity in the fruit pulp at different stages of berry development was significant higher in the treatments when compared with the control stages. A continuous increase in the activity of enzyme was recorded at various stages of berry development by DW spraying and it attained the peak value in the fully matured yellow berries (80 days of growth). Over matured berries registered a decline in the enzyme activity. No significant difference was observed in the enzyme activity in the young fruitpulps i.e. at the age of 20, 30 and 40 days.
old berries in the \( \text{H}_2\text{O}_2 \) and AA treatments. The activity was significantly decreased by AA spraying, at the age of 50 days which again registered an increase at 60 days and maintained the same level throughout the phase of ripening. Similar to AA treatment, a decline in the enzyme activity was also recorded in the \( \text{H}_2\text{O}_2 \) spraying at the stage (fully matured green berries) just prior to the beginning of maturation phase. Maturing stages of the berries maintained higher levels of the enzyme activity. The lower levels of the enzyme activity was recorded in the fruit-pulp of 30 and 50 days old berries while 20, 40, 60, 70, 80 and 90 days old berries showed higher levels of the enzyme activity in their fruit-pulps in the combined treatment of AA with \( \text{H}_2\text{O}_2 \). Similar to the enzyme activity in the berry wall, here also the process of ripening has definite effect on the enzyme activity of the fruit-pulps (Plate 26 B). The treatments caused significant enhancement in the enzyme activity over control.

3.4. Nucleic acid metabolism

(a) Total nucleic acid contents

The young berry walls showed the maximum content of nucleic acids in all the treatments and control stages except in case of DH sprayed plants where a continuous increase was observed reaching to its maximum in the fully matured yellow berries (80 days old). The maximum nucleic acid contents were recorded in the young berry walls of
AA + H₂O₂ sprayed plants followed by AA, control and H₂O₂ treatment. DW treated plants showed the least content of the nucleic acids in the young berry walls. Golden yellow berries (90 days old) showed a general decline in the content of nucleic acids in all the treatments. The nucleic acid contents decreased rapidly in all the treatments except DW spraying and reached to its minimum in the berries of 50 days old. Thereafter a comparative increase in the content of nucleic acids was observed which was maintained more or less at the same level during the phase of ripening in all the treatments (Plate 27 A). A quite significant enhancement was noted in the nucleic acid content by AA + H₂O₂ spraying and it was discernible throughout the course of berry development. In general, a negative correlation was observed between the content of nucleic acids and the berry age, contrary to this, the levels of nucleic acid contents in the fruit pulp of young berries were at low which were increased during progressive berry development and reached to its maximum in the fully matured bellow berries (80 days old) in all the treatments and control plants (Plate 27 B). Exactly as in the case of berry wall, over ripened berries showed a general decline in the nucleic acid contents. The nucleic acid contents were significantly increased by AA, AA + H₂O₂ and H₂O₂ spraying and increased levels were maintained throughout the berry development. Control plants
showed a more close correlation in the nucleic acid contents with that of DW sprayed plants. A highly significant positive correlation was observed between the content of nucleic acids in the fruit-pulp and fruit age while correlation was significantly negative between the content of nucleic acid in berry wall and fruit pulp when a comparison was made in the nucleic acid contents of berry wall with that of fruit-pulp, the fruit pulp always showed significantly higher contents of nucleic acids.

(b) RNase activity

A steady increase in the activity of RNase enzyme was observed in the berry wall during progressive berry development and reached to its maximum at the age of 80 (fully matured yellow berries) and 90 (over ripened golden yellow berries) days of berry growth in all the treatments as well as control stages (Plate 27 C). A significant increase in the enzyme activity was observed at all the stages of fruit development and in all the treatments over control. The highest enzyme activity was recorded in the combined treatment of AA and H₂O₂ while control plants showed the minimum activity of this enzyme. There was a positive correlation between the enzyme activity and berry age while a negative correlation was observed between the enzyme activity of berry wall and its nucleic acid contents.
Similar to the enzyme activity in the berry wall, the enzyme activity in the fruit-pulp also increased with the progressive berry growth and reached to its maximum at the juncture from where ripening commenced. Contrary to this, AA + H$_2$O$_2$ treatment showed a continuous rise in the enzyme activity of the fruit-pulp throughout the course of berry development (Plate 27 D). Maximum activity of enzyme was recorded by AA + H$_2$O$_2$ spraying followed by DW, AA and H$_2$O$_2$ treatments. The control berries in their fruit-pulps showed the minimum enzyme activity. Increase in the enzyme activity observed a direct correlation with fruit age and also with the increase in the nucleic acid contents. Over ripened berries (golden-yellow) recorded a general decline in the enzyme activity while it could not be effected to that extent in the AA + H$_2$O$_2$ and DW treatments both in the berry wall and the fruit pulp.

B-5 Solasodine content

Maximum solasodine content was recorded in the walls of the young berries which was significantly decreased with increase in fruit age and reached to the minimum on the onset of ripening (in the turning yellow berries of 70 days old) generally in all the treatments. A increase in the content of solasodine was observed in the fully matured 80 days old yellow berries which was maintained in the over
matured berries (Plate 28 A). The highest solasodine content was observed in the young berry walls of the AA + H₂O₂, H₂O₂ treatment, and control group respectively. No significant difference was observed in the content of solasodine among the control and treated plants at the later stages of berry growth and ripening. Initially a significant decrease in the content of solasodine was noted in the AA + H₂O₂ treatment which was superimposed over other treatments during ripening. The treatment by H₂O₂ and AA when sprayed individually showed higher levels of solasodine in overall fruit development. The changes in the solasodine content of the berry wall showed a negative correlation with respect to fruit age. Contrary to this, a highly positive correlation was observed in the content of solasodine of the fruit pulp with respect to fruit age in all the treatments as well as control group (Plate 28 B), where solasodine content increased with the age and reached its maximum in the fully matured 80 days old yellow berries in all the treatments and control. Over matured 90 days old golden yellow berries registered a sharp decline in the solasodine content of the fruit pulp in all the treatments and control plants. At the initial stage of berry growth, the combined treatment with AA and H₂O₂ showed the lowest levels of the solasodine content but it attained the peak value at the age of 80 days surpassing the content of solasodine in the
SOLANUM KHASIANUM CLARKE

A

B

C

D

PLATE-28
Overall, higher levels of solasodine content in the fruit-pulp were maintained by \( \text{H}_2\text{O}_2 \) treatment. It was very interesting to note here that at the age of 80 days, the berry wall recorded the minimum solasodine content while at the same age fruit pulp accumulated maximum. The changes in the content of solasodine of berry wall with fruit age showed a negative correlation with that of the fruit pulp. The content of solasodine was also determined from the dry berries of different age groups (Plate 28 C) and there was a significant increase in the content of solasodine by AA and AA + \( \text{H}_2\text{O}_2 \) spraying. Both these treatments maintained the higher levels of solasodine content when compared with control stages and corresponding stages of other treatments. The respective percent increment over control were 47.95 and 41.17 on dry weight basis (Table 4). There was a significant decrease (19.20 % on dry weight basis) in the content of solasodine by DN spraying throughout the course of berry development and showed the least values. Although, there was an increase in the content of solasodine (3.18 % on dry weight basis) by \( \text{H}_2\text{O}_2 \) spray over control, it was not significant when compared with AA alone and AA + \( \text{H}_2\text{O}_2 \) spraying. Solasodine content had its highest values in the fully matured 80 days old yellow berries with a general decline in over matured 90 days old golden yellow berries in all the treatments. Excepting \( \text{H}_2\text{O}_2 \)
foliar spray, all other treatments resulted in increased number of fruits per plant throughout the plant growth. However, among BU, AA and AA + H₂O₂ treatments, only AA and AA + H₂O₂ spray showed a marked increase in solascriine content on dry weight basis. Hence, these two treatments has a remarkable impact on the potential of the plants for net solasodine production.

5-6 Nitrogen content

The content of total nitrogen (percentage calculated on dry weight basis) was maximum in the young berries which decreased rapidly on maturation and minimum content of percentage nitrogen was obtained at the age of 60 days, where berry growth completely ceased and the phase of ripening begins, generally in all the treatments (Plate 28 D). The nitrogen content again showed an increase at 80 days of berry growth in AA + H₂O₂, AA and H₂O₂ treatments respectively with a decline in over matured 90 days old golden yellow berries except that H₂O₂ treated plants which showed a continuous increase during maturation. The highest percentage of nitrogen was recorded in the youngest berries of AA, H₂O₂ and AA + H₂O₂ treated plants while at maturation H₂O₂ treatment showed a significant increase over other treatments and control group. The point at which nitrogen content was least always indicated the highest accumulation of solasodine is worth noting in the present study.
Table 4

Determination of solasodine content from the berries of *Solanum khasianum* Clarke in different treatments. (Mean of eight stages of berry growth)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Content of solasodine (mg/g. dry weight)</th>
<th>Percent increment over control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>14.937</td>
<td>-</td>
</tr>
<tr>
<td>DW</td>
<td>12.069</td>
<td>-19.20</td>
</tr>
<tr>
<td>H$_2$O$_2$</td>
<td>15.412</td>
<td>+03.18</td>
</tr>
<tr>
<td>AA</td>
<td>22.100</td>
<td>+47.95</td>
</tr>
<tr>
<td>AA + H$_2$O$_2$</td>
<td>21.087</td>
<td>+41.17</td>
</tr>
</tbody>
</table>