EXPERIMENTAL FINDINGS

Experiment - I: Effect of photoperiodic treatments (SD, ND and LD) on flowering and metabolic events like ascorbic acid turnover, biosynthesis of Nucleic acids (DNA and RNA), Proteins and Histones as well as activities of related enzymes like, Peroxidase, AA-PR-peroxidase, RNase and protease during growth and development.

Ascorbic acid (AA): Reproductive organ (R.O.) (Plate 2.1): Ascorbic acid content is low in vegetative shoot apex (I) compared with that in the flower bud (II) in SD and ND treatments. In SD, AA content then falls in the reproductive organ at the fertilized carpel stage (IV). AA content shoots up in young seed. It then declines gradually in seed-II (VI) and mature seed (VII). Under LD condition AA content is high in the fertilized carpel. It declines in seed-II stage. ND plants show fluctuating trend during various stages of life cycle.

The AA content in the corresponding leaf of reproductive organ (Leaf-R) (Plate 2.2) shows an increasing trend upto fertilized carpel stage under LD condition. It then declines in seed stages. In ND, AA content increases.
Plate 2: Ascorbic acid in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARIETINUM Cv. CHAFA

RO

LEAF (R)

SHOOT APEX

LEAF (S)

ASCORBIC ACID

PLATE-2

SD  ND  LD
after flowerbud formation reaching to a maximum level in the fertilized carpel. It declines slightly in seed stages. AA content shoots up in seed-I and seed-III stages under SD condition.

Rate of the AA biosynthesis (Plate 3.1) is higher in reproductive organs, fertilized carpel and young seed under LD condition. It is low in flower bud, seed-II and seed-III stages. In ND, rate of AA biosynthesis is high in the flower bud and reproductive organs. It then decreases in remaining stages of life cycle. Rate of AA biosynthesis shows a fluctuating trend under SD condition.

The rate of AA biosynthesis in corresponding leaf of reproductive organ (Leaf-R) (Plate 3.2) is highest in flower bud (II) under SD, ND and LD photoperiods. In LD, it is high in reproductive organ (III) and fertilized carpel (IV) stage. It decreases after the young seed formation. SD plants show fluctuating trend. Under ND condition, the trend for rate of biosynthesis is more or less similar to that of LD treatment.

Shoot Apex (Plate 2.3): Terminal apex under LD condition shows an increasing trend after flower bud formation up to the end of life-cycle. Under ND condition, AA content reaches at the peak level during reproductive organ (III) and fertilized carpel (IV) stage. In SD, the level of AA content
Plate 3: Rate of ascorbic acid biosynthesis in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARIETINUM Cv. CHAFA

RATE-ASCORBIC ACID

RO  I

LEAF (R)  II

SHOOT APEX  III

LEAF (S)  IV

PLATE-3

□  SD  □  ND  ■  LD
remains at the same level up to fertilization. It then increases in seed stages.

AA content of the corresponding leaf of shoot apex (Plate 2.4) shows an increasing trend right from vegetative shoot apex to seed stages, under LD and SD conditions. In ND, AA increases and reaches its maxima in reproductive organ and fertilized carpel. It then decreases during seed formation and remains at a uniform level up to the end of life cycle.

Rate of AA biosynthesis (Plate 3.3) in shoot apex is low in flower bud (II) under LD condition. It then increases in reproductive organ and this rate is maintained at about the same level in seed stages. In ND condition AA biosynthesis is high in the shoot apex at the time of III and IV stages of development. It is low during flower bud (II) and seed (V, VI and VII) stages. The rate of AA biosynthesis is high during seed stages and low in reproductive organs and fertilized carpel under SD condition.

The rate of AA biosynthesis for corresponding leaf of shoot apex is high during the flower bud (Plate 3.4) under SD and LD conditions. Under LD it decreases in the leaf during the reproductive organ and fertilized carpel stages and remains at a more or less same level in seed stages. Under SD condition, the rate of biosynthesis of the
leaf decreases during reproductive organ and fertilized carpel. It rises again in seed stages. Under ND condition, the rate of biosynthesis is higher in the leaf at the time of reproductive organ and fertilized carpel stages compared with that during flowerbud and seed stages.

Ascorbigen (ASG):
Reproductive organ (Plate 4.1): Ascorbigen is high in vegetative shoot apex (I) under SD condition followed by a fall in the flower bud (II). Reproductive organ, fertilized carpel and seed-II show an increase in ASG content. In LD condition ASG content is high in the vegetative shoot apex (I). It then decreases after flower bud formation and remains at a more or less the same level. Under ND condition, ASG content is high in vegetative shoot apex and then it decreases.

ASG content in corresponding leaf of reproductive organ (Plate 4.2) is low in general under SD, ND and LD conditions. In ND and LD conditions, ASG content is high in vegetative shoot apex. In LD, ASG content decreases in the leaf corresponding to the flower bud and reproductive organ. Leaves during fertilized carpel, seed-II and mature seed show high ASG content. Under ND, ASG is more in the leaf of vegetative shoot apex followed by a fall in that of the flower bud. It again rises in the leaf during the
Plate 4: Ascorbigen in reproductive organ, terminal shoot apex and their corresponding leaves.
reproductive organ seed-II, and mature seed (Seed-III) stages. It decreases during the fertilized carpel and young seed. SD plants show a fluctuating trend.

Rate of ASG biosynthesis in reproductive organ (Plate 5-1) is low during various stages of development under SD, ND and LD conditions except, for that, it is high in reproductive organ and seed-II under SD condition.

The rate of ASG biosynthesis (Plate 5-2) in the corresponding leaf of reproductive organ is low throughout the various reproductive stages of life-cycle, under SD, ND and LD conditions.

Shoot Apex (Plate 4-3): Ascorbigen is high in vegetative shoot apex (I) compared with that in the shoot apex during the reproductive stages in LD condition. It then shoots up in LD during seed stages. Initially it is high in SD condition in vegetative shoot apex (I). It then decreases during the flower bud stage and again it rises and remains at the same level during other stages of life-cycle. Under ND photoperiod, ascorbigen is more in vegetative shoot apex. It then declines in the shoot apex upto fertilized carpel stage. However during the seed stages there is a slight increase in ASG content of the shoot apex.

In general corresponding leaf of shoot apex shows less ASG content (Plate 4-4). In LD, ASG is high in the
Plate 5: Rate of ascorbigen biosynthesis in reproductive organ, terminal shoot apex and their corresponding leaves.
leaf during the vegetative shoot apex stage followed by its fall during the flower bud stage. It again increases in the leaf during the reproductive organ and fertilized carpel stages. Leaf at the time of seed stages show decrease in ASG content. In ND, ASG is high in the leaf during vegetative shoot apex and flower bud stages. It then decreases during reproductive stages and again increases during seed formation. ASG is more in the leaf during reproductive stages in SD. Leaf during seed stages shows low ASG content.

Rate of ASG biosynthesis is low in the shoot apex during various stages of life-cycle under SD, ND and LD photoperiods. But it is very low at the time of flower-bud stage compared with that during the other developmental stages under SD and LD photoperiods (Plate 5.3).

The rate of ASG biosynthesis in corresponding leaf of shoot apex (Plate 5.4) is low during the flower bud and seed stages under LD and SD treatments. The leaf substending the reproductive organ (III) and fertilized carpel (IV) shows higher ASG content compared with that of the leaf at the time of vegetative shoot-apex. It is more at the time of flower bud stage under ND and very low in the leaf during the reproductive stages. Rate of ASG biosynthesis in the leaf during the seed stages declines under all the three light conditions.
Plate 6: Ascorbic acid utilization in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARRIETINUM Cv. CHAFA

PLATE 6

ASCORBIC ACID UTILIZATION (%)

RO

LEAF (R)

SHOOT APEX

LEAF (S)

I II III IV V VI VII

SD ND LD

PLATE 6
Ascorbic Acid Utilization (AAU):

Reproductive organ (Plate 6.1): AAU is high in vegetative shoot apex followed by its decline in the flower bud (II). It again increases in R.O. during the remaining stages of development under LD and ND conditions. SD plants show a fluctuating trend.

AAU in the corresponding leaf of reproductive organ (Plate 6.2) is high in the vegetative shoot apex as compared to the flower bud and reproductive organ stages in SD condition. It then shows a continuous decline in the remaining stages of life cycle. Under ND, it increases in the seed stages. While under LD it shows fluctuating trend.

Rate of AA utilization in reproductive organ (Plate 7.1) is very low in the flower bud in comparison with other various stages of differentiation in LD condition. SD plants show a fluctuating trend. In ND the rate of utilization is very low in the flower bud.

In the corresponding leaf (Plate 7.2) the rate of utilization is low during the flower bud (II) and reproductive organ (IV) stages under LD condition. In LD the leaf at the time of fertilized carpel and seed-II stages shows high rate of utilization. The rate of ascorbic acid utilization is low in ND upto fertilization. In SD, rate of utilization shows a declining trend.
Plate 7: Rate of ascorbic acid utilization in reproductive organ, terminal shoot apex and their corresponding leaves.
Shoot Apex (Plate 6.3): Under LD AA utilization is high in the shoot apex during the various stages of development and remains at more or less the same level throughout the life-cycle. Under SD condition, AA utilization declines gradually from flower bud stage to seed formation. AAU is high in the vegetative shoot apex and flower bud stage in ND. It declines in the shoot apex during the reproductive organ and fertilized carpel stages and again it increases slightly during the seed stages.

In the corresponding leaf of the shoot apex (Plate 6.4) AAU is lower during various stages of life-cycle in LD compared with that in SD and ND conditions. Under LD photoperiod AA utilization of the leaf is higher during vegetative shoot apex compared with that at the time of flower buds. It increases slightly after flower bud formation and remains at the same level till maturation of seeds. In ND condition leaf at the time of reproductive organ (III) and fertilized carpel (IV) show high AA utilization. SD plant shows a fluctuating trend.

The rate of AA utilization in the shoot apex (Plate 7.3) is low during reproductive differentiation in SD, ND and LD conditions. Under LD condition rate of AAU in the shoot apex increases with the progress of development.

The corresponding leaf of shoot apex shows low AAU in the flower bud stage (Plate 7.4). In ND, it increases in
Plate 8: AA-MM-complex in reproductive organ, terminal shoot apex and their corresponding leaves.
the leaf during the reproductive organ and fertilized carpel stages. Under LD photoperiod, it increases with the progress in development. SD plant shows a fluctuating trend.

**AA-MM-complexing (AA-MM-complex):**

**Reproductive organ** (Plate 8.1): The binding of AA with macromolecules is generally low in various stages of growth and development in all the three photoperiods. In LD AA-MM-complex is high in vegetative shoot apex (I), seed-II and mature seed stages. It is very low in the flower bud and reproductive organ stages. After fertilization, it increases gradually. In ND condition, complexing declines after flower bud formation. Under SD photoperiod, the trend is fluctuating during growth and differentiation.

Leaf corresponding to different stages of reproductive differentiation (Plate 8.2) shows low binding of AA in ND compared with that in SD and LD conditions. In LD, AA-MM-complex increases in the leaf during the vegetative shoot apex stage compared with that in the flower bud stage. It again rises during the fertilized carpel stage. It then declines during seed formation. SD plants show an increasing trend upto reproductive stage. It then decreases in fertilized carpel followed by a rise during seed development.

Rate of AA-MM-complexing in reproductive organ is low in all the three photoperiods during various stages of
Plate 9: Rate of AA-MM-complex in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARIETINUM Cv. CHAFA

RATE — AA — MM — COMPLEX

RO — 1

LEAF (R) — 2

SHOOT APEX — 3

LEAF (S) — 4

II III IV V VI VII II III IV V VI VII

SD ND LD

PLATE — 9
life-cycle (Plate 9.1). In LD, however, the rate of complexing steadily increases with advance in development.

The rate of complexing in the corresponding leaf of reproductive organ (Plate 9.2) is high during fertilized carpel and young seed in LD condition. In SD, seed stages show increasing trend. AA-MM-complex is very low in the flower bud under ND condition.

Shoot apex (Plate 8.3): The binding of ascorbic acid is also low in the shoot apex at various stages of development. AA-MM-complex is high in vegetative shoot apex under all the three photoperiodic conditions. It then declines gradually upto fertilization and again increases during seed formation in LD and ND. While in SD, it is low in flower bud and seed stages but shows slight increase in reproductive organ and fertilized carpel.

Corresponding leaf of shoot apex shows more binding of AA as compared to the flower bud (Plate 8.4). AA-MM-complex shows an increasing trend in SD and LD conditions after flower bud formation. But in ND, it increases and remains more or less at the same level in seed developmental stages.

Rate of complexing in shoot apex is very low during the flower bud stage under SD photoperiod (Plate 9.3). In ND and LD conditions, it is low in the flower bud and reproductive organ stages.
Rate of complexing of corresponding leaf of shoot apex (Plate 9.4) is very low in the flower bud under all the three photoperiods. In ND and LD, it increases with the progress in other stages of development. Under SD condition seed stages show an increase in AA-MM-complex.

**AA-FR-peroxidase activity:**

Reproductive organ (Plate 10.1): AA-FR-peroxidase activity is low in the vegetative shoot apex (I) under LD condition. It increases in the flower bud and reaches to a very high level in the reproductive organ. It then decreases in fertilized carpel and again increases slightly in young seed and seed-II. Mature seed shows a decrease in AA-FR-peroxidase activity. In ND and SD conditions increasing trend is seen upto fertilized carpel stage. After fertilization, in ND condition AA-FR-peroxidase activity shows a downward trend gradually upto seed-II stage. It rises a little in the mature seed. AA-FR-peroxidase activity under SD condition declines in fertilized carpel and again it rises in seed-I and seed-II stages. Mature seed shows low activity.

In the corresponding leaf-R (Plate 10.2) the enzymic reaction is low in vegetative shoot apex (I) under LD and ND conditions. It rises in flower bud, whereas in SD condition reverse case is registered. Under LD condition it decreases in the reproductive organ, fertilized carpel and young seed
Plate 10: AA-FR-peroxidase activity in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARRIETINUM Cv. CHIFA

RO

LEAF (R)

SHOOT APEX

LEAF (S)

AA - FR - PEROXIDASE ACTIVITY

SD  ND  LD

PLATE-10
stages. It again increases in seed II and mature seed.
Under SD, AA-FR-peroxidase activity shows a gradual
increasing trend up to young seed after flower bud formation.
It then declines in seed-II and mature seed. In ND condition,
the trend of enzymic reaction is similar to that of SD, but
the only difference is that the level of enzymic reaction
is higher in ND compared with that in SD condition.

Rate of AA-FR-peroxidase activity in reproductive
organ (Plate 11.1) is high in all the three photoperiodic
conditions. It is low only in fertilized carpel, young and
mature seeds under LD condition.

The rate of enzymic reaction of corresponding
leaf-R (Plate 11.2) is higher in the various stages of
differentiation under SD, ND, LD photoperiods compared with
that in the leaf corresponding to the vegetative apex. It
is very high in the flower bud under LD condition. SD and
ND plants show fluctuating trends.

Shoot Apex (Plate 10.3): AA-FR-peroxidase activity is high
in vegetative shoot apex compared with that during the
flower bud stage under the three photoperiodic conditions.
Under LD, enzymic reaction is enhanced in the shoot apex
gradually during developmental stages. In ND, AA-FR-
peroxidase activity of the shoot apex is high during the
reproductive organ and fertilized carpel stages. It then
Plate 11: Rate of AA-FR-peroxidase activity in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARIETINUM Cv. CHAFA

PLATE-II

RATE -AA -FR-PEROXIDASE

LEAF (R) 2

LEAF (S) 4

SHOOT APEX 3

RO 1

II III IV V VI VII II III IV V VI VII

SD ND LD

PLATE-II
decreases during seed formation. Enzymic reaction increases and reaches a higher level in the shoot apex during the seed stages under SD.

AA-FR-peroxidase activity in the corresponding leaf-(S) under LD condition is low during the vegetative shoot apex stage (Plate 10.4). It then increases in the leaf during the flower bud stage and remains at the same level during the reproductive organ and fertilized carpel stages. In SD and ND, leaf-(S) corresponding to vegetative shoot apex stage shows higher activity as compared to the flower bud. It then rises in the leaf during the reproductive organ and fertilized carpel stages. It is higher in ND compared with that in SD. The enzymic reaction declines in seed stages under ND condition whereas under SD and LD conditions, AA-FR-peroxidase activity reaches a higher level.

The rate of AA-FR-peroxidase activity is high in the shoot apex at the time of formation of the reproductive organ under ND condition (Plate 11.3). It rises during seed stages under SD condition. In all the three conditions, AA-FR-peroxidase activity is low in the shoot apex during the flower bud stage.

The corresponding leaf of shoot apex (leaf-S) shows high rate of AA-FR-peroxidase activity (Plate 11.4) in LD
condition throughout the course of reproductive differentiation. The rate of enzymic reaction under SD and ND is low in leaf-S at the time of flower bud formation. It then gradually increases in SD. While in ND, the enzymic reaction of leaf-S increases during the reproductive organ stage followed by fall during seed development.

Peroxidase activity:

Reproductive organ (Plate 12.1): General peroxidase activity is very low in the vegetative shoot apex under SD, ND and LD conditions. The activity increases considerably reaching its maximum level in the flower bud and fertilized carpel of ND plants. It then declines gradually during seed development. Under LD, the enzymic reaction is faster in the flower bud compared with that in the vegetative shoot apex. It then decreases in reproductive organ and fertilized carpel. Peroxidase activity rises during seed development. In SD, flower bud shows higher activity than vegetative shoot apex. It then declines in reproductive organ and fertilized carpel followed by increase to a maximum level in young seed and seed-II stage.

The leaf-R corresponding to different reproductive organs shows an increasing trend of peroxidase activity (Plate 12.2) reaching to a maximum level gradually after flower bud formation under LD condition. Under SD peroxidase
plate 12: Peroxidase activity in reproductive organ, terminal shoot apex and their corresponding leaves.
activity of the leaf rises during flower bud formation in comparison with that in the vegetative shoot-apex. It then declines. Leaf-Â at the time of fertilized carpel and young seed stages show an increasing trend followed by slight fall in enzymic reaction in seed-II and mature seed stages. ND plants show a fluctuating trend during development.

The rate of peroxidase activity in the reproductive organ is high in the flower bud of SD and ND plants (Plate 13.1). It decreases in reproductive organ and fertilized carpel under ND condition. Seeds stages show a gradual declining trend under ND. SD plant shows a fluctuating trend after flower bud formation. Under LD, rate of the enzymic reaction is high in the flower bud compared with that in the reproductive organ and fertilized carpel. It then rises during seed development.

The leaf-Â corresponding to different reproductive organs (Plate 13.2) shows a high rate of the peroxidase activity during flower bud formation under SD and ND conditions followed by fall during development of the reproductive organ. It again increases at the time of formation of the fertilized carpel under ND condition and then decreases gradually. The rate of peroxidase activity in leaf-Â remains at the same level in seed development stages except in mature seed it declines slightly.
Plate 13: Rate of peroxidase activity in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARIETINUM Cv. CHAFA

PLATE - 13

RATE - PEROXIDASE

LEAF (R)

RO

SHOOT APEX

LEAF (S)

II III IV V VI VII II III IV V VI VII

SD ND LD

PLATE - 13


** Shoot Apex (Plate 12.3) **: Peroxidase is in general at a very high level in ND plants compared with that in LD and SD ones. During seed development SD plants have slightly enhanced peroxidase activity compared with that in LD ones. Peroxidase activity is very low in the vegetative shoot apex under all the three photoperiods. It then rises in the shoot apex at the time of flower bud formation and reaches its peak level during reproductive organ and fertilized carpel stages.

In the leaf-S corresponding to the shoot apex at different stages of development (Plate 12.4) peroxidase activity is at a higher level in ND treatment. Peroxidase activity is low in the leaf-S of the vegetative shoot apex under SD and ND conditions followed by an increase which reaches a high level during the flower bud stage under ND condition. It then decreases in leaf-S and remains at the same level during other developmental stages. In LD, enzymic reaction is high during vegetative shoot apex stage compared with that during the flower bud, reproductive organ and fertilized carpel stages. It again increases during seed formation. Peroxidase activity under SD is high in the flower bud stage followed by a fall in activity during the reproductive organ and fertilized carpel stages. It then reaches a high level during seed development.
The rate of peroxidase activity in shoot apex (Plate 13.3) is higher during reproductive differentiation in all the photoperiods compared with that in the vegetative phase. The rate is the highest in ND which progressively declines during reproductive differentiation but remains higher up to the last than that in vegetative apex. Peroxidase activity is high in the shoot apex during flower bud stage under SD and LD conditions. It then declines up to fertilized carpel stage and again it increases during seed development under both SD and LD photoperiods.

General trend for corresponding leaf of S.A. shows higher rate of activity in SD and ND than LD. Rate of peroxidase activity under ND is high in the leaf-S during the flower bud stage (Plate 13.4). It then decreases with progress in development.

RNase activity:
Reproductive organ (Plate 14.1): RNase activity is high in the vegetative shoot apex under LD condition compared with that in the flower bud. After fertilization, RNase activity increases gradually up to seed-II stage. In ND, RNase activity is high in vegetative shoot apex and flower bud compared with that in the reproductive organ and fertilized carpel. Young seed and seed-II show an increase in RNase activity. RNase activity decreases in mature seed
Plate 14: RNase activity in reproductive organ, terminal shoot apex and their corresponding leaves.
Under SD photoperiod, RNase activity is the same from vegetative shoot apex to fertilized carpel stage. Young seed and seed-II show higher enzymic activity, whereas mature seed show a decline in RNase activity.

The trend of RNase activity in leaf-R corresponding to different stages of reproductive differentiation (Plate 14.2) under LD is the same as in the reproductive organ itself (Plate 14.1). Under ND RNase activity is high in leaf-R during the vegetative shoot apex and flower bud stages compared with that during the reproductive organ and fertilized carpel stages. It again increases during seed development. Under SD, the trend of RNase activity of leaf-R is the same upto fertilization stage.

The rate of RNase activity increases in young seed and seed-II stages in all photoperiods (Plate 15.1). In LD plants it is low in the flower bud, reproductive organ, fertilized carpel and mature seed. In SD, rate of RNase activity increases in seed stages. It is less in the flower bud, reproductive organ and fertilized carpel. In ND plants RNase activity is slightly higher in the flower bud, young seed, seed-II and mature seed.

The rate of RNase activity in leaf-R corresponding to different stages of reproductive organ (Plate 15.2) under ND is very high in young seed. LD plants show a fluctuating
Plate 15: Rate of RNase activity in reproductive organ, terminal shoot apex and their corresponding leaves.
trend. In SD plants rate of RNase activity in leaf-R is low at flower bud stage. It increases slightly during reproductive organ and fertilized carpel stages. RNase activity of leaf-R is higher during seed development compared with that during vegetative apex stage.

**Shoot apex**: RNase activity is high in vegetative shoot apex compared with that during the flower bud stage under SD and LD conditions (Plate 14.3). It increases gradually upto seed-III stage after flower bud formation. Under ND, RNase activity is high in the vegetative shoot apex. Shoot apex at the time of flower bud, reproductive organ and fertilized carpel stages shows a declining trend of enzymic reaction. It is high again during seed formation.

In the corresponding leaf-S of shoot apex (Plate 14.4) the trend of RNase activity is very similar to that observed in the shoot apex under all the three photoperiods.

The rate of RNase activity in shoot apex (Plate 15.3) is low during the flower bud, reproductive organ, and fertilized carpel stages under LD, ND and SD conditions. In ND and SD it increases in the shoot apex during seed development.

The corresponding leaf of the shoot apex (Plate 15.4) shows a higher rate of enzymic activity during seed
development under all photoperiods. It is low during the flower bud, reproductive organ and fertilized carpel stages.

**RNA:**

**Reproductive organ** (Plate 16.1): RNA content is low in the vegetative shoot apex (I) of LD plants followed by an increase which reaches its maximum level in the reproductive organ and fertilized carpel. It then declines in developing seed. Under ND, RNA content is low in the vegetative shoot apex and the flower bud. It then increases and remains at the same level in other stages of development, SD plant shows a fluctuating trend during various stages of development.

RNA content is low in the leaf-R corresponding to different stages of reproductive differentiation especially during vegetative shoot apex and flower bud stages under LD (Plate 16.2). It then rises during seed formation. RNA content of leaf-R of SD plants is low during the vegetative shoot apex stage compared with that during flower bud formation. It then declines gradually in leaf-R during the reproductive organ, fertilized carpel and seed formation stages. RNA content of leaf-R of ND plants increases slightly in fertilized carpel and remains more or less at the same level during seed development (Plate 16.2).

The rate of RNA biosynthesis is higher in the flower bud in LD, SD and ND compared with that in the vegetative
Plate 16: RNA in reproductive organ, terminal shoot apex and their corresponding leaves.
shoot apex. Rate of biosynthesis declines gradually with the progress of development. Rate of RNA biosynthesis in ND plants increases after flower bud formation in the anther and fertilized carpel. It then declines during seed development. SD plants show a fluctuating trend in various stages of development (Plate 17.1).

Rate of RNA biosynthesis, in leaf-R corresponding to various stages of reproductive differentiation is higher in SD plants during the flower bud stage (Plate 17.2). It then declines gradually during various stages of development. Rate of RNA biosynthesis in LD plants is more in the leaf-R at anther and fertilized carpel stages. The rate of RNA biosynthesis in leaf-R is low during various stages of the life-cycle under ND condition.

Shoot apex (Plate 16.3): RNA content of LD plants is more in the vegetative shoot apex compared with that in the flower bud. It then increases and remains at a same level in the shoot apex during other stages of development. The level of RNA content of SD plants is the highest in all the stages of development except the vegetative shoot apex stage. Under ND condition it is low in the vegetative shoot apex. It then increases and reaches a high level in the shoot apex at the time of the flower bud, anther and fertilized carpel stages. RNA content of ND plants
Plate 17: Rate of RNA biosynthesis in reproductive organ, terminal shoot apex and their corresponding leaves.
RATE - RNA

CICER ARIETINUM Cv. CHAFA

RO 1

LEAF (R) 2

SHOOT APEX 3

LEAF (S) 4

PLATE 17

II III IV V VI VII

SD ND LD

PLATE - 17
declines during seed development.

The leaf-S corresponding to the shoot apex (Plate 16.4) has more RNA content in the vegetative shoot apex of ND and LD plants. RNA content of leaf-S increases after flower bud formation and reaches a high level during seed development in LD plants. Under ND photoperiod RNA of leaf-S remains at the same level in the anther and seed development stages after flower bud formation. Under SD condition, RNA content of leaf-S corresponding to the vegetative shoot apex is low compared with that during the flower bud formation. It then declines in the anther and during seed development.

The rate of RNA biosynthesis in shoot apex (Plate 17.3) is very slow in the flower bud under LD condition. It is higher in the shoot apex during the flower bud, anther and fertilized carpel stages of ND plants. The rate during seed development is low. In SD, rate of biosynthesis in the shoot apex is high during various stages of differentiation. It is very high in the flower bud stage.

The rate of RNA biosynthesis in the corresponding leaf of S.A. of SD plants is high during the flower bud stage. It then declines in leaf-S of the anther, fertilized carpel and seed stages. In ND, it remains lower than that in the vegetative apex during various stages of development. The
Plate 18: DNA in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARIETINUM Cv. CHAFA

DNA

LEAF (R)

SHOOT APEX

LEAF (S)

SD  ND  LD

PLATE - 18
rate of RNA biosynthesis in LD plants is higher during the development of the seed (Plate 17.4).

**DNA:**

**Reproductive organ** (Plate 18.1): DNA content in the reproductive organ is low in the vegetative shoot apex under all photoperiods. There is a sharp increase in the flower bud of LD, ND and SD plants which reaches its maximum at anther development stage except in ND where it attains its maximum during fertilized carpel stage. It declines in young seed and seed-II. It, however, again increases in the mature seed of LD and ND plants.

DNA content of the leaf-R corresponding to the reproductive organ (Plate 18.2) of SD and LD plants is low in the vegetative shoot apex. It then rises in the leaf-R of the flower bud followed by a decline during the anther and fertilized carpel stages of both the above mentioned photoperiods. It again increases during seed development under LD whereas in SD, reverse case is observed. In ND, DNA is more in the leaf-R of the vegetative shoot apex compared with that during the flower bud stage of ND plants. DNA content of leaf-R of the anther and fertilized carpel stages increases and remains more or less at the same level during seed development.
Plate 19: Rate of DNA biosynthesis in reproductive organ, terminal shoot apex and their corresponding leaves.
DNA biosynthesis in the reproductive organ is significantly higher compared with that in vegetative shoot apex (Plate 19.1). The greatest increase is observed at the flower bud stage, after which there is a decline unto mature seed stage. However, the DNA remains at a higher level at all stages of development compared with that in the vegetative shoot apex.

The leaf-R of the corresponding reproductive organ shows a sharp increase in DNA biosynthesis (Plate 19.2) in the flower bud stage under SD and LD conditions. It then declines but remains at a higher level in leaf-R of SD and LD plants compared with that in the leaf-R of vegetative shoot apex stage. In ND plants, biosynthesis of DNA is low at the flower bud stage. DNA biosynthesis then increases during other stages of differentiation.

Shoot apex (Plate 18.3): DNA content of the shoot apex is low in the vegetative shoot apex under SD, ND and LD conditions. It shoots up during the flower bud stage in SD, ND and LD plants. In SD and ND plants, the DNA content of the shoot apex declines slightly and remains at the same level throughout reproductive differentiation. In LD it increases in the flower bud stage and gradually decreases in later stages of development.
DNA content in the corresponding leaf of vegetative shoot apex (Plate 13) is low under SD, ND and LD conditions. It then rises in leaf-S and remains at the same level at the flower bud, anther development and fertilized carpel stages in SD and LD. It decreases in LD plants during seed development. DNA content of leaf-S in ND increases during seed development.

Biosynthesis of DNA is very high in the shoot apex (Plate 19) during flower bud stage under all the photoperiods. It then declines gradually during the succeeding stages of development. The level of DNA, however, remains significantly higher than that in the vegetative shoot apex.

In the corresponding leaf of shoot apex (Plate 19) DNA biosynthesis is very high in SD and LD plants. It declines with the progress of development under all the photoperiods. Nevertheless DNA content is higher in leaf-S at every stage of development compared with that in the leaf-S at the time of vegetative shoot apex.

Protease activity:
Reproductive organ (Plate 20) : Protease activity is low in the vegetative shoot apex compared with that in the flower bud under all photoperiods. The level of protease activity is higher in SD and LD plants compared with that in ND ones.
Plate 20: Protease activity in reproductive organ, terminal shoot apex and their corresponding leaves.
Reproductive organ possess very high enzymic activity in LD. In SD and ND plants it declines in the anther. Under SD condition, protease activity increases gradually after flower bud formation upto seed-II stage. Mature seed (Seed-III) shows slight fall in protease activity. Under LD, protease activity decreases after fertilization.

In LD plants, protease activity is in general at a low level in leaf-R corresponding to the stage of reproductive development (Plate 20.2) and remains more or less at a constant level throughout the development. Protease activity is high in the flower bud and seed stages under SD and ND conditions. It is low in the leaf-R at the time of vegetative shoot apex, anther development and fertilized carpel.

Protease activity is higher than that in the vegetative shoot apex at all stages of development (Plate 21.1). It, however, declines with the progress in development under all the photoperiods. Under ND condition, the enzymic activity increases upto the fertilized carpel stage.

In the corresponding leaf-R of the reproductive organ (Plate 21.2) protease activity is low in SD, ND and LD plants as compared to that in the reproductive organ. It is high only in the leaf-R of the flower bud under SD.
Rate 21: Rate of protease activity in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARIETINUM Cv. CHAFA

RATE - PROTEASE

RO 1 LEAF (R) 2

SHOOT APEX 3 LEAF (S) 4

II III IV V VI VII II III IV V VI VII

☐ SD ☐ ND ☐ LD

PLATE - 21
condition. In SD plants it declines and remains at the same level unto the end of development. ND and LD plants show fluctuating trend.

**Shoot apex** (Plate 2C.3): Vegetative shoot apex has low protease activity under all photoperiods. In LD and ND plant, it increases in the flower bud followed by a slight fall in the anther and fertilized carpel. It again increases in the shoot apex during seed development. Under SD condition, protease activity increases and remains more or less at the same level during entire period of development.

The leaf-S corresponding to the vegetative shoot apex as well as flower bud (Plate 20.4) has low protease activity which is followed by a slight increase during the anther and fertilized carpel stages. It reaches its maximum level during seed development in LD and ND plants. In SD plants there is a gradual increase in protease activity of leaf-S corresponding to vegetative shoot apex onwards to the anther development stage after which it remains at the same high level up to seed development stages.

There is high protease activity in its main shoot apex of SD and LD plants (Plate 21.3) at the time of flower bud formation. It then declines during the anther development and fertilized carpel stages in both the photoperiods. Main shoot apex of SD plants have progressively lesser protease
activity up to the end. Protease activity of the shoot apex of LD plants increases again during seed development. In ND, it is high in the flower bud and seed stages. Protease activity is very low in ND plants during anther development and fertilized carpel stages.

The corresponding leaf-S of the shoot apex shows high protease activity in the flower bud under SD condition. It then declines gradually up to the end of life-cycle (Plate 21.4). In LD, rate of enzymic reaction is very little in the flower bud. It then increases in the anther/carpel and fertilized carpel stages and reaches a high level during seed development. Under ND condition protease activity of leaf-S is high during the flower bud stage compared with that found during anther development and fertilized carpel stages. It then increases during seed development.

**Protein:**

**Reproductive organ (Plate 22.1):** Protein content is maintained at more or less the same level during the vegetative shoot apex, flower bud, anther development and fertilized carpel stages under all the photoperiods. There is an increase in protein content during seed development (V to VII).

In the leaf-R corresponding to the vegetative shoot apex (Plate 22.2) protein is low under all the three
Plate 22: Protein in reproductive organ, terminal shoot apex and their corresponding leaves.
CICER ARIETINUM Cv. CHAFA

PROTEIN

120
80
40
0

I
II
III
IV
V
VI
VII

I
II
III
IV
V
VI
VII

LEAF (R)

RO

LEAF (S)

SHOOT APEX

PLATE - 22
photoperiods. LD plants show a fluctuating trend throughout the life cycle. In ND, protein content of leaf-R increases during flower bud stage and reaches a high level during anther development and fertilized carpel stages followed by a slight fall during seed development. Under SD condition, protein content is low in leaf-R during the vegetative shoot apex and flower bud stages. Protein content of leaf-R rises to a very high level during the anther development and fertilized carpel stages. It is followed by a very slight fall during seed development.

Biosynthesis of protein during reproductive differentiation in ND and LD plants is higher compared with that in the vegetative shoot apex (Plate 23.1). There is an increasing trend in values of protein content with advance in development.

Protein contents of leaf-R corresponding to different reproductive organs (Plate 23.2) are significantly higher than that of leaf of vegetative shoot apex.

Shoot apex (Plate 22.3): Protein content of vegetative shoot apex in SD, ND and LD plants is slightly more as compared with that in the flower bud. It increases during anther development stage in the shoot apices of SD and ND plants and remains at the same level in the fertilized carpel and seed development stages of ND plants. In SD there is a
Plate 23: Rate of protein biosynthesis in reproductive organ, terminal shoot apex and their corresponding leaves.
slight fall. There is not much fluctuation in LD plants.

In the leaf-S corresponding to the shoot apex (Plate 22.4) is more or less the same as that obtained in the shoot apex (Plate 22.3). Protein content is less in the leaf-S of vegetative shoot apex and flower bud stages under all the three photoperiods. It increases slightly during the reproductive organ and fertilized carpel stages in LD plants. Protein content of leaf-S shoots up during the anther development and fertilized carpel stages of SD and ND plants followed by a fall in the protein content during seed development.

Protein biosynthesis in shoot apex during development in LD and SD plants is lower than that in the vegetative shoot apex (Plate 23.3). In ND plants, however, it is higher than in the vegetative shoot apex.

In the corresponding leaf of the shoot apex (Plate 23.4) protein biosynthesis is more in ND and LD plants compared with that in leaf-S of the vegetative apex. It increases in the leaf-S corresponding to anther and fertilized carpel stages and reaches a very high level in LD plants during seed development.

Histones:
Reproductive organ (Plate 24.1): Histone content is more in the vegetative shoot apex under all the three photoperiods.
Plate 24: Histone in reproductive organ and terminal shoot apex and their corresponding leaves.
There is a decline in histone content unto anther stage in SD and ND plants and unto fertilized carpel in LD. There is an increase in later stages of development except in the case of LD.

The leaf-R corresponding to the reproductive organ (Plate 24.2) has more histone content in the flower bud of LD plants. It then declines in the reproductive organs and remains at the same level in the fertilized carpel and young seed, after which it decreases in the leaf-R corresponding to seed-II and mature seed. In SD and ND histone is high in the vegetative shoot apex as compared to the flower bud. It increases in the leaf during anther development stage and reaches a high level in fertilized carpel of both the photoperiods, followed by a slight fall in histone content of leaf-R during seed development.

Histone biosynthesis is very low during reproductive differentiation under all photoperiods compared with that in the vegetative shoot apex (Plate 25.1).

In the corresponding leaf of reproductive organ (Plate 25.2) under LD, the biosynthesis of histone is lesser at all stages of development except in the flower bud stage. In SD and ND plants there is an enhancement in histone content over that in the vegetative shoot apex.
Plate 25: Rate of histone biosynthesis in reproductive organ and terminal shoot apex and their corresponding leaves.
CICER ARIETINUM Cv. CHAFA

RO

LEAF (R)

LEAF (S)

SHOOT APEX

PLATE -25
except in the case of flower bud.

**Shoot apex (Plate 24.3)**: Histone content is high in the vegetative shoot apex and main apex at the time of flower bud formation under LD condition. It decreases and remains more or less at a same level during the anther development, fertilized carpel and seed development stages. Histone is at a higher level in the vegetative shoot apex as compared to the flower bud stage in SD and ND plants. It shoots up under both the photoperiods in the anther as well as fertilized carpel.

In the corresponding leaf of the shoot apex also (Plate 24.4) the trend of histone formation is very similar to that of the shoot apex under all the photoperiods.

Biosynthesis of histone is at a low level in the shoot apex during the entire period of differentiation (Plate 25.3). It is very low in the flower bud under SD and ND conditions.

Production of histone in the corresponding leaf of shoot apex is low throughout the life-cycle in LD (Plate 25.4). Under SD and ND, it is very low in flower bud but is high in the anther and fertilized carpel followed by a decrease in histone content in seed development stages in SD and ND plants.
Statistical Significance of Data:

The data presented of AA and its turnover, proteins, histones, RNA, DNA and enzymic activities like peroxidase, AA-FR-peroxidase, protease and RNase is analysed statistically by the method of analysis of variance and summarised data of degree of freedom, variance and F value is presented in tables 1 and 2 after testing its significance at 1% and 5% level.

ASG, AAU, peroxidase, protease, RNase, RNA, DNA, proteins and histones are highly significant at 1% level in correlation with different stages in the reproductive organs, and in case of AA and AA-FR-peroxidase at 5% level. The influence of photoperiod on the synthesis of metabolites and enzymic activities is significant at 1% in case of RNA, DNA, protein, histones, RNase, protease and peroxidase and in case of AA at 5% level. The interaction between photoperiod and stages is also significant at 1% in case of ASG, peroxidase, AA-FR-peroxidase, RNase, protease, RNA, DNA, protein and histones and in case of AA and AAU at 5% level (Table 1).

In leaves corresponding to reproductive organs statistical significance of stages is at 1% in case of AAU, peroxidase, AA-FR peroxidase, RNase, protease, RNA, DNA, protein and histones, while in case of AA, AA-MM-complex at 5% level. The significant effect of photoperiod at 1% is
### Table 1: Analysis of Variance

<table>
<thead>
<tr>
<th>Factors</th>
<th>DF</th>
<th>Variance</th>
<th>F Value</th>
<th>Variance</th>
<th>F Value</th>
<th>Variance</th>
<th>F Value</th>
<th>Variance</th>
<th>F Value</th>
<th>Variance</th>
<th>F Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage(S)</td>
<td>6</td>
<td>0.39</td>
<td>3.32</td>
<td>0.28</td>
<td>74.00</td>
<td>0.39</td>
<td>1.85</td>
<td>19.16</td>
<td>0.39</td>
<td>91.93</td>
<td>3.13</td>
</tr>
<tr>
<td>Photoperiod(P)</td>
<td>2</td>
<td>1.40</td>
<td>5.38</td>
<td>0.05</td>
<td>2.5</td>
<td>2.49</td>
<td>0.69</td>
<td>10.29</td>
<td>0.69</td>
<td>4233.27</td>
<td>17.29</td>
</tr>
<tr>
<td>Replicate</td>
<td>1</td>
<td>0.02</td>
<td>0.07</td>
<td>0.19</td>
<td>9.5</td>
<td>8.94</td>
<td>2.37</td>
<td>12.09</td>
<td>2.37</td>
<td>36.32</td>
<td>1.32</td>
</tr>
<tr>
<td>S x P</td>
<td>12</td>
<td>0.82</td>
<td>3.15</td>
<td>0.12</td>
<td>6.06</td>
<td>0.46</td>
<td>2.19</td>
<td>1137.57</td>
<td>0.46</td>
<td>29.52</td>
<td>10.07</td>
</tr>
<tr>
<td>Error</td>
<td>20</td>
<td>0.28</td>
<td>-</td>
<td>0.02</td>
<td>-</td>
<td>29.47</td>
<td>-</td>
<td>0.21</td>
<td>-</td>
<td>239.06</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Reproductive Organs**

<table>
<thead>
<tr>
<th></th>
<th>AAA</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage(S)</td>
<td>6</td>
<td>6.34</td>
<td>26.61</td>
<td>728.31</td>
<td>42.31</td>
<td>23.40</td>
<td>60.000</td>
<td>406.16</td>
<td>820.25</td>
<td>55.60</td>
<td>60%</td>
</tr>
<tr>
<td>Photoperiod(P)</td>
<td>2</td>
<td>6.02</td>
<td>23.08</td>
<td>131.92</td>
<td>7.66</td>
<td>2.29</td>
<td>6.61</td>
<td>318.2</td>
<td>513.2</td>
<td>6.13</td>
<td>191.98</td>
</tr>
<tr>
<td>Replicate</td>
<td>1</td>
<td>0.02</td>
<td>0.083</td>
<td>1.77</td>
<td>0.101</td>
<td>0.47</td>
<td>1.20</td>
<td>0.61</td>
<td>1.3</td>
<td>0.52</td>
<td>0.31</td>
</tr>
<tr>
<td>S x P</td>
<td>12</td>
<td>1.01</td>
<td>4.20</td>
<td>183.46</td>
<td>10.66</td>
<td>4.30</td>
<td>11.0x</td>
<td>193.17</td>
<td>253.11</td>
<td>88.76</td>
<td>9.36</td>
</tr>
<tr>
<td>Error</td>
<td>20</td>
<td>0.24</td>
<td>-</td>
<td>1.72</td>
<td>-</td>
<td>0.39</td>
<td>-</td>
<td>0.62</td>
<td>-</td>
<td>16.55</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Phase**

<table>
<thead>
<tr>
<th></th>
<th>AAA</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage(S)</td>
<td>6</td>
<td>6.34</td>
<td>26.61</td>
<td>728.31</td>
<td>42.31</td>
<td>23.40</td>
<td>60.000</td>
<td>406.16</td>
<td>820.25</td>
<td>55.60</td>
<td>60%</td>
</tr>
<tr>
<td>Photoperiod(P)</td>
<td>2</td>
<td>6.02</td>
<td>23.08</td>
<td>131.92</td>
<td>7.66</td>
<td>2.29</td>
<td>6.61</td>
<td>318.2</td>
<td>513.2</td>
<td>6.13</td>
<td>191.98</td>
</tr>
<tr>
<td>Replicate</td>
<td>1</td>
<td>0.02</td>
<td>0.083</td>
<td>1.77</td>
<td>0.101</td>
<td>0.47</td>
<td>1.20</td>
<td>0.61</td>
<td>1.3</td>
<td>0.52</td>
<td>0.31</td>
</tr>
<tr>
<td>S x P</td>
<td>12</td>
<td>1.01</td>
<td>4.20</td>
<td>183.46</td>
<td>10.66</td>
<td>4.30</td>
<td>11.0x</td>
<td>193.17</td>
<td>253.11</td>
<td>88.76</td>
<td>9.36</td>
</tr>
<tr>
<td>Error</td>
<td>20</td>
<td>0.24</td>
<td>-</td>
<td>1.72</td>
<td>-</td>
<td>0.39</td>
<td>-</td>
<td>0.62</td>
<td>-</td>
<td>16.55</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Leaves**

<table>
<thead>
<tr>
<th></th>
<th>AAA</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage(S)</td>
<td>6</td>
<td>6.34</td>
<td>26.61</td>
<td>728.31</td>
<td>42.31</td>
<td>23.40</td>
<td>60.000</td>
<td>406.16</td>
<td>820.25</td>
<td>55.60</td>
<td>60%</td>
</tr>
<tr>
<td>Photoperiod(P)</td>
<td>2</td>
<td>6.02</td>
<td>23.08</td>
<td>131.92</td>
<td>7.66</td>
<td>2.29</td>
<td>6.61</td>
<td>318.2</td>
<td>513.2</td>
<td>6.13</td>
<td>191.98</td>
</tr>
<tr>
<td>Replicate</td>
<td>1</td>
<td>0.02</td>
<td>0.083</td>
<td>1.77</td>
<td>0.101</td>
<td>0.47</td>
<td>1.20</td>
<td>0.61</td>
<td>1.3</td>
<td>0.52</td>
<td>0.31</td>
</tr>
<tr>
<td>S x P</td>
<td>12</td>
<td>1.01</td>
<td>4.20</td>
<td>183.46</td>
<td>10.66</td>
<td>4.30</td>
<td>11.0x</td>
<td>193.17</td>
<td>253.11</td>
<td>88.76</td>
<td>9.36</td>
</tr>
<tr>
<td>Error</td>
<td>20</td>
<td>0.24</td>
<td>-</td>
<td>1.72</td>
<td>-</td>
<td>0.39</td>
<td>-</td>
<td>0.62</td>
<td>-</td>
<td>16.55</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Factors
- **Stage(S)**: Significant at 1% level
- **Photoperiod(P)**: Significant at 5% level
- **Replicate**: Significant at 1% level
- **S x P**: Significant at 5% level
- **Error**: Not significant

**H * Significant at 1% level**
**xx Significant at 5% level**
### Cicer arietinum Cr. Chae

#### Analysis of Variance

**(Experiment 1)**

| Table - 2 |

<table>
<thead>
<tr>
<th>Factors</th>
<th>DF</th>
<th>Variance F Value</th>
<th>Variance F Value</th>
<th>Variance F Value</th>
<th>Variance F Value</th>
<th>Variance F Value</th>
<th>Variance F Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>AA</strong></td>
<td><strong>ABG</strong></td>
<td><strong>AA</strong></td>
<td><strong>ABG</strong></td>
<td><strong>KAB</strong></td>
<td><strong>Paraoxidase</strong></td>
</tr>
<tr>
<td>Stage(s)</td>
<td>6</td>
<td>1.26</td>
<td>25.26</td>
<td>0.36</td>
<td>3.00</td>
<td>74.36</td>
<td>4.69</td>
</tr>
<tr>
<td>Photoperiod(P)</td>
<td>2</td>
<td>1.50</td>
<td>30.25</td>
<td>0.61</td>
<td>5.06</td>
<td>10.60</td>
<td>0.85</td>
</tr>
<tr>
<td>Replicate</td>
<td>1</td>
<td>0.11</td>
<td>2.20</td>
<td>0.20</td>
<td>1.66</td>
<td>11.09</td>
<td>0.69</td>
</tr>
<tr>
<td>S x P</td>
<td>12</td>
<td>1.01</td>
<td>20.22</td>
<td>0.14</td>
<td>1.16</td>
<td>35.47</td>
<td>2.23</td>
</tr>
<tr>
<td>Error</td>
<td>20</td>
<td>0.05</td>
<td>0.12</td>
<td>-</td>
<td>-</td>
<td>15.05</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>126.12</td>
<td>-</td>
</tr>
</tbody>
</table>

| Stage(s) | 6 | 1.89 | 1.40 | 58.78 | 0.93 | 12.73 | 11.06 | 320.16 | 144.36 | 348.20 | 10.65 | 1271.41 | 13.15 |
| Photoperiod(P) | 2 | 3.29 | 2.43 | 60.61 | 6.82 | 25.42 | 5.74 | 2.73 | 1.21 | 420.97 | 14.76 | 456.23 | 158.47 |
| Replicate | 1 | 0.60 | 0.62 | 95.32 | 0.58 | 9.57 | 4.84 | 19.30 | 8.57 | 213.61 | 7.98 | 92.68 | 3.23 |
| S x P | 12 | 0.20 | 0.14 | 211.44 | 2.25 | 2.25 | 2.24 | 63.72 | 25.31 | 103.16 | 3.55 | 777.75 | 27.20 |
| Error | 20 | 1.35 | - | 93.81 | - | 1.15 | - | 2.25 | - | 25.01 | - | 25.40 | - |
| Total | 41 | - | - | - | - | - | - | - | - | - | - | - |

| Stage(s) | 6 | 2.66 | 10.23 | 0.10 | 5.00 | 90.85 | 2.47 | 0.41 | 117.34 | 305.21 | 10.07 | 92.36 | 13.45 |
| Photoperiod(P) | 2 | 0.85 | 0.39 | 0.05 | 0.50 | 279.13 | 7.99 | 0.09 | 25.71 | 3945.27 | 10.78 | 3.66 | 0.33 |
| Replicate | 1 | 0.11 | 0.42 | 0.09 | 4.5 | 90.43 | 2.62 | 0.00 | 0.00 | 213.08 | 6.84 | 0.15 | 0.002 |
| S x P | 12 | 0.01 | 3.11 | 0.21 | 1.5 | 40.17 | 0.49 | 0.00 | 0.49 | 151.16 | 4.25 | 34.79 | 3.46 |
| Error | 20 | 0.26 | - | 0.02 | - | 36.77 | - | 0.0035 | - | 361.82 | - | 6.86 | - |
| Total | 41 | - | - | - | - | - | - | - | - | - | - | - |

| Stage(s) | 6 | 3.97 | 372.92 | 0.27 | 3.31 | 12.17 | 7.19 | 11.51 | 13.34 | 407.19 | 30.19 | 112.54 | 31.42 | 2320.53 | 215.03 |
| Photoperiod(P) | 2 | 3.55 | 397.56 | 20.80 | 5.67 | 30.17 | 6.59 | 6.96 | 6.96 | 363.67 | 40.34 | 587.62 | 45.72 |
| Replicate | 1 | 0.01 | 2.50 | 4.38 | 3.33 | 0.68 | 0.55 | 7.60 | 7.16 | 37.83 | 4.04 | 7.88 | 0.756 |
| S x P | 12 | 0.44 | 100.00 | 149.71 | 11.02 | 7.06 | 8.08 | 53.26 | 50.24 | 169.66 | 17.94 | 143.02 | 126.16 |
| Error | 20 | 0.24 | - | 1.28 | - | 0.46 | - | 0.50 | - | 8.52 | - | 10.11 | - |
| Total | 41 | - | - | - | - | - | - | - | - | - | - | - |

- *x* = Significant at 1% level
- **xx** = Significant at 5% level
on enzymic activities of peroxidase, RNase, protease and synthesis of AAU, NAB, RNA, DNA, protein, histones, and at 5% in AA. Interaction between stages and photoperiod is significant at 1% for AAU, NAB, peroxidase, RNase, protease, RNA, DNA and histones whereas in case of AA, ASG and protein it is significant at 5% level (Table 1).

Enzymic activities and synthesis of metabolites as mentioned earlier are also analysed statistically for shoot apex and corresponding leaves. In the shoot apex, stages are significant at 1% level in ascorbic acid turnover except ASG, histones, peroxidase, AA-FR-peroxidase, RNA, DNA, protease and ASG shows significance at 5% level. Significance of photoperiod in case of AA, peroxidase, RNA, DNA, protein and histones is at 1% level and in case of ASG at 5% level. Interaction between stages and photoperiod is significant at 1% in case of AA, DNA, protein, histones and protease (Table 2).

In leaves corresponding to shoot apex, significant effect of advancement of stages is seen at 1% level on the content of AA, ASG, AA-MM-complex, peroxidase, AA-FR-peroxidase, RNase, RNA, DNA, protease, protein and histones. While in the case of photoperiod it is significant in AAU, NAB, RNA, DNA, protein and histones, and on enzymes like peroxidase, RNase at 1% level; whereas only protease show
significance at 5% level. Interaction between stages and photoperiod is significant at 1% level for AA-MM-complex, peroxidase, AA-FR-peroxidase, RNase, protease and in metabolites like RNA, DNA, protein and histones and at 5% level for AA and its utilization (Table 2).

**Experiment - II:** Effect of different photoperiods on growth characters like: height, leaf number, branch number and branch leaf number, fresh and dry weight of root, stem, leaf and whole plant as well as growth period and ripening period.

**Height:** The height of the plant increases as the growth advances. As regards the height of the plants under different photoperiods the height initially during 19 days of growth is more in LD than that in ND. After 19 days of growth the increment in height in LD is greater than in SD and ND, and it continuously increases up to 47 days of growth in all the three photoperiods. After 54 days of growth the height comes to almost similar in all the three photoperiodic conditions (SD, ND and LD) (Plate 26.1).

**Leaf number:** During the first 19 days of growth the leaf number is nearly the same under all the three photoperiods. Generally the rate of leaf formation is equally fast under all the three conditions. After 40 days of growth there is marked increase in the leaf number under LD and SD is more
Plate 26: Growth characters.
Cicer Arietinum Cv. CHAFA

GROWTH PERIOD-DAYS

X X SD  O O ND  △ △ LD

PLATE - 26
than that in ND. After 54 days of growth number of leaves is significantly greater in SD plants followed by ND and LD. (Plate 26.2).

**Branch number:** Initiation of branch is noticed at the same time in all the three photoperiods i.e. SD, ND and LD. But there are less number of branches in LD than SD and ND. The rate of branch formation is highest under SD after 40 days of growth period. Under ND, branch formation is fast after 40 days. But in later period its rate of growth is slower than in SD. While in LD, the rate of branch formation after 40 days of growth period shows more or less negligible increase (Plate 26.3).

**Branch leaf number:** In this case visible formation of leaves is at the same time under all photoperiodic treatments. But number of the branch leaf is less in LD than SD and ND plants. The trend of branch leaf formation shows the same pattern as in the branch formation under all the three photoperiods (Plate 26.4).

**Dry weight of root:** The dry weight of root increases as growth advances. ND plants show higher dry weight of root than LD and SD plants throughout the life-cycle. Upto 34 days of growth period, LD plant shows more dry weight than ND and SD plants. After 62 days of growth period, dry weight of root is less in LD than ND and SD. In LD, after 48 days of
Plate 27: Dry weight of root, stem, cotyledon, leaf, branch and branch leaf.
growth; dry weight of root is less and remain more or less at a same level (Plate 27.1).

**Dry weight of main stem:** Dry weight of main stem also increases as growth advances. During first 13 days of growth period the dry weight is more in SD than ND and LD. LD plants show more dry weight than dry weight of SD and ND plants after 27 days of growth period (Plate 27.2).

**Cotyledon dry weight:** Initially during 13 days of growth period dry weight of cotyledon is more in ND and LD, than SD. In all the three conditions, dry weight of cotyledon decreases as growth period increases (Plate 27.3).

**Dry weight of main leaves:** LD plants show maximum leaf dry weight followed by SD and LD plants. The dry weight of leaves under three photoperiods is nearly the same in the beginning. Later on LD plants show more of dry matter followed by SD and ND upto 41 days of growth and then LD shows maximum value (Plate 27.4).

**Dry weight of branch:** The dry weight of branch is more in SD followed by ND and LD. Upto 27 days of growth dry weight is nearly equal in all the three photoperiods. After 62 days of growth, dry matter is more in ND followed by SD and LD. After 69 days of growth, dry matter is more in SD followed by ND and LD (Plate 27.5).
Plate 28: Dry weight of fruit, whole plant, total stem, and total leaves.
Dry weight of branch leaf number: Dry weight is more in SD and LD than ND after 34 days of growth, but after 41 days of growth dry matter is more in ND than SD and LD. After 62 days of growth, dry matter increases rapidly in ND than SD and LD. But finally up to 76 days of growth period the dry matter is more in ND followed by SD and LD (Plate 27.6).

Dry weight of fruit: Dry weight of fruit is highest in LD than ND and SD. Fruit dry weight is more in ND than SD up to 69 days of growth. Dry weight increases in ND than SD after 69 days of growth period (Plate 28.1).

Dry weight of whole plant: The dry weight of whole plant increases as growth advances under all the three photoperiods. Dry matter is more in LD than SD and ND throughout the life cycle. Initially dry weight is nearly the same under all conditions. After 27 days of growth the dry matter increases more in LD than SD and ND. Regarding SD and ND photoperiods, dry matter show fluctuation (Plate 28.2).

Dry weight of total stem: Dry weight of total stem is more in LD than ND and SD up to 48 days of growth. After 62 days of growth dry matter increases in SD followed by ND and LD (Plate 28.3).
Dry weight of total leaves: Dry matter of leaves is more in LD than SD and ND throughout the life-cycle. Initially during 13 days of growth dry matter is nearly same in all the three conditions. Upto 27 days of growth, dry weight of total leaves is more in LD followed by ND and SD. After 62 days of growth, the dry matter is more in ND than SD but at the end of life cycle dry matter slight increases in SD than ND (Plate 29.4).

Relative Growth Rate of -

Root: The relative growth rate is highest in ND followed by LD and SD upto 27 days of growth. After 34 days of growth relative growth rate for LD plants shows a declining trend whereas SD and ND plants shows a fluctuating trend throughout the life-cycle (Plate 29.1).

Stem: Initially RGR is low in SD than ND and LD upto 27 days of growth. After 34 days of growth, LD plant shows decreasing trend for relative growth rate, ND plants show fluctuating trend. RGR for SD after 43 days of growth increases upto 76 days of growth (Plate 29.2).

Leaf: The relative growth rate is highest in LD followed by ND and SD upto 20 days of growth. In LD, RGR declines upto 34 days of growth. It again increases after 34 days of growth and then declines continuously. SD plant shows a decreasing trend for RGR upto 34 days of growth. After 34 days of
Plate 29: Relative growth rate (RGR) of root, stem, leaf and whole plant, leaf weight ratio (LWR) and Net assimilation rate (NAR).
After 34 days of growth relative growth rate is maximum. Later RGR is fluctuating. ND plant shows fluctuating trend (Plate 29.3).

**Whole plant:** The relative growth rate for LD plants is initially less, it increases upto 27 days of growth. After 27 days relative growth rate more or less decreases. In LD, RGR is highest at 27 days of growth whereas in ND it is highest at 62 days. SD and ND plants show fluctuation very much (Plate 29.4).

**Net Assimilation Rate (NAR):** Net assimilation rate is less initially during 20 days of growth. NAR increases to a very high level upto 27 days of growth. After 34 days of growth net assimilation rate is fluctuating whereas ND plant shows fluctuation upto 34 days and later declines down after 34 days of growth. SD plant shows a fluctuating trend (Plate 29.5).

**Leaf weight ratio:** Initially leaf weight ratio is high in SD than LD and ND. In LD after 20 days of growth LWR increases more or less and reaches a high level during 48 to 63 days of growth. Leaf weight ratio declines after 62 days. SD plant shows a fluctuating trend throughout the life-cycle. Leaf weight ratio increases from 48 days onwards upto 69 days of growth (Plate 29.6).
**Percentage flowering of plants:** The rate of flowering is always faster in long day plants as compared with normal day and short day plants. In LD plants 100% flowering was observed only after 39 days of growth whereas in SD and ND plants 10% and 5% flowering was observed after 39 days. Later the rate of flowering is faster in ND than SD. 100% flowering was observed after 47 days of growth in ND plants and after 49 days of growth in SD plants (Plate 30.1).

**Number of fruits per plant:** The fruits were seen after 39 days in long day condition and after 44 days in normal day and short day conditions. Fruit number increases as the development proceeds. However, a larger number of fruits are produced under long day photoperiod as compared to that in short and normal day. But practically there is no increase in fruit number per plant after 49 days under LD condition while in short and normal day, fruit production is not more after 53 days of growth (Table 4).

**Harvest data:** The harvest data for *różera lorentina* Cv. Chafa is presented in plate 30.2.

**Height of the plant:** The final height in SD plant is more than that in ND and LD.

**Dry weight of whole plant:** Under SD is twice compared with that in LD plant. In normal day plant also it is appreciably higher than in LD (Plate 30.2).
Plate 30: Flowering % and Harvest data.
CICER ARIETINUM Cv. CHAFA

FLOWERING %

FLOWERING

GROWTH PERIOD - DAYS

HEIGHT - CM.

PLANT WEIGHT (g)

ROOT WEIGHT (g)

STEM WEIGHT (g)

FRUIT WEIGHT (g)

FRUIT NUMBER

GRAIN WEIGHT (g)

GRAIN NUMBER

1000 KERNEL WEIGHT

SD

ND

LD

PLATE - 30
CICER AHLETINUM Cv. CHAFA

FLOWERING DATA

TABLE 4

<table>
<thead>
<tr>
<th>GROWTH PERIOD</th>
<th>Flowering %</th>
<th>Fruits/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAYS</td>
<td>SD</td>
<td>ND</td>
</tr>
<tr>
<td>30</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>31</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>32</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>33</td>
<td>1.9</td>
<td>2.2</td>
</tr>
<tr>
<td>34</td>
<td>2.2</td>
<td>2.4</td>
</tr>
<tr>
<td>35</td>
<td>2.3</td>
<td>2.5</td>
</tr>
<tr>
<td>36</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>37</td>
<td>2.7</td>
<td>2.8</td>
</tr>
<tr>
<td>38</td>
<td>2.8</td>
<td>3.6</td>
</tr>
<tr>
<td>39</td>
<td>3.1</td>
<td>4.0</td>
</tr>
<tr>
<td>40</td>
<td>3.5</td>
<td>4.0</td>
</tr>
<tr>
<td>41</td>
<td>3.4</td>
<td>3.8</td>
</tr>
<tr>
<td>42</td>
<td>3.3</td>
<td>3.6</td>
</tr>
<tr>
<td>43</td>
<td>3.2</td>
<td>3.5</td>
</tr>
<tr>
<td>44</td>
<td>3.1</td>
<td>3.5</td>
</tr>
<tr>
<td>45</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td>46</td>
<td>2.4</td>
<td>2.5</td>
</tr>
<tr>
<td>47</td>
<td>2.3</td>
<td>2.2</td>
</tr>
<tr>
<td>49</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>53</td>
<td>1.9</td>
<td>1.8</td>
</tr>
<tr>
<td>54</td>
<td>1.7</td>
<td>2.0</td>
</tr>
<tr>
<td>57</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Dry weight of root: Dry weight of root is more in ND followed by LD and SD.

Dry weight of stem: is also twice in short day plant and appreciably higher in normal day plant than it is in long day plant (Plate 30.2).

Number of fruits: The number of fruits are more in short day and normal day followed by long day. The fruit number is doubled in ND and SD than LD (Plate 30.2).

Dry weight of fruits: As the number of fruits are more in SD and ND, the same is true with their dry weight. So the fruit dry weight is more in SD and ND compared with that in LD (Plate 30.2).

Total number of grains: are higher in short days and normal days as compared to long days. Grain number is more in short day than normal day (Plate 30.2).

Total grain weight: Plants show the same trend as that in total grain number (Plate 30.2).

1000 kernel weight: The 1000 kernel weight is much higher in LD than ND and SD (Plate 30.2).
**Cicer arietinum** Cv. *Chafa*

Analysis of Variance

(Experiment-II)

**Table - 3**

<table>
<thead>
<tr>
<th>Factors</th>
<th>DF</th>
<th>Variance</th>
<th>F value</th>
<th>Variance</th>
<th>F value</th>
<th>Variance</th>
<th>F value</th>
<th>Variance</th>
<th>F value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period</td>
<td>9</td>
<td>1649.02</td>
<td>224836x</td>
<td>1173.98</td>
<td>219.84x</td>
<td>587.48</td>
<td>62.63x</td>
<td>5594.95</td>
<td>125.72x</td>
</tr>
<tr>
<td>Photoperiod</td>
<td>2</td>
<td>246.86</td>
<td>41470x</td>
<td>14.99</td>
<td>2.80</td>
<td>397.54</td>
<td>42.38x</td>
<td>7993.06</td>
<td>179.61x</td>
</tr>
<tr>
<td>Replicate</td>
<td>9</td>
<td>4.28</td>
<td>7.13</td>
<td>6.79</td>
<td>1.27</td>
<td>3.50</td>
<td>0.373</td>
<td>23.18</td>
<td>0.5208</td>
</tr>
<tr>
<td>Periodx</td>
<td>18</td>
<td>31.53</td>
<td>5255x</td>
<td>13.07</td>
<td>2.44x</td>
<td>72.10</td>
<td>7.68x</td>
<td>867.19</td>
<td>19.48x</td>
</tr>
<tr>
<td>Photoperiod</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9.38</td>
<td>-</td>
<td>44.50</td>
</tr>
<tr>
<td>Error</td>
<td>261</td>
<td>0.60</td>
<td>-</td>
<td>5.34</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>299</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

| **Leaf number** | | | | | | | | | |
| Period | 9 | 1649.02 | 224836x | 1173.98 | 219.84x | 587.48 | 62.63x | 5594.95 | 125.72x |
| Photoperiod | 2 | 246.86 | 41470x | 14.99 | 2.80 | 397.54 | 42.38x | 7993.06 | 179.61x |
| Replicate | 9 | 4.28 | 7.13 | 6.79 | 1.27 | 3.50 | 0.373 | 23.18 | 0.5208 |
| Periodx | 18 | 31.53 | 5255x | 13.07 | 2.44x | 72.10 | 7.68x | 867.19 | 19.48x |
| Photoperiod | - | - | - | - | - | - | 9.38 | - | 44.50 |
| Error | 261 | 0.60 | - | 5.34 | - | - | - | - | - |
| Total | 299 | - | - | - | - | - | - | - | - |

| **Branch** | | | | | | | | | |
| Period | 9 | 1649.02 | 224836x | 1173.98 | 219.84x | 587.48 | 62.63x | 5594.95 | 125.72x |
| Photoperiod | 2 | 246.86 | 41470x | 14.99 | 2.80 | 397.54 | 42.38x | 7993.06 | 179.61x |
| Replicate | 9 | 4.28 | 7.13 | 6.79 | 1.27 | 3.50 | 0.373 | 23.18 | 0.5208 |
| Periodx | 18 | 31.53 | 5255x | 13.07 | 2.44x | 72.10 | 7.68x | 867.19 | 19.48x |
| Photoperiod | - | - | - | - | - | - | 9.38 | - | 44.50 |
| Error | 261 | 0.60 | - | 5.34 | - | - | - | - | - |
| Total | 299 | - | - | - | - | - | - | - | - |

| **Branch leaf no.** | | | | | | | | | |
| Period | 9 | 1649.02 | 224836x | 1173.98 | 219.84x | 587.48 | 62.63x | 5594.95 | 125.72x |
| Photoperiod | 2 | 246.86 | 41470x | 14.99 | 2.80 | 397.54 | 42.38x | 7993.06 | 179.61x |
| Replicate | 9 | 4.28 | 7.13 | 6.79 | 1.27 | 3.50 | 0.373 | 23.18 | 0.5208 |
| Periodx | 18 | 31.53 | 5255x | 13.07 | 2.44x | 72.10 | 7.68x | 867.19 | 19.48x |
| Photoperiod | - | - | - | - | - | - | 9.38 | - | 44.50 |
| Error | 261 | 0.60 | - | 5.34 | - | - | - | - | - |
| Total | 299 | - | - | - | - | - | - | - | - |

**GROWTH DATA** (SD ND LD)

**DRY WEIGHTS** (SD ND LD)

x = Significant at 1 % level

xx = Significant at 5 % level
Statistical significance of data: The observations presented in this experiment have been analysed by the method of analysis of variance for growth characters such as height, leaf and branch number as well as for dry weight of root, stem and leaf. The summarised data for degree of freedom, variance and F value are presented in table 3. The significance of data has been tested at 1% and 5% level.

As from the data height of the main stem, leaf number, branch, branch leaf number and dry matter production in root, stem, leaf and whole plant show continuous increase with the advance in growth in all the treatments. The same is confirmed by statistical analysis. The photoperiodic treatment gives considerable difference showing the significance at 1% level. Interactions between period and photoperiod treatment is also significant at 1% level. Even photoperiodic treatment also gives significant values at 1% level for height and number of branches and branch leaves.